



Technology Transfer and Commercialization Partnerships

TECHNOLOGY TRANSFER AND COMMERCIALIZATION PARTNERSHIPS

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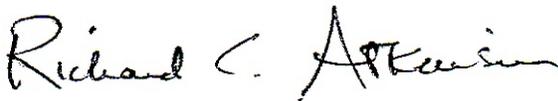
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FOREWORD

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

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We want to particularly acknowledge Louis Tornatzky, Professor and Chair, Industrial Technology at California Polytechnic State University and author of *Innovation U: New University Roles in a Knowledge Economy* for his helpful suggestions. We are most grateful to the numerous individuals from universities and local/state organizations who shared their valuable time and knowledge. Some academic leaders provided not only valuable input on their individual universities but also their knowledge and views on research, innovation and technology transfer, some of which were incorporated into our discussions and recommendations. These individuals included Luis Proenza, President of the University of Akron and a member of the (U.S.) President's Council of Advisors on Science and Technology, and John Brighton, Vice President for Research and Economic Development, Iowa State University, who until recently served as Assistant Director for Engineering at the NSF. We also thank John Fraser, Assistant Vice President for Research and Economic Development and Executive Director, Office of Intellectual Property Development and Commercialization, Florida State University and 2006 President, Association for University Technology Managers for his insight regarding several technology transfer issues. In addition, Chris Busch's insight on issues affecting academic institutions and corporate partners is always much appreciated. We extend a special thanks to Dan Loague, Executive Director, Capital Formation Institute for his assistance in processing data. Other individuals from academic institutions, too many to name here, appear in Appendix C.

EXECUTIVE SUMMARY

Technology transfer and commercialization activities in universities are skyrocketing. In 10 years, academic institutions have nearly doubled the number of licenses executed annually and more than doubled the number of startups launched.¹ The 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 locations 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, ranked 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 were 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 was 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.

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

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 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 linkage 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 spinoffs 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.

Other factors that appeared to contribute to successful technology transfer included (a) excellent technology transfer personnel who most often had industrial or entrepreneurial experience, (b) sufficient resources to support technology transfer personnel, (c) high standards and performance goals, and (d) hiring and promotion practices that rewarded technology transfer and external relations. In addition, most successful operations provided strong financial incentives that personally rewarded innovators or supported their research.

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.

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

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.
- 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 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

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.

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.

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 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 the combined 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.

ABBREVIATIONS

AIC	Akron Innovation Campus
AIPLA	Association of Intellectual Patent Law Attorneys
ARCH	Akron Regional Exchange Angels
ATE	Advanced Technological Education (NSF)
ATP	Advanced Technology Program, National Institutes for Standards & Technology
ATR	Alfred Technology Resources
AU	Alfred University
AUTM	Association of University Technology Managers®
BYU	Brigham Young University
CACT	Center for Advanced Ceramics Technology (AU)
CAT	Centers for Advanced Technology (New York)
CATS	Center for Automation Technologies and Systems (RPI)
CCIC	Ceramics Corridor Innovations Center
CCUR	Center for Crops Utilization Research (ISU)
CED	Council for Entrepreneurial Development (North Carolina)
CEG	Center for Economic Growth (Troy, New York)
CII	Center for Industrial Innovation (RPI)
CIRAS	Center for Industrial Research and Service (ISU)
CRADA	Cooperative Research and Development Agreement
CWO	Creative Works Office (BYU)
DOE	U.S. Department of Energy
DOD	U.S. Department of Defense
EPSCoR	Experimental Program to Stimulate Competitive Research (NSF)
ERC	Engineering Research Center, National Science Foundation
FAMU	Florida Agricultural and Mechanical University
FFRDC	Federally funded research and development center
FSU	Florida State University
IDF	Innovations Development Facility (ISU)
IP	Intellectual property
IPRT	Institute for Physical Research and Technology (ISU)
ISIS	Iowa State Innovation Systems (ISU)
ISU	Iowa State University
ISURF	Iowa State University Research Fund
I/UCRC	Industry/University Cooperative Research Center (NSF)
JPL	Jet Propulsion Laboratory (NASA)
LES	Licensing Executives Society
MEP	Manufacturing Extension Partnership (NIST, U.S. Department of Commerce)
MMEC	Montana Manufacturing Extension Center
MSU	Montana State University
NACCE	National Association for Community College Entrepreneurship
NASA	National Aeronautics and Space Administration
NCTT	National Center for Telecommunications Technologies
NIST	National Institute of Standards & Technology, U.S. Department of Commerce

NMTA	National Machine Tool Association
NSEC	Nanoscale Science and Engineering Center (RPI)
NSF	National Science Foundation
NYSTAR	New York Office of Science, Technology and Academic Research
OIPDC	Office of Intellectual Property Development and Commercialization (FSU)
OIPTT	Office of Intellectual Property and Technology Transfer (ISU)
OTC	Office of Technology Commercialization (RPI)
OTT	Office of Technology Transfer (UA)
PFI	Partnerships for Innovation (NSF)
PSI	Plant Sciences Institute (ISU)
PVLSI	Pioneer Valley Life Sciences Institute
PVTIDE	Pioneer Valley Technology Innovation Development Exchange
R&D	Research and development
RenTEC	Rensselaer Technological Entrepreneurial Council
RPI	Rensselaer Polytechnic Institute
RTTC	Regional Technology Transfer Center (NASA)
SBI	Springfield Business Incubator
SBIR	Small Business Innovation Research
SCTE	Severino Center for Technological Entrepreneurship (RPI)
SEC	Springfield Enterprise Center
STBIC	Seminole Technology Business Incubation Center (UCF)
STCC	Springfield Technical Community College
STCCAC	Springfield Technical Community College Assistance Corporation
STTR	Small Business Technology Transfer
S&E	Science and engineering
S&T	Science and technology
SUNY	State University of New York
TCAP	Technology Commercialization Acceleration Program (ISU)
TTLC	Office of Technology Transfer, Licensing and Commercialization (FAMU)
TTO	Technology transfer office
UA	University of Akron
UARF	University of Akron Research Foundation
UCF	University of Central Florida
UIV	University Innovation Ventures (UA)
UNC	University of North Carolina
WIC	Watervliet Innovation Center (Troy, New York)
YES	Young Entrepreneurial Scholars (STCC)

**PART I: FINDINGS, CONCLUSIONS
AND RECOMMENDATIONS**

TECHNOLOGY TRANSFER AND COMMERCIALIZATION PARTNERSHIPS

INTRODUCTION

Technology transfer and commercialization have become increasingly important as a means of advancing and disseminating academic-based innovations to the private sector and to the general public. Some academic-based innovations have changed the way in which the world operates and have contributed to the health and well-being of its global citizens. Advances in health care, agriculture, engineering, chemistry, and other fields have contributed to the Internet, the fight against cancer, and development of alternative fuels. Universities such as the Massachusetts Institute of Technology (MIT), Stanford University, and the California Institute of Technology each year execute about 100 licenses and launch 20 to 25 enterprises based on their innovations. Much of the current research has focused on these technology transfer “stars.” But there are other, less-known academic institutions that are successfully developing and transferring innovations, and contributing to the economic development of their regions and beyond. Despite their geographic locations and relatively modest research and development (R&D) 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 based on their research. These emerging institutions have partnered with corporations, entrepreneurs, venture capitalists, and business and public organizations to achieve impressive technology transfer outcomes.

In 2005 *Accelerating Economic Development through University Technology* reported on nine universities that successfully transferred and commercialized technologies.⁹ These universities were Carnegie Mellon University, Georgia Institute of Technology, Massachusetts Institute of Technology, Purdue University, Stanford University, University of California, San Diego, University of Pennsylvania, University of Wisconsin-Madison, and Washington University. All of the universities except one were in the top 50 nationally for R&D expenditures. A previous study – *Innovation U: New University Roles in a Knowledge Economy* – examined the roles of 12 research universities in innovation.¹⁰ Through funding from the National Science Foundation (NSF), Innovation Associates (IA) sought to identify other successful academic institutions that did not have the advantages of high R&D funding or a location characterized by technology enterprises, but nevertheless successfully transferred and commercialized university-based innovations. IA targeted successful academic institutions with modest research funding and greater technology transfer obstacles in order to provide examples and recommendations for the great majority of universities and colleges that are not the “Stanfords” and the “MITs,” and for the private and public sector leaders that have the hope of developing technology-based regions without the benefits of Silicon Valley or Route 128.

⁹ Diane Palminteri, *Accelerating Economic Development through University Technology Transfer*, Innovation Associates Inc., 2005. (Available at www.InnovationAssociates.us)

¹⁰ Louis Tornatzky, Paul Waugaman, and Denis Gray, *Innovation U: New University Roles in a Knowledge Economy*, Southern Growth Policies Board, 2002. (Available at www.Southern.org)

This report focuses mainly on technology transfer and commercialization of university innovations as a type of partnership activity aimed at disseminating research innovations and knowledge. It also addresses entrepreneurial development and to a lesser extent, university-industry R&D collaboration, as they apply to technology transfer and commercialization and the promotion of university innovations. We address these areas from an academic institution perspective, and more research needs to be conducted to adequately capture the corporate perspective regarding technology transfer, commercialization and entrepreneurship.

This work was supported under a grant from the NSF's Partnerships for Innovation (PFI) program. PFI was created in 2000 as part of an effort to build a new innovation infrastructure in communities through partnerships among colleges and universities, state and local governments, the private sector and relevant organizations. The partnerships are intended to catalyze innovation by creating and disseminating new knowledge, enhancing a scientific and technological workforce and promoting an infrastructure that fosters innovation. This includes partnerships that develop and disseminate knowledge, strengthen a scientific and technological workforce, and promote innovation.¹¹

Methodology

IA/National Advisory Committee identified 10 U.S. academic institutions that showed exemplary practices in technology transfer and commercialization despite potential obstacles such as modest research funding, rural locations or traditional industry settings. The exemplars also usually exhibited other related exemplary partnership practices involving university-industry collaborative research, entrepreneurial development, and linkages with external organizations.

In order to select exemplars, IA developed selection criteria, assessed data on potential exemplars, and organized and solicited input from a National Advisory Committee. The Committee was composed of 16 national leaders in innovation, technology transfer, academia, and economic development. The Committee provided suggestions on exemplary academic institutions, input and feedback on preliminary selections, and review of the final report. Members of the Committee appear in Appendix A. IA also solicited suggestions and advice from additional experts from numerous organizations, and those organizations are listed in Appendix B.

The case sample was drawn from "candidate lists" consisting of the mid- to low-range of research-performing colleges and universities that ranked at or below 50 on NSF rankings of university and college research expenditures.¹² In addition, IA/National Advisory Committee

¹¹ For more information on PFI see http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5261&from=fund.

¹² FY 2003 data was the latest available at the time of exemplar selection. Source: Table 26. R&D expenditures at universities and colleges, ranked by FY 2003 R&D expenditures: FY 1996–2003. National Science Foundation/Division of Science Resources Statistics, *Academic Research and Development Expenditures: Fiscal Year 2003*. Arlington, VA (NSF 05-320), August 2005.

sought at least one minority institution and one community college. Selected exemplars were expected to meet the following criteria:

- Demonstrate exemplary partnerships with industries, other universities/colleges, technology organizations, industry associations, local/state government, and others leading to successful technology transfer and commercialization or dissemination of knowledge regarding innovations originating at universities/colleges.
- Rank in the top quartile, relative to research expenditures, in at least one major technology transfer category: (a) new patents filed, (b) patents issued, (c) licenses and options executed, (d) active licenses yielding income, and (e) startups launched.¹³
- Receive recommendations from at least two National Advisory Committee members and additional national experts.

In addition to the criteria, IA sought some distribution with respect to (a) geographic location, (b) size of institution, and (c) science and engineering concentration.

Exemplars

The academic institutions chosen for this report span a broad spectrum – from Alfred University, a small university of a couple thousand students that focuses on a niche research area to Iowa State University, a large rural, land-grant institution with numerous outstanding research programs. Many of the exemplars showed strong technology transfer capabilities (relative to research expenditures) either in executing licenses or launching startups. Although researchers examined patent activity, we viewed patent activity as an intermediate outcome and not necessarily indicative of successful external partnering and technology transfer activity. Other exemplars showed strong research or other collaborative relations with industry and/or strong entrepreneurial activities related to technology transfer. The universities and colleges selected were (in alphabetical order)

- Alfred University (AU)
- Brigham Young University (BYU)
- Florida Agricultural and Mechanical University (FAMU)
- Iowa State University (ISU)
- Montana State University (MSU)
- Rensselaer Polytechnic Institute (RPI)
- Springfield Technical Community College (STCC)
- University of Akron (UA)

¹³ IA calculated national rankings of universities based on the total number in each category (such as U.S. patent applications filed) for FY 2003 per \$ thousand R&D expenditures in FY 2003. The total number in each category represents self-reported responses to the FY 2003 AUTM Licensing Survey,TM Association of University Technology Managers.[®] R&D expenditures were based on NSF university R&D expenditure data for FY 2003; Source: Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005, NSF. FY 2003 data were the latest available at the time of exemplar selection. For more on the AUTM Licensing SurveyTM see www.autm.net; for more on NSF statistical data on universities and colleges see <http://www.nsf.gov/statistics/nsf06323/tableshtm#rd2>.

- University of Central Florida (UCF)
- University of North Carolina at Charlotte (UNC Charlotte)

Table 1 shows the exemplars by technology transfer outcomes, relative to research expenditures. Readers should be aware that Table 1 provides a one-year “snap shot” that sometimes under represents exemplars’ activities over several years. In addition, technology transfer outcomes were only one criterion for selection and may not necessarily reflect the full impact of exemplars’ activities.

Table 1
University Exemplars
by Technology Transfer Data & R&D Expenditures (FY 2005)

University	R&D Expnd. ^a	Patent Apps. ^b		Patents Issued ^c		Licenses & Options Executed ^d		Licenses Yielding Income ^e		Startups ^f	
	\$ in Thous.	Rank	No.	Rank	No.	Rank	No.	Rank	No.	Rank	No.
Alfred U.	8,239	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Brigham Young U.	24,334	1	64	49	2	2	18	1	115	1	4
Florida A&M U.	26,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iowa State U.	238,838	72	47	73	15	1	218	2	745	40	5
Montana State U.	98,475	52	24	138	1	10	27	15	108	71	1
Rensselaer Poly. I.	62,161	4	73	5	21	17	14	46	40	17	2
U. of Central FL	121,699	15	80	9	29	123	6	135	17	48	2
UNC Charlotte	25,113	2	56	1	12	57	3	13	28	3	3
U. of Akron	51,345	7	42	10	12	45	7	47	33	6	4

Source: AUTM Licensing Survey™: FY 2005, The Association of University Technology Managers,® 2007, and Innovation Associates, Inc.

Notes: (a) R&D expenditure data were derived from AUTM Licensing Survey™: FY 2005 except for data on Alfred University and Florida Agricultural and Mechanical University that were derived from Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005, NSF. (b) Number represents total U.S. patent applications filed. (c) Number represents total U.S. patents issued. (d) Number represents total licenses/options executed. (e) Number represents total licenses/options yielding license income in FY 2005. (f) Number represents total startup companies formed during FY 2005 that were dependent upon the licensing of the institution’s technology for initiation. Rank in each category represents the number per \$ thousand of R&D expenditures. Rank was calculated by Innovation Associates Inc. All data were self-reported by the institution to the AUTM Licensing Survey.™

The reader should not infer that the exemplars are the national “top 10” or the only exemplary institutions. Moreover, IA/National Advisory Committee sought a variety of examples; thus, it should not be inferred that the exemplars are in any way comparable. Many universities deserve mention for their strong technology transfer and commercialization partnerships and may not have been selected for this report because of geographic considerations or because their research expenditures exceeded the cutoff. In addition, we did not select academic institutions that have been covered in other recent work.

In order to examine exemplary practices, IA conducted interviews with key persons responsible for developing and administering research, technology transfer, corporate relations, and sometimes entrepreneurship programs. Depending upon the academic institution, these individuals included (but were not limited to) (a) vice presidents of research and research center/program directors; (b) directors of technology transfer offices; (c) directors of related program activities such as centers for entrepreneurship, research parks, and incubators; (d) CEOs and principals in private firms; and (e) directors of entrepreneurial networks, state and local technology programs, and other intermediary organizations and agencies. Most interviews were conducted on-site; some were conducted by telephone. The names of most professionals who were interviewed appear in Appendix C. IA used information from the interviews to develop the case studies on academic institutions found in this report's Part II, and to form the basis of discussion and recommendations found in Part I.

Organization of the Report

In the next section, we provide lessons and recommendations that crystallize the report's findings and provide useful steps to build effective technology transfer practices. In "Outstanding Issues" we discuss factors that may affect the ability of institutions, particularly emerging institutions to conduct technology transfer. In "Implications for the PFI Program" we outline some suggestions for the national program. This is followed by a "Checklist" for academic institutions. We present a brief discussion on background and history, and then in several sections present findings on (a) technology transfer and commercialization, (b) building a research base, (c) industry research and related partnerships, (d) entrepreneurial development, and (e) PFI activities in exemplars. Part II presents case studies on individual exemplars.

LESSONS AND RECOMMENDATIONS

The lessons from exemplars in this report confirm many of the lessons learned earlier at major research universities.¹⁴ While some lessons apply to all research universities, others have a greater impact on academic institutions that are challenged because of modest research expenditures, geographic locations and/or other factors. As in major research institutions, the success of technology transfer in emerging institutions is not dependent on any one factor but instead the confluence of multiple factors inside and outside the academic institution.

Technology transfer and commercialization, and the partnerships that contribute to their success are as much an art as a science, and personal relationships between technology transfer agents and faculty, corporate licensees, and the business and investment communities are key to successful efforts. All successful technology transfer operations have (a) excellent technology transfer personnel who often have experience in industry or as entrepreneurs, (b) sufficient resources to support technology transfer, (c) high standards and performance goals, and (d) hiring and promotion practices that reward technology transfer, and corporate and other external relationships.

¹⁴ See *Accelerating Economic Development through University Technology Transfer*, Innovation Associates, 2005.

Leadership by academic presidents and the “buy in” of deans and department chairs are factors seen consistently across universities. Successful institutions have a culture that promotes technology transfer, commercialization and entrepreneurship. That culture is encouraged by academic leaders and fostered by internal incentives that reward and celebrate commercial partnerships and entrepreneurial successes. In the case of academic institutions that launch startups based on academic research, the presence of and linkages between technology transfer and entrepreneurial development resources, including investment capital and incubation is important. This is especially true for institutions located in rural areas and other areas with few entrepreneurs and little venture capital.

These and other findings from case studies on exemplars form the basis for recommendations provided here. Many members from the National Advisory Committee (see Appendix A) also provided input to the recommendations, particularly those directed to national policy makers. We provide recommendations for three groups: (a) academic leaders, (b) state and local governments, organizations and policy makers, and (c) national policy makers. The recommendations primarily focus on the first group. We discuss “outstanding issues” and implications for the PFI program following the recommendations.

Recommendations for Academic Leaders

Building the Innovation Pipeline

- **Focus on building excellent research and leveraging research strengths.** Excellent technology transfer is based on excellent research. An institution that wants to build its technology transfer capacity should start by assessing its core research competencies and developing strategic plans to enhance those competencies.
- **Target and build niche research strengths.** Academic institutions with limited research funding have been successful in creating technology partnerships and conducting technology transfer by identifying and focusing on specific research niches. Examples include University of Akron that focused on polymer research and Alfred University that focused on ceramics research.
- **Aggressively pursue federal funds to support research strengths.** Federal funds generally represent more than three-fifths of research expenditures in academic institutions.¹⁵ Increases in technology transfer outcomes often are associated with increases in research funding, and increases in research funding almost always involve greater federal awards.
- **Build research strengths in space dominated by local industries.** The University of Akron built its polymer research, in part, with partners from chemical corporations in Northeast Ohio. Alfred University also built its ceramics department and centers with the

¹⁵ In FY 2005 federal funding sources represented 63.8 percent of total R&D expenditures in the top 200 academic institutions. Source: 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.

help of ceramics companies in Southwestern New York. Close industrial relationships provide a window into corporate research needs and opportunities as well as direct research support.

- **Create research centers that involve industry members.** Research centers that involve industry members provide a natural link to the industrial community. Although there is no empirical evidence that suggests these centers increase technology transfer outcomes, technology transfer occurs in many informal and indirect ways. In research centers that involve industry members, the reciprocal flow of information between industries and academic institutions happens naturally and benefits both parties.
- **Tap foundations and successful entrepreneurs to build research capacity and entrepreneurial programs.** Exemplars such as Rensselaer Polytechnic Institute, Iowa State University, Brigham Young University and others benefited substantially from corporate foundations and successful entrepreneurs funding major research centers, schools, and centers for entrepreneurship. Academic institutions also benefited from successful entrepreneurs who contributed time and “in-kind” services.

Promoting Technology Transfer

- **Set a tone that supports a technology transfer culture.** In many academic institutions that are successful in technology transfer, the institution’s president articulates support for technology transfer as an important part of the institute’s mission. The president’s support often is articulated in the institution’s strategic plans and goals, and this sends a strong message to department heads and faculty. This is the case in many exemplars including University of Akron, University of North Carolina at Charlotte, and Rensselaer Polytechnic Institute. Institutional support also is demonstrated by the institution’s hiring and faculty promotion decisions that reward work with industries and technology transfer. In addition, “buy-in” and leadership from deans and department chairs are critical to faculty participation in technology transfer and industry partnerships.
- **Raise technology transfer to a higher level and promote excellence.** Institutions that want to promote technology transfer should structure reporting relationships sufficiently high in the institution, and fund operations to reflect goals set by the institution. Hiring practices should focus on attracting top personnel with excellent technology transfer credentials, industrial/entrepreneurial background or experience working with industries and entrepreneurs, and demonstrated teamwork. Internal promotion policies should reward technology transfer excellence. At the same time, professionals should be held to performance goals, and technology transfer offices should be expected to produce significant and “real” outcomes that result in the most productive innovation transfers.
- **Focus on building industry partnerships to achieve long-term benefits rather than short-term “pay-offs.”** Many universities that exhibit exemplary technology transfer outcomes work with industries in ways that may not produce direct and immediate results. For many years, universities with high-yield technology transfer outcomes have worked routinely with corporations through research and other collaborative relationships

without expecting payback. In the long-run, these universities ultimately benefit from their long-term corporate relationships. The institutional benefits derived from successful entrepreneurs who fund endowments, laboratories, new/improved schools, etc. most often far exceeds that of near or future license income.

- **Build flexibility and responsiveness into technology transfer programs.** Corporate research partners and corporate licensees of university innovations increasingly complain that academic institutions are not flexible and do not sufficiently take into account their needs. Academic institutions should build robust, flexible and mutually beneficial partnerships with the private sector and state/federal agencies that build and nurture research and commercialization partnerships.
- **Make a commitment to economic development.** Some academic institutions have a tradition of service to the agricultural, industrial and business communities. The leaders in these institutions recognize that their engagement in community and state economic development can have a major economic impact that ultimately benefits the institution. Their support for research partnerships with industry, and technology transfer and commercialization are often natural extensions of the institutions' economic development and service commitments.
- **Focus on launching startups as part of the institution's technology transfer and economic development commitments.** By launching startups, academic institutions begin to build a critical mass of science and technology enterprises that are likely to locate in the region, especially given proper infrastructure and services. As these startups grow and spin off other startups their value exponentially increases. This growth ultimately benefits academic institutions by improving the entrepreneurial and economic environments that attract top faculty and students.

Fostering Entrepreneurship to Support Commercialization

- **Build entrepreneurial resources in academic institutions and link technology transfer activities to those resources.** In order to effectively launch startups, academic institutions should have in place entrepreneurial infrastructure and services, and/or close linkages with those resources in the community and state. These entrepreneurial resources include incubators, research parks, enterprise forums, mentoring, and other business development services. Institutions with modest research funding can start by setting aside incubation space and providing some business development services.
- **Coordinate technology transfer and entrepreneurial services.** Technology transfer offices should actively identify and refer potential startups to internal and external entrepreneurial resources. Moreover, technology transfer offices, incubators, entrepreneurial development centers, etc. should regularly communicate to insure coordination and effective flow of services.

- **Increase linkages with sources of investment capital for startups.** Seed capital is an essential ingredient in launching startups. Startups associated with small academic institutions and those located in areas with few venture capitalists are particularly challenged. It is especially important for technology transfer offices in these academic institutions to identify and establish relationships with sources of seed capital, which may include angel networks, venture capital firms focused on early-stage investments, enterprise forums, and state venture capital programs.
- **Build networking opportunities.** Successful technology transfer activities almost always have internal and/or external networks available to academic-based innovators. These networking opportunities facilitate introductions between faculty innovators and potential licensees, partners, investors and service providers.

Building Credibility and Awareness

- **Capture the results from technology transfer and other industry partnerships.** One of the best ways to increase support for technology transfer inside and outside the university is to capture and publicize successes. Most academic institutions active in technology transfer collect data for the AUTM Licensing Survey,TM but some collect additional data and attempt to assess value. This provides the justification needed to support the allocation of funds within academic institutions and, in the case of public universities, funding from state legislatures.
- **Publicize technology transfer successes.** Publicizing and celebrating successful faculty innovators adds academic legitimacy to technology transfer activities and encourages future innovators. It also encourages local and state support for research, technology transfer and related entrepreneurial efforts.
- **Educate state policy makers on the value of technology transfer and industry research partnerships.** States support university technology transfer in many ways – by providing funds for university-industry research, seed/venture capital, entrepreneurial infrastructure, recruitment of academic “stars,” and tax incentives to stimulate investments in university research and startups. It is critical that academic institutions that benefit from these funds and incentives regularly educate policy makers on the value to and return on the state’s investments.
- **Educate federal policy makers.** At the federal level, there are many programs that directly or indirectly impact university technology transfer including basic research, industry-university collaborative programs, entrepreneurial development infrastructure and services, and small business innovation research and commercialization. Academic leaders should actively support these programs/policies that impact their ability to create, develop and transfer innovations. Moreover, academic and other leaders interested in realizing the benefits derived from technology transfer should actively initiate and support federal efforts to enhance commercialization efforts.

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.** The tone set by the state governor and state legislature can affect the economic and technology transfer direction in academic institutions, particularly state-related institutions. However, policy makers must carefully consider input from stakeholders before forming policy conclusions, and should take a long-term view regarding economic returns. In addition, policy makers should be careful to ensure that the expectations imposed upon the academic institutions are realistic.
- **Work with academic institutions to identify core competencies.** Economic development professionals can help academic institutions identify core research competencies as well as regional, industrial R&D strengths. By working with academic institutions to identify research strengths and opportunities, state/local organizations can add value to institutional strategic plans designed to build a research pipeline for future business and economic growth.
- **Provide state funding for targeted R&D in academic institutions.** A number of states provide competitive grants to academic institutions in targeted research areas, normally associated with state clusters. These grants often are used to build up research in areas that the state has a competitive advantage or to spur new R&D in emerging fields. Many universities use these state funds to leverage federal funding, and while state grants tend to be small, they can result in federal funding many times that of the state's original investment. Academic institutions in New York and Ohio, for example, have effectively used R&D grants to leverage federal funding.
- **Encourage industry-university R&D collaboration by funding cooperative grants and research centers, and implementing tax incentives.** States such as New York provide a suite of initiatives designed to encourage industry-university R&D collaboration including Centers for Advanced Technology, competitive grants that require collaboration, and other incentives. These programs and incentives promote R&D that are relevant to industries' needs and focus on commercialization as an end product.

Building an Entrepreneurial Environment

- **Develop/enhance regional infrastructure and services to capture and retain startups from academic institutions.** The entrepreneurial infrastructure, services and investment capital available to entrepreneurs, in part, will determine whether startups from academic institutions remain in the community and state or relocate elsewhere. State and local governments should evaluate whether they have sufficient entrepreneurial conditions to retain startups at various stages in the business development cycle.

- **Build investment and networking opportunities.** Communities and states, particularly those in rural areas and areas with little venture capital can enhance the potential of local/state entrepreneurs by building and supporting angel capital networks, seed capital funds, “fund-of-funds,” and enterprise forums.¹⁶ Moreover, community/state organizations can facilitate entrepreneurial growth by providing networking opportunities that introduce entrepreneurs to potential investors, customers, partners and service providers.
- **Educate academic institutions about local/state entrepreneurial resources and coordinate the resources with those at academic institutions.** Economic development corporations, state technology programs, and others that provide entrepreneurial services should educate university technology transfer offices, entrepreneurship centers, etc. about the community/state’s entrepreneurial resources. They should work with the academic institutions to coordinate services and insure academic and local/state resources leverage and add value to the other.
- **Develop programs and work with academic institutions to improve Small Business Innovation Research (SBIR) awards.** Many states have developed programs to help startups write SBIR/Small Technology Transfer Research (STTR) proposals, and Phase I awardees transition to Phase II/III through gap funding and commercialization assistance. State and local organizations that provide SBIR/STTR assistance should work with academic institutions to insure that affiliated startups are aware of and receive these services.

Promoting Academic Institutions as Economic Assets

- **Work with corporations and foundations to encourage sponsorship of and participation in academic-based R&D, technology transfer and entrepreneurship.** Business, technology and economic development organizations can act as intermediaries to help “market” academic institutions to local/state foundations, corporations, successful entrepreneurs, etc. They can work with industrial liaison and technology transfer offices to provide introductions and help liaise between corporations and the institution.
- **Market academic institutions as community/state economic assets.** State and local organizations can work with the university’s press office, technology transfer office, and incubator/research park to publicize successes locally, regionally, and nationally. The organizations can sponsor media events such as local award dinners that help create an entrepreneurial atmosphere in and around the academic institution.

¹⁶For more on various types of seed funding go to www.cfi-institute.org, www.ncet2.org, www.nasvf.org, and www.nvca.org.

- **Encourage academic leadership to become fully engaged in economic development.** State and local organizations can organize meetings between the university leadership, policy makers, corporations and other key stakeholders and otherwise facilitate university engagement in economic development and alignment of strategies and goals.
- **Help academic institutions evaluate their impact on local and state economies and present the outcomes to policy makers.** Academic institutions, particularly state universities, need credible economic impact data to justify their requests for state funding of research, technology transfer and entrepreneurial activities. Helping the university “make its case” serves the institutions’ and the community/state’s economic interests.

Recommendations for National Policy Makers

- **Recognize that innovation involves advancing science and technology at various levels, by multiple means and through a wide range of academic institutions.** Various types of academic institutions provide different but nevertheless important elements in advancing and disseminating innovations. These institutions range from major research universities that develop next-generation innovations to colleges that produce “low-tech” but valuable applications to community colleges that educate a technical workforce and increasingly entrepreneurs. Federal policies and funding should focus on stimulating innovation, collaboration, technology transfer in the broadest sense, and entrepreneurship through various means and in a wide range of institutions. Moreover, policies and funding should encourage comprehensive strategic planning, and greater coordination and cooperation between these institutions.
- **Provide additional funding for partnership-related activities.** Although PFI is a small program, it has had a positive impact on the activities of several exemplars covered in this report including Florida Agricultural and Mechanical University, University of Central Florida and Montana State University. It is one of the few federal programs that facilitate flexibility and experimentation involving partnerships to promote innovation. The PFI program should be expanded and should coordinate with other NSF and federal programs to leverage these programs, where possible. In addition, the PFI program could be replicated or adapted by other federal agencies that fund major research in life sciences, energy, defense and other areas.
- **Create and fund new initiatives to bridge the “valley of death.”** Academic practitioners in the exemplars covered in this report almost all point to gaps in early-stage capital, management capacity, and other business-related issues as stumbling blocks in the development of successful academic-based startups. NSF and/or other government-related entities should explore options and implement pilot projects designed to better address these gaps. These initiatives should be designed especially to stimulate and leverage private sector involvement and solutions.
- **Assess and address the effect of technology transfer from a corporate perspective.** Research directors at academic institutions covered in this report were quite concerned about the potential negative impact of current technology transfer practices on industrial

research partnerships. NSF or other appropriate entity should undertake an evaluation and organize discussions with the private sector to develop policies that optimize industry-university R&D relationships as well as protect university intellectual property rights.

- **Provide technology transfer and commercialization education and mentoring activities in emerging academic institutions.** Academic institutions in EPSCoR and other states, and minority institutions would benefit from NSF initiatives to educate and help them organize technology transfer activities. Moreover, a mentoring program that would team a successful university with an emerging institution would be one effective way to address weaknesses in emerging institutions.
- **Promote regional R&D partnerships.** As NSF has promoted industry-university R&D partnerships, it also should more strenuously promote R&D partnerships that cross county and state boundaries. Several exemplars in this report participated in federally-supported, regional partnerships that brought together the best academic and industrial minds in a field such as nanotechnology. The nation faces global competition that requires partnerships among the best institutions in emerging scientific and technological fields. Federal funding should stimulate and support regional partnerships wherever possible.
- **Develop metrics that effectively capture the value of innovation-related activities.** The NSF or other appropriate entity should organize an effort to develop metrics that will reflect the true value of technology transfer and commercialization activities. The metrics should include long-term outcomes such as the retention and growth of startups as well as other measures. In addition, the NSF should work with leading organizations and institutions to improve data collection procedures and reporting, and to insure not only the accuracy but also the usefulness of the data.
- **Create a clearinghouse for technology transfer data and best practices.** The NSF or other appropriate entity should create a clearinghouse to provide on-going data collection and best practices that are readily available to the community. Such a clearinghouse should be actively involved in the dissemination of those data and best practices to universities, industries, state governments and national trade organizations. Professional organizations and representative institutions should be involved in any such effort.
- **Review government-wide incentives and support for small technology enterprises.** Many of the exemplars for this report and previous reports used federal and state programs and services to increase SBIR/STTR participation and to help startups develop business and marketing plans, increase management capacity, locate investment capital, and meet other critical needs. While some of these programs are useful, others are outmoded and limited in their ability to address the needs of entrepreneurs and technology startups. NSF or other appropriate entity should identify and assess various federal incentives and programs that are intended to stimulate and assist small technology enterprises, and provide recommendations for improvements.

OUTSTANDING ISSUES

In this section, we touch on some outstanding issues that affect the ability of academic institutions to form relationships with corporations and effectively transfer technologies. Many of the issues discussed here are not new but deserve mention because they persist in impeding progress in technology transfer and commercialization of academic-based innovations. We do not delve into any single issue in any great depth but instead outline some aspects with the intention of stimulating further discussion.

Technology Transfer: A Tug-and-Pull at Some Universities

Within some universities issues still remain regarding the role of technology transfer vis-à-vis the university's primary academic mission of teaching and education. At these universities there is less than whole-hearted support from leadership or rank and file. As we suggested under "Lessons and Recommendations," the importance placed on technology transfer often depends on the academic institution's leadership, historical role with industry, commitment to disseminate information and engagement in economic development. Although technology transfer has gained acceptance and legitimacy in many academic institutions, it nevertheless is still considered a peripheral activity in some institutions, and in others is not considered a legitimate academic practice. A reluctance to embrace technology transfer often results in technology transfer operations being placed at organizational levels far from academic leadership and given insufficient funds and staff to carry out mandates. AUTM asserts that technology transfer success is largely dependent upon staffing, and we also found that the number and quality of staff appears to be a significant factor in the institution's success.¹⁷ As we noted in our recommendations to academic institutions under "Promoting Technology Transfer," if academic institutions are interested in reaping the benefits of technology transfer they must be willing to elevate and support operations by hiring substantial and highly qualified staff. At the same time, it is reasonable that administrators set and hold professionals to high performance standards.

Universities have a social compact with society. As educational and research institutions, it is our responsibility to generate and transmit knowledge, both to our students and the wider society. We have a specific and central role in helping to advance knowledge in many fields and to manage the deployment of resulting innovations for the public benefit.

- Excerpted from "In the Public Interest: Nine Points to Consider in Licensing University Technology," March 2007
[Initiated by Stanford University and endorsed by 20 universities (at the writing of this report)]

¹⁷ AUTM U.S. Licensing Survey: FY 2005, pg. 18.

Conflicting Interests between Academic Institutions and Corporations

Universities that conduct technology transfer often have difficulty reconciling the differences between academic and corporate perspectives on licensing innovations. Academic institutions and corporations represent very different environments with contrasting values and cultures. Universities sometimes are concerned about commercial-oriented activities taking faculty time away from teaching and research, and expect faculty to place academic responsibilities over commercial concerns and deadlines. In addition, pressure on faculty and academic researchers to publish as a requirement for tenure and promotion often runs counter to the corporate need for confidentiality.

We used to be able to work with industries in all kinds of ways. Recently our technology transfer office and others in the university have been pushing us to make things more formal and to protect the intellectual property before we even know if there is a possible result. We do not have the flexibility we used to have and companies are now more reluctant to work with us. Relationships that we have built over many years are now in jeopardy.

- Director (anonymity requested) of a major university research center, 2006

As universities gain commercialization experience, their research partnerships and licensing agreements often become more structured and formalized. Research directors at exemplars report that corporations increasingly complain that it is more difficult to establish productive research relationships with universities. Directors of some university research centers also complain that they increasingly are hampered in working with corporate partners as a result of university administrators pressuring them to formalize relationships too early in the research process. Some university researchers believe that this pressure makes it more difficult to explore relationships in early stages when it is not clear what may result from the research, and impedes mutually productive information exchanges. Some directors of university research centers also believe that the increasing inflexibility has been responsible, in part, for decreased corporate funding of research in some universities. Some directors also believe that corporations are increasingly sponsoring research at foreign universities in order to circumvent intellectual property rights assigned to U.S. academic institutions. Corporations also complain that technology transfer policies and procedures do not adequately account for the differences among various types of scientific and technological developments and commercialization processes. On the other hand, university administrators claim that corporations have grown accustomed to a “free ride.” Administrators claim that the academic institutions need more formal processes to protect their research interests and intellectual property.

Administrators at emerging academic institutions also sometimes put into place aggressive intellectual property policies. They do so in the hope of achieving the high royalty incomes that they see at a few major research universities without fully appreciating that “big hits” are rare. They fail to recognize what more experienced universities know – that building long-term corporate relationships most often produces much greater returns than license income.

Academic institutions and corporations must try to achieve a balance between their competing interests in development of research and technology transfer partnerships. The National Academy of Sciences (NAS) recently has embarked on a University Industry Demonstration Project that brings together corporate and academic communities to explore this relationship, and there are the additional continuing efforts by the Association of University Technology Managers® (AUTM) and the Licensing Executive Society (LES).¹⁸ However, we believe that a more concerted effort is called for. To that end, we recommend to national policy makers that the NSF or other appropriate entity undertake a major effort that more fully explores and addresses competing university and corporate interests. This entity should examine competing interests from a corporate perspective, which is often under-represented, as well as from an academic perspective. The body should recommend policies and protocol to achieve the original intent of the Bayh-Dole Act; that is, to insure that innovations are most productively disseminated and utilized.¹⁹

The “Valley-of-Death” Persists

The “valley-of-death” has been described in many ways. For our purposes here we describe it as the gap between later stage, academic-based innovations and the commercial application of those innovations in the market place. Although there has been much discussion about the valley-of-death, we believe there is the need for even greater discussion and action – in universities, corporations, and federal and state governments – on tools to build bridges over the valley.

There are many factors that contribute to the valley and these factors differ somewhat depending on whether a university 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 or early-stage capital is often a key factor in the ability of the startup to commercialize the university-based innovation. Some universities have sought to fill this gap by creating small seed funds, most of which are too limited to have a significant impact. Others have established enterprise forums and other means to link entrepreneurs and investors. Other key factors mainly involve building sufficient business and management capacity to commercialize innovations. Some academic institutions fill this need by involving CEOs-in-residence and others to mentor university innovators. In order to remedy the lack of business experience in university startups, private investors often replace university innovators with professional CEOs and CFOs, and a few universities also routinely replace inventors with professionals as part of their process in launching startups.²⁰

¹⁸ For more on UIDP see www.uidp.org; for AUTM see www.autm.net; for LES see www.lesi.org.

¹⁹ The Bayh-Dole Act is discussed under “Background and History.”

²⁰ For a comprehensive entrepreneurial/commercialization program see Georgia Institute of Technology VentureLab at www.venturelab.gatech.edu.

Whether a university-based innovation is licensed or transferred through the launch of a startup, major impediments to commercialization often revolve around the innovation's early development stage and lack of direct applicability for commercial use. There are some universities that have implemented commercialization programs focused on advancing innovations to close-to-market stages. In previous work we have highlighted examples such as MIT's Deshpande Center and there new examples such as Stevens Institute for Innovation at the University of Southern California that are designed to accelerate research to more advanced stages.²¹ Some states also have created "accelerators" with the intention of advancing university innovations to commercialization stages, but most of these programs attempt to fill seed capital gaps and assist entrepreneurs, and do not focus on the technological challenges of advancing innovations to a stage where they can be directly applied for commercial use. Moreover, the question remains regarding who should be responsible for advancing the innovation to a commercial stage. Most universities will not make the investment in advancing innovations, and commercial enterprises and venture capitalists often opt not to make an investment because the academic-based innovation is too far from commercial readiness. This creates a major gap that is not being adequately addressed by any party.

In response to the critical need to fill these gaps, we recommend that national policy makers conduct an in-depth examination of the valley-of-death, and develop and test potential solutions. Any such effort should examine how current federal programs are addressing these gaps. Proposed remedies, where possible, should be designed to stimulate private sector solutions.

Technology transfer is very geography based. Outside of a few major technology areas, even in places with large universities, there often aren't sufficient entrepreneurial resources for startups. These entrepreneurial services and seed capital are critical ... The pay-back to regions is large as startups begin to multiply and create a growing entrepreneurial region.

- John Fraser, Assistant Vice President for Research and Economic Development, Florida State University and 2006 President, Association of University Technology Managers

Executing Licenses versus Launching Startups

Many academic technology transfer offices focus on patenting and licensing activities, and tend to steer away from launching startups. Although this has been changing in recent years and the portion of university startups to licensing has increased, technology transfer offices often are ill

²¹ For more on MIT Deshpande Center, see <http://web.mit.edu/deshpandecenter>; for USC Stevens Institute for Innovation at <http://stevens.usc.edu>.

equipped to launch enterprises. They often do not have the number or type of staff needed to launch startups, and if they are located in an area with few venture capitalists and serial entrepreneurs find it difficult to make the necessary linkages to investment capital and business development resources.

The ability of the institution to launch startups may or may not be an issue depending upon the academic institution's goals and that of state and federal policy makers. In general, academic-based innovations are licensed to firms outside of the community in which the institution is located but startups often, at least initially, locate closer to home. If the goals of the academic institution and policy makers are to build new technology enterprises in regions where universities are located, it behooves them to create the conditions necessary to launch startups based on university innovations and to implement the services and conditions needed to stimulate and support these startups. As startups grow they often spin off other enterprises and exponentially create employment opportunities that can retain university graduates and enhance the environment around the university. We recommended numerous actions to help academic institutions and state and local governments, organizations, and policy makers build entrepreneurial environments that support and retain academic-based startups. These recommendations included (but were not limited to) enhancing access to seed capital, entrepreneurial infrastructure, business development services, mentoring and networking.

Making the Link between Technology Transfer and Entrepreneurship

Initially, academic institutions established technology transfer operations to file patents and execute licenses, and most technology transfer offices began launching startups later. Entrepreneurial related infrastructure and services developed about the same time, but separately from technology transfer activities. The separate development and administration of these operations in many institutions has created a “disconnect” between functions that should come together to support academic-based entrepreneurs. Some academic institutions have addressed this weakness by establishing an umbrella organization that encompasses technology transfer, entrepreneurial infrastructure and services, and sometimes extension services.²² Others have established committees that regularly meet to coordinate activities. It is most important that academic administrators understand and address the need to coordinate technology transfer and entrepreneurial development services. The coordination of these disparate operations, it strengthens the ability of technology transfer offices to launch startups and strengthens the institute's ability to support entrepreneurs.

Participation of Small Universities, Minority Institutions and Community Colleges

Universities that have research expenditures under \$100 million face different challenges than those with greater research funding. In this report we have addressed some of the ways in which universities with modest research expenditures can achieve technology transfer results. While it may not be practical to have technology transfer operations at some small academic institutions, such institutions may produce some technologies with commercial value. State and federal

²² For an example of an umbrella organization see the case study on Iowa State University.

policy makers should address how innovations in these institutions might be vetted and transferred. NSF or other appropriate body could take the lead in exploring options to address this weakness and potentially initiate a pilot program to test potential solutions.

In addition to the need for funding, we need to change the universities' culture. This is not only a HBCU, Hispanic Colleges and Universities or Native American Schools problem – it is a “Limited Resource Institution” problem. Just as the university presidents (in these institutions) in the 1980s recognized the value of sponsored research offices, we now must make them more aware of the importance of technology transfer and entrepreneurship.

- Rose Glee, Director, Technology Transfer, Licensing and Commercialization, Florida Agricultural & Mechanical University

Minority institutions, for the most part, are not active in technology transfer. This may be due in part to less research focus and limited research funding in many of these institutions, although some minority institutions have made great strides in research. A PFI grant was awarded to Florida Agricultural and Mechanical University for the purpose of enhancing technology transfer at the University and eight additional Historically Black Colleges and Universities (HBCU). According to the University's Director of Technology Transfer, Licensing and Commercialization, many HBCUs have no technology transfer office and others are severely under-funded. For several years Florida State University's technology transfer Director has mentored the Director at Florida Agricultural and Mechanical University and has substantially enhanced the University's technology transfer operations. Under the PFI grant, the two Universities educated and trained other HBCUs participating in the PFI project. In order to address the need for enhanced technology transfer operations at HBCUs, we recommend to national policy makers that the NSF or other appropriate body implement a program in which experienced technology transfer offices educate and mentor HBCUs and other emerging institutions.

Community colleges also are often ignored in discussions on innovation partnerships and technology transfer. Community colleges are a growing presence in entrepreneurship, and it should be noted that innovations and entrepreneurs come from many different venues. These colleges have a long history of working with industries and have built trusted and long-established relationships with local corporations. As we conducted research for this report we found a major “disconnect” between the research and technology transfer taking place at research universities and the workforce and entrepreneurship activities being conducted at community colleges. Springfield Technical Community College, which is highlighted in this report, is one of the exceptions in that the College links some workforce and entrepreneurial activities with Massachusetts research universities and several other colleges.

The NSF Advanced Technology Education (ATE) program focuses on advancing an innovation workforce through collaborative efforts between industries and two-year colleges, and programs such as this should be encouraged and strongly supported. In addition, we have recommended that state and national policy makers consider establishing incentives that promote comprehensive, strategic approaches to innovation and technology transfer in the broadest sense. This comprehensive, strategic approach necessarily involves coordination and collaboration on research, entrepreneurship and workforce development among institutions that are performing different but equally important innovation-related functions.

Measuring Results and Making the Results Meaningful

Evaluating the results and assessing the value of university technology transfer is currently an inexact science and an area that requires greater attention. No government agency at this time collects data on technology transfer outcomes even though federal legislation established the basis of university technology transfer activities. (This is discussed more in subsequent sections.) AUTM, one of the major national associations in the field, collects annual outcome data through its Licensing Survey™ and those in the field owe AUTM a debt of gratitude for collecting these data. However, the Survey relies on self-reported data and there have been some reporting inconsistencies. Individual universities and some states also collect additional data, but these data often focus on narrow and short-term economic development measures such as job creation and retention. Most professionals in the field feel that the current data are inadequate to reflect the true value of technology transfer and commercialization activities. This is true also for outcome measures on industry-university R&D, entrepreneurial development, extension services and other efforts involving innovation partnerships and outreach. Capturing the true value of these activities is important in order for academic, local, state, and federal policy makers to assess the return on their investments and make future funding decisions. The NSF, NAS and/or other appropriate body should bring together national experts to identify measures and methods that accurately reflect the full value of technology transfer and other innovation partnership activities.

IMPLICATIONS FOR THE PFI PROGRAM

The NSF PFI program is designed to foster partnerships among colleges and universities, state and local governments, the private sector and organizations. These partnerships are intended to catalyze innovation, develop and disseminate knowledge, strengthen a scientific and technological workforce, and promote an infrastructure and environment that supports innovation.

In this report we have focused on technology transfer and commercialization activities, and related entrepreneurial initiatives as one type of partnership between academic institutions and the private sector. Technology transfer and commercialization partnerships are intended to disseminate knowledge and innovations to the commercial sector and government. Related entrepreneurial initiatives help academic institutions use their innovations as the basis for startups that adapt and commercialize the innovations. Academic institutions can use technology transfer and commercialization activities not only as a means of disseminating innovations but

also as a catalyst to stimulate it. Technology transfer and commercialization catalyze innovations by encouraging academic researchers to consider the implications and adaptability of their research to solve “real world” problems and to advance science and technology in a useful and useable way. Whether academic innovations are commercialized through licenses or startups, they have an impact on the economic development of regions, states, and the nation. They do so by providing new knowledge and advancing scientific and technological products, processes and services that create new markets, diversify and add value to existing markets, and build new businesses. We know from examining technology intensive regions in the U.S. and elsewhere that these activities can have a major impact on economic growth.

But what happens when academic institutions are in areas of low technology intensity and the “anchor” institutions are not in the top research funding tier? We have highlighted several examples in this report that showed how some academic institutions can start to build a critical mass of innovation and entrepreneurship. In some of these institutions as well as others not covered here, the PFI program has facilitated experimentation with new partnership ideas. But in order for programs such as PFI to have a significant impact, funding would have to be far greater than it has been to date. Although the federal government spends more than \$141 billion per year in R&D and invests almost \$30 billion of that amount in academic R&D, it devotes an insignificant amount to the technology transfer and commercialization of the research and partnerships that facilitate commercialization.²³ This includes programs such as SBIR/STTR that have commercialization as part of their mission but almost no funding or flexibility to support that mission. Federal policy makers have traditionally not funded the “commercialization side” of research including commercialization strategies, technology transfer and transitioning, acceleration and adaptation, pre-seed/seed capital, linkages with investors, and partnerships. These elements are some of the missing links in the pipeline that moves innovation from research to the market. The federal government has a role in “incentivizing” academic institutions, FFRDCs, federal laboratories, and organizations by funding activities that fill innovation and entrepreneurial gaps, and leverage R&D for economic purposes. Filling these gaps is particularly important in regions with low technology and entrepreneurial concentrations.

As we mentioned in earlier discussion, the NSF could play a greater role in identifying and addressing various gaps, often referred to as “valley-of-death” gaps, in the commercialization process. NSF should not only be concerned about expanding the research pipeline but also accelerating research through the pipeline. There also needs to be a better understanding of conflicts between corporate and academic research communities. Some programs are starting a dialogue about these issues but a much broader and more concerted effort is called for and the NSF could play a much greater role.

²³\$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.

PFI is one of the few programs in NSF and the federal government that allows academic institutions and others the flexibility to experiment and forge new types of partnerships. We have already recommended that the PFI program be greatly expanded in order to have a significant impact. We also recommended that other agencies that focus on specific R&D areas (such as NIH, DOE and DOD) consider replicating PFI. Even without increased funding, there are some ways that PFI could enhance the impact of its current funding, by (a) focusing its awards, (b) replicating successful awards, and (c) leveraging other NSF (and other agency) programs. Focusing PFI awards on creative partnerships to enhance commercialization and fill commercialization gaps would be one way to optimize PFI's value. Moreover, encouraging further experimentation with new models, particularly in emerging institutions would further increase PFI's value. The PFI awards that have addressed technology transfer and commercialization gaps in emerging geographic regions and institutions, including those in minority institutions particularly need to be revisited and potentially replicated at other institutions. In addition, PFI should leverage other NSF programs such as (but not limited to) EPSCoR, I/UCRC, and SBIR/STTR that serve complementary purposes. PFI awards could "piggyback" and leverage existing grants from these programs (and others) and add value by facilitating commercialization partnerships and experimenting with new tools to do so. Leveraging other NSF programs is a potentially effective method of expanding PFI's impact and adding value to PFI and other NSF programs.

CHECKLIST FOR ACADEMIC INSTITUTIONS

- Has the institution identified core research strengths and does the institution have a strategy for building its research base?
- Is the institution's president/chancellor supportive of technology transfer and is that support demonstrated in academic policies?
- Is there "buy-in" from academic deans and faculty researchers, and are there sufficient incentives to encourage "buy-in"?
- Does the institution have sufficient funding and staff to transfer and commercialize research?
- Do the institution's hiring, promotion and intellectual property policies encourage faculty participation and promote excellence in technology transfer?
- Does the institution have the infrastructure and services, and/or linkages with external entrepreneurial resources to launch startups?
- Does the institution have an "entrepreneurial culture;" does it celebrate and reward entrepreneurial success?
- Are there effective research and commercialization relationships with industry; and is there sufficient flexibility and responsiveness to benefit both parties?
- Do the institution's policies and practices focus on short-term technology transfer gains or promote long-term benefits?
- Are academic administrators aware of the benefits derived from engaging in technology transfer and entrepreneurial activities? Are state policy makers aware of the benefits?
- Does the institution work with state and local policy makers and organizations to develop and implement comprehensive strategies that support industry-university R&D partnerships, commercialization and entrepreneurship?

BACKGROUND AND HISTORY

The traditional role of academic institutions has expanded from a narrowly defined role involving the education of future workers and leaders to an enlarged role that includes retooling and advancing workers, creating and disseminating knowledge and, in some cases, providing a base for generating economic activity founded on university research and innovation. Since World War II there has been a changing paradigm for academic institutions, particularly research universities. While education remains the primary and central mission of all academic institutions, the creation and dissemination of knowledge has become an increasing responsibility of research universities. Other academic institutions complement the activities of research universities. They do so through workforce development, outreach and entrepreneurship that extends knowledge dissemination to a broader population.

In recent years, there has been increasing debate about the role and priority of knowledge dissemination versus the education mission of academic institutions. Knowledge dissemination through various outreach activities has always been an integral mission of land grant universities. In land-grant universities, extension services originally created to spread agricultural knowledge, and later manufacturing extension, have significantly impacted the nation's agriculture and manufacturing sectors. Later, the federal Manufacturing Extension Partnership (MEP), which emulated exemplary state programs at Pennsylvania State University and Georgia Institute of Technology, spread manufacturing extension to all 50 states. Many of these programs were located at or affiliated with land grant and research universities. Other corporate interaction, mainly involving research collaboration with universities, began during World War II to support the war effort and continued afterwards to advance technologies and technological know-how. Programs such as the NSF's Engineering Research Centers (ERC) and Industry/University Cooperative Research Centers (I/UCRC), the National Institute of Technology and Standard's Advanced Technology Program, and others additionally promoted university-industry research relationships. In addition, the federal Small Business Technology Transfer (STTR) program was added to the Small Business Innovation Research (SBIR) program in order to facilitate linkages between small technology businesses and research taking place in nonprofit research laboratories, particularly research in universities.

In 1980 the Bayh-Dole Act provided a critical impetus to disseminate university knowledge through the transfer and commercialization of innovations created with federally funded research. The legislation accelerated university technology transfer by establishing a uniform federal invention policy that permitted universities to retain title to inventions developed through federally funded research. It also encouraged universities to collaborate with industry in promoting commercialization of inventions and retained federal government "march-in" rights to insure diligence in commercialization by patent licensees.

During the 1980s entrepreneurial initiatives, primarily small business incubators and research parks, also began to appear at academic institutions and, in the 1990s, entrepreneurship curriculum and services became more prevalent. More recently, academic institutions have expanded entrepreneurial services involving students and faculty, and sometimes involving external entrepreneurs in a wide variety of activities and services designed to launch startups.

Beginning about the same time, states launched programs intended to stimulate university technology transfer and entrepreneurship aimed at (a) hiring academic “stars,” often in targeted academic fields or economic “clusters,” (b) creating targeted research centers, (c) funding R&D through competitive grants or matching federal awards, (d) supporting maturation and commercialization of innovations, (e) establishing early-stage and venture capital funds and/or linkages with private funds, and (f) developing physical infrastructure, including research and laboratory buildings, incubators, and research parks. Programs such as Pennsylvania’s Ben Franklin Partnership and New York’s Science and Technology Foundation were some of the earlier state programs that offered a range of services and investment tools focused on accelerating university research and spawning entrepreneurs. Programs such as the Georgia Research Alliance (GRA) recruited top academic talent from around the country. Rensselaer Polytechnic Institute and Georgia Institute of Technology were the first universities to create incubators to capture startups generated from their research as well as bring other entrepreneurs closer to the source of innovation. Rensselaer also was one of the first institutions to develop a research park to foster and retain growing institution-related startups and link regional enterprises to academic research and services.

All of these federal and state policies and programs contributed to the phenomena that we now see at the nation’s research universities and other academic institutions. Universities are increasingly partnering with industries and others to discover, advance and transfer innovations that benefit the university, community and nation. Moreover, the increasing emphasis on entrepreneurial development and launching startups based on university innovations has generated ever-increasing economic activity around academic institutions. Community colleges and other institutions that for many years have worked with industries on workforce development also are playing an increasing role in innovation and entrepreneurial development.

Over the past couple decades the field of innovation partnerships, particularly technology transfer and commercialization has changed rapidly. In the early 1980s few universities conducted technology transfer and commercialization. Today, there are at least 200 U.S. universities that perform some type of technology transfer.²⁴ There are many factors that affect the university’s ability to transfer and commercialize its research. Those factors include the strength and focus of the university research base; leadership, incentives, and rewards; history and strength of corporate relations; entrepreneurial infrastructure and ties between entrepreneurial resources and technology transfer activities. Other factors external to the university such as the availability of angel and seed capital, laboratory and incubation space, legal assistance, business development resources, and networking opportunities are just a few of the elements that form the infrastructure that supports university technology transfer and commercialization efforts. We discuss these and other factors in greater depth in following sections.

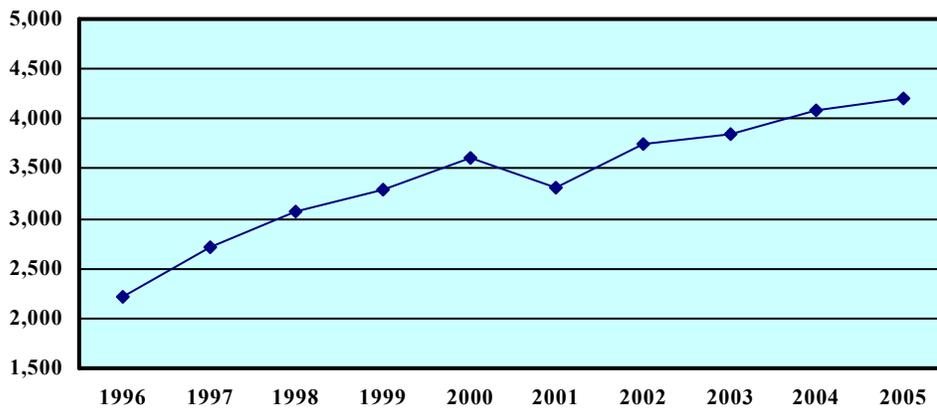
²⁴ Estimated by AUTM.

TECHNOLOGY TRANSFER AND COMMERCIALIZATION

Technology transfer and commercialization are by their nature partnership driven – they involve the academic institution linking its research upstream in the innovation chain with corporations that license the institution’s innovations and/or by launching startups based on those innovations. Patenting of the innovations is sometimes part of that process. Today, there are about 200 U.S. universities and colleges that conduct some level of technology transfer.²⁵ The 2005 AUTM Licensing Survey™ reported

- Since FY 1998, 3,641 new products based on academic technology transfer efforts have been released to the public.
- In FY 2005 U.S. universities executed 4,201 licenses and options; 13.9 percent of those licenses and options went to startups, an additional 52.2 percent went to small companies, and the remaining 28.6 percent went to large companies.
- Since 1980 universities and research institutions have launched 5,171 new companies.
- In FY 2005 universities spun off more than 400 startups.

Figure 1
Licenses and Options Executed by U.S. Universities
(FY 1996-2005)



Source: AUTM Licensing Survey,™ FY 1996-2005 and Innovation Associates Inc.

Note: “Licenses and options executed” represent the number of total licenses/options executed during the specified year as reported by the institution in response to the AUTM Licensing Survey.™ The number of institutions that report to the AUTM Licensing Survey™ varies each year.

In the past two decades, technology transfer and commercialization activities in universities have skyrocketed.²⁶ From FY 1996 to 2005 universities responding to the AUTM Licensing Survey™ more than quadrupled the total number of active licenses, more than doubled the number of

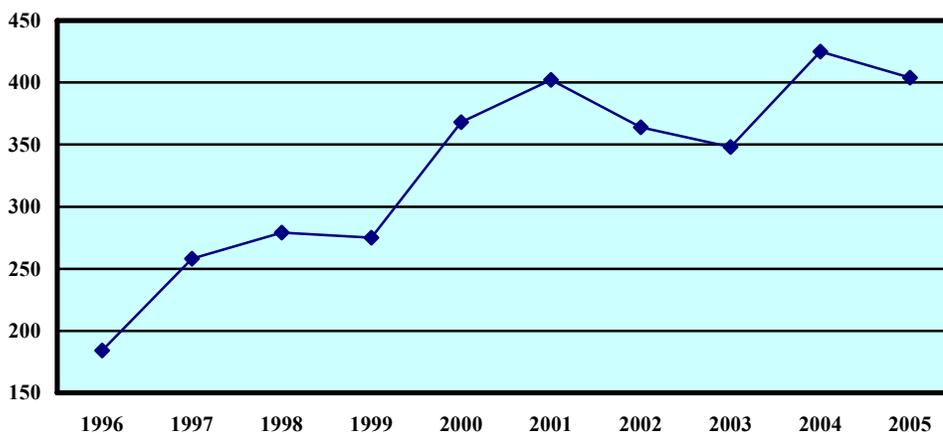
²⁵ Estimated by AUTM®.

²⁶ For more technology transfer data go to www.autm.net and for stories on how the transferred innovations affect “every day lives” go to www.betterworldproject.net.

licenses executed in one year, and more than doubled the number of startups launched.²⁷ (See Figures 1 and 2.) Moreover, gross license income for FY 2005 reported by universities totaled about \$1.6 billion.

The depth and breath of these activities vary widely among universities. For example, two-thirds of universities that responded to the FY 2005 AUTM Licensing Survey™ executed 20 or fewer licenses and options in FY 2005, while three universities – the University of California system, ISU, and the University of Wisconsin-Madison – each executed more than 200 licenses and options that year. Similar distributions are reflected in active licenses, patent applications, and patents issued. The difference in university performance is even more pronounced in license income which often reflects the culmination of a couple “big hits” in a small number of universities; in FY 2005, these were Emory University and New York University. Although there are about 10 universities that consistently launch more than seven or eight startups each year, there are a surprising number of universities emerging over the past five years that launch at least one startup each year; and in FY 2005, the majority of reporting universities launched two or more startups. This not only reflects the fact that more universities now focus on startups but also shows the strength of recovery from the “dot com” bust of just a few years earlier.

Figure 2
Startups Launched by U.S. Universities
(FY 1996-2005)



Source: AUTM Licensing Survey,™ FY 1996-2005 and Innovation Associates Inc.
Note: “Startups launched” represents the number of startup companies formed during the specified year that were dependent upon the licensing of the institution’s technology, as reported by the institution in response to the AUTM Licensing Survey™. The number of institutions reporting to the AUTM Licensing Survey™ varies each year.

In previous reports we focused on universities that were technology transfer “stars” such as MIT, Stanford, University of California, etc. In this report we have highlighted some of the emerging stars that despite modest research expenditures and in some cases additional obstacles have been

²⁷ 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.

able to produce outstanding commercialization results from their research. Several exemplars stand out for their licensing capacity. ISU is a powerhouse in this category; in FY 2005, it executed more licenses than any university in the nation except the University of California system. BYU and MSU also consistently rank in the top 10 nationally for licenses executed, relative to research expenditures. Several of the models, particularly UNC Charlotte, BYU and UA have launched between two and four startups each year for the past five years. These three universities are in the top 10 nationally, relative to research expenditures. RPI and MSU also generally launch a couple startups each year. BYU, UNC Charlotte, RPI and UA also stand out for their patent record and consistently place in the top 10 nationally, relative to research expenditures, for annual patent applications and patents issued. We discuss the technology transfer activities of several of these outstanding universities below.

DID YOU KNOW

- ❖ UNC at Chapel Hill (Research Triangle) has an international reputation for technology transfer but UNC Charlotte generated more patents per research dollar in FY 2005.
- ❖ In FY 2005 Iowa State University executed more than double the number of licenses that Massachusetts Institute of Technology executed.
- ❖ With only \$51 million in research expenditures, the University of Akron launched four startups in FY 2005.

University of North Carolina at Charlotte

UNC Charlotte is an outstanding example of a university that despite modest research expenditures generates startups. Although UNC Charlotte's Office of Technology Transfer (OTT) has only operated since 1998, and its present office since 2000, it already has spun off 19 startups. Moreover, its accelerated patent activity – 56 patent applications filed in FY 2005 alone – placed it second nationally relative to research expenditures. What made UNC Charlotte even more outstanding was the fact that the University's annual research expenditures were only about \$25 million,²⁸ and its OTT operated with an annual budget of about \$500,000 and a staff of four professionals.

²⁸ Reported by UNC Charlotte to the AUTM Licensing Survey: FY 2005.

There were a number of factors that contributed to UNC Charlotte's success. One of those factors was the former OTT Director's "pro-active" stance in establishing relationships with local businesses. The former Director, who had worked for local industry, believed that UNC Charlotte's strong technology transfer activities were based on the University's efforts to build effective relationships with potential commercial partners. One initiative intended to enhance these relationships was the creation of a generic "master R&D agreement" that expedited corporate agreements and lessened potential obstacles to licensing later in the process.

UNC Charlotte provided "cradle to grave" services for startups and helped them prepare for meetings with potential investors and customers, at times accompanying them to the meetings. In addition, UNC Charlotte formed a Commercialization Committee that involved about 30 mentors from corporate and investment communities who worked with startups in "early-stage" and "late-stage" groups. UNC Charlotte also took advantage of their neighbors in the Research Triangle, and worked with the Triangle's Council for Entrepreneurial Development to promote UNC Charlotte innovations statewide and nationwide. The former OTT Director believed that networking and "connectivity" in the Charlotte community and elsewhere in the State was critical to their success.

Iowa State University

As we discussed earlier, ISU has one of the nation's highest licensing rates in terms of both new licenses executed and current active licenses. As the case in many universities that have high licensing activity, most of the activity comes from a couple major discoveries. Over the past 10 years, an average of 85 percent of ISU's licenses and options were related to patented and non-patented plant-related products.²⁹ In FY 2005 ISU's royalty income jumped to \$4.9 million, almost doubling its income from the previous year. More than 40 percent of the license and option agreements in ISU's portfolio generated income, and 35 of the 317 licenses generating income produced about three-fourths of the total income.

ISU is a land-grant university and as such has a strong tradition of service and outreach to the agriculture and corporate communities in the State. ISU administrators view the Office of Intellectual Property and Technology Transfer (OIPTT) and the ISU Research Foundation (ISURF), a non-profit organization that handles ISU intellectual property, as part of the University's "service arm" to the Iowa agriculture and business communities. Licensing managers make a special effort to inform Iowa firms about licensing opportunities, and if possible license to Iowa firms. They make marketing calls to local businesses and build personal relationships with these companies. In FY 2005 more than one-third of all University licenses went to Iowa firms.³⁰ In order to generate additional interest in ISU technologies OIPTT also developed a user-friendly Web site in which companies register and receive emailed technology briefs in specific science and technology fields. Started in 2004, this site one year later had registered several hundred individuals.

²⁹ The products referenced are non-patented plant germplasm and patented Altered Fatty Acid (AFA) soybean varieties.

³⁰ Reported by OIPTT, Iowa State University, 2007.

OIPTT works closely with ISU's Industry Liaison and Ames Laboratory's Office of Sponsored Research Administration. Ames Laboratory is a federally funded research and development center (FFRDC) located at ISU. The Ames Lab is a major draw for corporate research collaboration, and its Office of Sponsored Research Administration routinely involves OIPTT in meetings with corporations that visit the Laboratory.

In FY 2005 ISU launched five startups, representing a jump from previous years in which one or two startups were typically launched. The ISURF and OIPTT Director, Ken Kirkland attributed this increase, in part to a new push from the State legislature and ISU Board of Regents who would like to see greater economic development returns in terms of business creation and jobs. Discussing the relative returns from licensing to startups or to established firms, Dr. Kirkland commented "if we license to a startup we're not going to get the same kind of licensing fees ... on the other hand (the startups) tend to be very focused on a particular technology and will likely make sure that (the innovation) is used."

Together, OIPTT and ISURF are composed of 13 professional staff, and the Director and Associate Director hold joint positions in OIPTT and ISURF. OIPTT and ISURF staffs work in teams involving an invention disclosure manager, IP portfolio manager, and licensing managers, who meet on a weekly basis to coordinate activities.

University of Akron

UA is a good example of a university that focuses on and leverages its core research strengths. UA's excellence in polymer research is nationally known, and most of UA's patents and startups are in some way linked to its polymer research. As part of President Luis Proenza's strategic plan, UA leveraged the University's core strengths to increase research funding, enhance relations with industry, and expand technology transfer. As part of the plan, President Proenza recruited nationally known professionals in research and technology transfer.

In FY 2005 UA placed in the top 10 for patent applications and patents issued, relative to research expenditures. In addition, from FY 2000-05 UA launched 14 startups. In FY 2005 alone UA launched four startups, placing it sixth nationally, relative to research expenditures. This is quite an achievement when one considers that prior to 1999 the State of Ohio did not allow faculty to own businesses.

Technology transfer activities are shared by the Office of Technology Transfer (OTT) and the University of Akron Research Foundation (UARF), a not-for-profit organization that provides IP management services. UARF receives and disposes of equity in University startups, and creates and holds for-profit companies as wholly-owned subsidiaries. In 2005 UARF expanded its activities by creating both non-profit and for-profit corporations to commercialize non-core IP derived from industry partners. UARF also manages the post-award processes for industry-sponsored research agreements. By combining some technology transfer functions and sponsored research functions, UARF intends to protect IP and improve commercialization potential earlier in the research process. Moreover, UARF administrators believe that the Foundation's handling of research agreements has reduced contract-related bureaucracy and facilitated industrial collaborations.

A major contributing factor to UA's successful technology transfer is its strong relationships with industry. UA focuses considerable attention to research and technology transfer activities that build collaborative relationships with industry in Northeast Ohio. It accomplishes this in part by working either directly or through the for-profit subsidiaries that it establishes. One of its for-profit subsidiaries, University Innovation Ventures (UIV), conducts a number of services for Northeast Ohio and Fortune 500 firms including realigning product development and networking companies to maximize each company's commercial potential. We discuss other industry related UARF activities under "Industry Research and Related Partnerships."

Rensselaer Polytechnic Institute

In 1976 the late George Low became President of Rensselaer Polytechnic Institute, where he spearheaded the Rensselaer 2000 Plan. Unusual for its time, the Plan laid out strategies for multi-disciplinary research centers linking higher education, government, and industry, the Incubator Program, and the Rensselaer Technology Park. His leadership and vision transformed the Institute and contributed to diversifying and strengthening the region's economy. Later Presidents such as Roland Schmitt continued to build RPI's research base. RPI's current President, Shirley Ann Jackson, is significantly expanding and diversifying the Institute's education and research through the new Rensselaer Plan.

RPI is an example of research excellence and strategic planning that have resulted in successful technology transfer. Long before most universities, RPI had developed a strategic plan – the Rensselaer Plan – that emphasized research excellence, promoted inter-disciplinary research, and laid the foundation for an entrepreneurial infrastructure that included one of the nation's first university incubators and research parks. Moreover, the Plan set technology transfer as a goal and "legitimized" it as an important academic activity. The Plan also recognized the Institute's role and commitment to improving the region's economy.

RPI has an exceptional number of patents and is also strong in executing new licenses and launching startups. In FY 2005 RPI applied for 73 patents, placing it fourth nationally relative to research expenditures. From FY 2003-05, RPI launched eight startups, and it consistently launches between two and four startups each year.

Created in 1990, RPI's Office of Technology Commercialization (OTC) until FY 2001 was staffed by only one full-time employee. The Office underwent significant changes, and by FY 2006 had increased its staff to eight full-time employees and one part-time employee. The OTC Director said that the "Rensselaer Plan" provided the justification for increasing the staff, and RPI's President Jackson fully supported the enhancement of technology transfer activities.

OTC has close working relations with the Institute's entrepreneurship programs. In 1996, RPI created a virtual group – the Rensselaer Technological Entrepreneurial Council (RenTEC) – that brought together the OTC with the Incubator, RPI Technology Park, and the Lally School of Management and Technology. OTC and the RPI Incubator are now part of Intellectual Property, Technology Transfer and New Ventures, and the Executive Director of this unit reports directly to President Jackson. Today, the linkages between technology transfer activities and RPI's entrepreneurial activities remain high. We discuss more about the RPI Technology Park and entrepreneurial services under "Entrepreneurial Development."

DID YOU KNOW

- ❖ Brigham Young University with only \$24 million research expenditures in FY 2005 had 115 active licenses.

Brigham Young University

Located in Provo, Utah, BYU is one of the nation's largest private universities, and is closely aligned to The Church of Jesus Christ of Latter-Day Saints (commonly known as the Mormon Church). Given its modest \$24 million research expenditures (FY 2005), BYU would seem an unlikely university to exhibit stellar technology transfer outcomes. Since BYU's technology transfer program started in 1987, the University has launched 55 startups; in 2006 about half of the startups were still in existence and about half had remained in Utah.³¹ In FY 2005 alone BYU spun off four startups, placing it first nationally relative to research expenditures. In addition, the University executed 18 licenses and had 115 active licenses, placing it second and first respectively, relative to research expenditures. Many of the active licenses involved copyrights, and most of the licenses went to Utah companies. In FY 2005 BYU also filed 64 patents, placing it first nationally relative to research expenditures.

Brigham Young University's Creative Works Office (CWO) is responsible for more than 100 active licenses involving copyrights. The CWO focuses strictly on copyrighted materials such as software, videos, music, instructional materials, and other areas that according to the CWO Director "do not quite fit into the more traditional technology transfer approach."

³¹ Information is based on an interview with Lynn Astle, Director, Technology Transfer Office, BYU.

BYU's IP services are divided among three professionals – one who directs the Technology Transfer Office (TTO), another who directs the Creative Works Office (CWO), and a copyright manager. The TTO manages IP and patents generated by BYU research related to science, engineering and technology. The CWO manages IP that is “creative” in nature such as artistic and instructional innovations. The copyright management office is responsible for in-licensing instructional materials.

Started in FY 1996, the CWO focuses strictly on copyrighted materials such as software, videos, music, instructional materials, and other areas that according to the CWO Director “do not quite fit into the more traditional technology transfer approach.” The CWO Director, Giovanni Tata said that BYU was a pioneer in the area of treating copyrighted materials as innovations. The CWO Director said that unlike the activities of the TTO, the CWO's handling of copyrighted materials requires a much higher deal flow to produce revenue. This need for a higher deal flow necessitates interaction with a greater number of faculty members who have smaller projects.

The CWO also is quite unusual in that it has established some facilities to advance and promote copyrighted licenses. It has set up a production facility that produces language software which is licensed by the University. The CWO also helps the School of Music with the promotion of a private music label. Because of the nature of their licensing activities, the CWO maintains close working relationships with the University's Center for Instructional Design, and music and drama departments.

BYU has an IP policy that strongly favors faculty innovators; 45 percent of royalties go directly to the innovator. The faculty innovators can elect to forgo the 45 percent and reinvest the returns in their research, in which case the University matches it equally. This arrangement provides a powerful incentive for innovators to reinvest their returns in BYU research. According to the Associate Academic Vice President for Research and Graduate Studies, a significant percentage of faculty innovators forgo the personal 45 percent income in order to leverage greater funds for their research. Another 27.5 percent of the royalties go to the innovator's college; and the remainder goes to the TTO or CWO. The TTO traditionally has passed on 15 to 20 percent to the Associate Academic Vice President to be used for student mentoring and other research related activities.

The TTO Director emphasized the importance of strong relations with individual faculty members. Moreover, because BYU has limited research expenditures, research projects tend to be small and focused, and this manageable number of research projects makes it possible for technology transfer professionals to personally know individual researchers. These personal relationships facilitate early identification of potential commercialization opportunities. BYU also encourages entrepreneurship in students and faculty through research mentoring activities, and the University has a strong Center for Entrepreneurship.³² We discuss BYU's mentoring activities under “Building a Research Base to Feed the Innovation Pipeline” and entrepreneurship activities under “Entrepreneurial Development.”

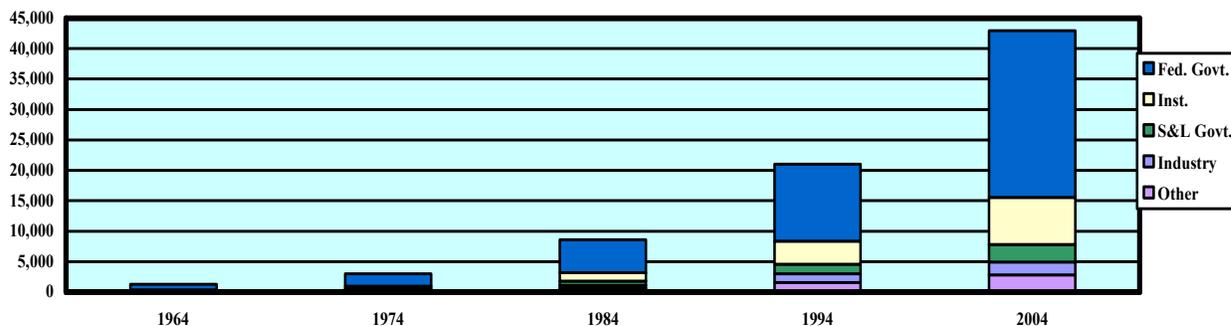
³² BYU Center of Entrepreneurship is nationally ranked 12th by the “The Princeton Review and Entrepreneur” magazine, October 2006.

BUILDING A RESEARCH BASE TO FEED THE INNOVATION PIPELINE

Although not the subject of this report, we briefly discuss the importance of building a strong, strategic research base to feed the innovation pipeline. For this and previous reports, IA asked directors of successful technology transfer offices about the factors that contributed to their success. One consistent response was the critical importance of a strong and focused research base.

In FY 2004 R&D expenditures at universities and colleges totaled more than \$43 billion dollars.³³ In the past 20 years, there has been a dramatic and steady rise in university research expenditures; in FY 2004, research expenditures were five times that of expenditures in FY 1984. (See Figure 3.) The federal government has been the major funding source for university research. In FY 2004, 63.8 percent of university research funding came from the federal government; 18.1 percent from institutional funds; 4.9 percent from industries and the remainder from a combination of state and local governments, and other sources.

Figure 3
R&D Expenditures at Universities & Colleges
by Source of Funds
FY 1964-2004 (in \$ millions)



Source: National Science Foundation/Division of Science Resources Statistics, Table 1.
R&D expenditures at universities and colleges, by source of funds: FY 1953-2004.

Over 20 years (FY 1984-2004) growth in federal funding mirrored that of total research funding growth, while the growth of state and local, and industry funding slightly lagged behind.³⁴ In more recent years, industry funding of R&D declined substantially as a portion of total funding, from a high of 7.4 percent in FY 1999 to 4.9 percent in FY 2004. This factor is particularly important because it not only affects the total amount of R&D funding available to universities and colleges but also affects the types of research conducted at institutions as well as the opportunity for industries to have input on institutional research. A NSF InfoBrief in January 2007 showed that industrial funding for R&D in academic science and engineering (S&E) fields

³³ National Science Foundation/Division of Science Resources Statistics, Table 1. R&D expenditures at universities and colleges, by source of funds: FY 1953-2004. NSF.

³⁴ *ibid.*

had reversed and grown in FY 2005, bringing the share of industrial funding to 5.0 percent, about the same share as in FY 1983. However, the share for industrial funding of R&D is still well below that of six years earlier.³⁵

In FY 2004 the U.S. Department of Health and Human Services (HHS) was by far the largest funding source of academic R&D expenditures, funding a little more than half of all expenditures.³⁶ Life sciences represented 59.7 percent of all R&D expenditures and this area has grown steadily as a portion of total R&D expenditures at universities and colleges. Engineering represented 14.7 percent, physical sciences represented 8.3 percent, and environmental sciences represented 5.5 percent.³⁷

It is well accepted that most universities and colleges successful in technology transfer and commercialization have substantial research bases. Although the research base is not the only factor that affects technology transfer and commercialization outcomes, it is certainly a critical one. When we correlated research expenditures at U.S. universities and technology transfer

Table 2
Technology Transfer Outcomes Correlation
To Research Expenditures
U.S. Universities (FY 2005)

TECHNOLOGY TRANSFER OUTCOMES	CORRELATION
Licenses & Options Executed (N=151)	.779
Cumulative Active Licenses (N=150)	.804
Startups Launched (N=147)	.667
U.S. Patents Issued (N=150)	.846
Patent Applications (N=150)	.733
License Income (N=150)	.196

Source: Innovation Associates Inc. based on data from the AUTM Licensing Survey™: FY 2005.

Note: Pearson correlations (r =) of technology transfer outcomes with FY 2005 research expenditures. Outcomes were reported by U.S. universities and colleges responding to the FY 2005 AUTM Licensing Survey.™

³⁵ “Industrial Funding of Academic R&D Rebounds in FY 2005,” NSF 07-311, National Science Foundation, January 2007.

³⁶ National Science Foundation/Division of Science Resource Statistics, Table 69. Federal financed R&D expenditures at universities and colleges, by science and engineering field and federal agency: FY 2004.

³⁷ National Science Foundation/Division of Science Resource Statistics, Table 4. R&D expenditures at universities and colleges, by source of funds and science and engineering field: FY 1997-2004.

outcomes reported by institutions to the AUTM Licensing Survey,TM we found significantly high correlations between research expenditures and all major technology transfer outcomes except license income. There is an especially high correlation between research expenditures and active and new licenses. (See Table 2.)

Institutional Strategies for Building Research

Although there is a high correlation between research expenditures and technology transfer outcomes, academic institutions that have modest research funding should not be discouraged. In this report we show that some universities and colleges with relatively little research funding are successful in technology transfer and commercialization. UNC Charlotte and BYU, for example, each have annual research expenditures of about \$25 million and yet execute a significant number of licenses and launch numerous startups.

Based on our observations for this and previous studies, successful academic institutions strategically target and leverage their research strengths to achieve impressive technology transfer outcomes. Often the leaders in these institutions have a vision to expand research and do so by developing strategic plans that identify and build core research strengths, often by hiring nationally prominent researchers. These institutions then capitalize on the expanded research through technology transfer. Many exemplars leverage regional industrial strengths as well as university research strengths. They engage industries as partners in the strategic development process and later tap the industries to sponsor research. In addition, institutions significantly benefit from state technology programs that, in some cases, provide substantial R&D funding. Institutions such as RPI, AU, and UA have combined state awards and industry funding to leverage greater federal funds. As some exemplars' research expenditures grow, the institutions leverage their core research to branch out into related multi-disciplinary research, expanding the breath of innovations. We discuss several examples here of institutions that effectively built and leveraged their core research.

University of Akron

At UA, President Proenza set out to identify the University's underlying competitive advantage and to leverage that advantage. He focused on UA's historical research strengths and ties to the region's chemical and polymer industries. The University focused on developing and leveraging science and engineering innovations, particularly chemistry with polymers (including polymers, biomedical engineering, and chemical engineering). President Proenza further committed to increasing sponsored research in areas of core research strengths by hiring nationally recognized faculty, improving and expanding facilities, increasing industrial partnerships and aggressively seeking federal funding. The University's focus and commitment to expanding research and leveraging core strengths paid off. UA almost doubled its research expenditures since the mid-1990s, from \$15.5 million (FY 1996) to \$28 million in FY 2004.³⁸ Polymer research comprised about 35 percent of the total research expenditures and represented the majority of industry-sponsored research. While industry funded research averaged 4.9 percent in universities

³⁸ National Science Foundation/Division of Science Resources Statistics, Table 1. R&D expenditures at universities and colleges, by source of funds: FY 1953-2004.

nationwide, it represented 12.6 percent of UA's total research expenditures.³⁹ Additionally, UA's planned National Polymer Innovation Center, its new Polymer Engineering Center, and its participation in multiple state-funded Third Frontier projects were fueling the University's research expansion and collaborative industry research efforts.⁴⁰

Alfred University

In FY 2005 AU had research expenditures of a little more than \$8 million, a substantial achievement for a university with only 2,500 students and about 300 faculty members. One-fourth of the total research expenditures came from industry, and this rate is exceptionally high compared to the national average. State government provided another 28 percent of total research funding.⁴¹

AU's former President, Edward Coll, who was President of AU from 1980-2000 has been credited with bringing substantial changes to AU and raising its international reputation. President Coll had a vision of changing AU from an educational institution to one that also excelled in research. President Coll actively attracted and engaged corporate heads and community leaders in AU's Board and raised funds that were used to attract top faculty and construct laboratories. In addition, Richard Ott, a former Provost in the 1980s made a commitment to make AU a research university and focused on building up the University's ceramics research. He worked with the State of New York and used the alumni contributions brought in by President Coll to leverage State funding. He also fostered a partnership with Corning Inc., and AU, Corning and the State joined forces to create New York's "Ceramic Corridor." The State funding and philanthropic contributions expanded AU's research centers, particularly the Center for Advanced Ceramic Technology, and that expansion attracted greater industry-sponsored research. In addition, AU successfully lobbied its U.S. Representatives to fund specific research projects and these projects were effective in enhancing AU's ceramics research base. AU attracted federal funding from NSF, U.S. Department of Justice, U.S. Department of Energy and U.S. Department of Defense. In the early 1990s, AU attracted some of the world's top researchers in ceramics. The combination of AU's four funding sources – State, industry, philanthropic, and federal government – has allowed AU to greatly expand its research base in ceramics and related areas. These initiatives have provided greater opportunities for faculty and students to work with industry and have provided educational advantages and opportunities for spinoffs.

³⁹ National Science Foundation/Division of Science Resource Statistics, Table 33. Industry-financed R&D expenditures at universities and colleges, ranked by FY 2004 expenditures for the first 200 institutions: FY 1997-2004.

⁴⁰ The State of Ohio in February 2002 initiated the Third Frontier Project, a 10-year, \$1.6 billion initiative to expand the State's high-tech research capabilities and promote innovation and startups. For more information go to http://www.ohiochannel.org/your_state/third_frontier_project/index.cfm.

⁴¹ Table 33. R&D expenditures at private universities and colleges, ranked by all R&D expenditures for the first 100 institutions, by source of funds: FY 2005. NSF.

INDUSTRY RESEARCH AND RELATED PARTNERSHIPS

As we have discussed in the previous section, industries fund a small portion of total research expenditures in most academic institutions. Industries nevertheless are important partners in the research process, especially in academic institutions that have modest research expenditures. In some of these institutions, industries fund a much larger share of total research and thus have a greater role in the research process. Industries add value by bringing a “real world,” market perspective to academic research, and research collaborations may facilitate future technology transfer by establishing a potential customer base. Several exemplars highlighted in this report had highly productive research relationships with industries. In some cases, these research relationships contributed substantially to the direction and outcome of the academic institution’s research, including licensing of innovations stemming from that research.

Federal and State Collaborative Research Programs

Federal and state collaborative programs played a significant role in research at many exemplars. More than half of the university exemplars selected for this report had NSF I/UCRCs: AU (Center for Glass Research), BYU (High-Performance Reconfigurable Computing), ISU (Center for Non-Destructive Evaluation, Center for Cyber Protection, and Power Systems Engineering Research Center), RPI (Connection One: Communication Circuits and Systems Research Center), UNC Charlotte (Center for Precision Metrology), and UCF (Center for e-Design).⁴² The I/UCRCs partner universities and industries for research and transfer of ideas and innovations.

Several of the exemplar I/UCRCs actively generated licenses and spun off startups, but more importantly they contributed to technology transfer in a broader manner that was not always reflected in the outcome data. These important outcomes included free exchange of ideas between universities and industries; “real world” training of students and faculty, and reciprocal transfer of techniques and knowledge that updated academic curricula as well as improved commercial products and processes.⁴³

In addition to NSF I/UCRCs, states provided funding for collaborative research at several exemplars. Some exemplars effectively used the state awards to leverage federal funding as well as attract additional industrial funding. Two exemplars – RPI and AU – had New York Centers for Advanced Technology (CAT). The CAT program was created by the State of New York in 1983 to facilitate the transfer of technology from the State’s research universities into commercially viable products produced in the private sector.⁴⁴ Another exemplar – UA – was the recipient of an Ohio Third Frontier project. The Ohio Third Frontier provides state grants to support academic-led, industry-university collaborative research and technology transfer. Some of these grants are intended to develop specific technology areas such as the Engineering and Physical Science Research and Commercialization Program (EPSRCP), the Fuel Cell Development Program, and the Wright Center of Innovation in Biosciences. In 2005 the State of

⁴² AU has a graduated I/UCRC – the Center for Glass Research – that was funded by NSF from FY 1986-2006.

⁴³ For more on NSF Industry/University Cooperative Research Centers see <http://www.nsf.gov/eng/iip/iucrc>.

⁴⁴ For more information on New York Centers for Advanced Technology see <http://www.nystar.state.ny.us/cats.htm>.

Ohio awarded UA a major EPSRCP grant that is being used to leverage additional industrial and federal funding.⁴⁵

Corporate relationships with academic institutions can influence the direction and outcome of the institution's research, including the licensing of innovations that stem from that research. In addition to research collaborations, various university services to and interaction with industries can build mutual trust and promote a university-industry innovation base that ultimately facilitates technology transfer.

Other Academic Relationships with Industries

In addition to forming collaborative research partnerships with corporations, exemplars collaborated with industries in variety of ways. Some academic institutions provided a wide range of corporate services that disseminated innovation and know-how, offered experiences for students and faculty, and facilitated feedback and input to the institution's educational mission. These relationships also helped form a base for technology transfer and commercialization activities as well as other research and education functions. Some of the many ways in which corporations interacted with exemplars included (but were not limited to)

- Sponsoring research and participating in research consortia.
- Contributing endowed chairs, facilities, equipment, scholarships, etc.
- Leasing/procuring laboratory equipment and space.
- Purchasing technical services such as testing and evaluation.
- Purchasing business services such as market analyses, business planning, etc.
- Sponsoring student and faculty internships.
- Providing adjunct expert faculty.
- Participating on advisory boards.
- Mentoring university-based entrepreneurs and startups.
- Participating on peer review panels for research grants.
- Purchasing continuing education instruction and customized workforce development.

These activities benefited the private enterprise by transferring the academic institution's technological innovations and know-how and benefited the academic institution through reciprocal transfer of technical knowledge and know-how. Moreover, the corporate services and activities established relationships that ultimately added value to technology transfer and

⁴⁵For more on the Ohio Third Frontier Project see http://www.ohiochannel.org/your_state/third_frontier_project/index.cfm.

commercialization activities. We provide some examples here of exemplars' collaboration with industry, and discuss collaborative activities related to entrepreneurship in the next section.

Examples of Research and Other Industrial Collaborations

Iowa State University

ISU has a long history of working closely in a variety of ways with the State's agriculture and manufacturing sectors. One way in which ISU works with industries is through its Company Assistance program at the Institute for Physical Research and Technology (IPRT). IPRT is a network of scientific research centers that conduct inter-disciplinary research. IPRT Company Assistance involves three major functions: (a) technical assistance, (b) contract research, and (c) commercialization assistance. The IPRT's Technology Commercialization Acceleration Program (TCAP) helps entrepreneurs and early-stage companies develop new products and processes. For very early-stage businesses, TCAP conducts proof-of-concept research on a cost-shared basis. This may involve matching the business with a faculty researcher or providing other research services. In the case of a startup, TCAP works with the startup in product development, market research, and business model development. IPRT also provides contract services for about 20-25 large companies per year, many of which are "Fortune 500" companies. Services to these companies often involve product improvements and testing. IPRT works closely with the ISU Industrial Liaison, the ISU Research Foundation, and the Pappajohn Center for Entrepreneurship, and representatives from these programs meet regularly to discuss projects that may need additional business assistance, IP protection, and partners and customers. In FY 2005 IPRT conducted 33 product development and process improvement projects with Iowa companies.⁴⁶ IPRT's Company Assistance programs are supported by the Iowa State Legislature through a line item to the Iowa Department of Economic Development.

Some of ISU's other research centers and pilot plants also provide product development, testing, evaluation, and training to companies. The Innovations Development Facility (IDF) of the Plant Sciences Institute focuses on the development and commercialization of ISU's world-renown plant sciences research, including the creation of startups based on the research. IDF has two components: incubation space housed in the Roy J. Carver Co-Laboratory, and a Public/Private Partnership Program for private sector companies to collaborate with ISU scientists. We discuss these activities in greater detail under "Entrepreneurial Development." In addition, ISU has a strong MEP and Center for Industrial Research and Service that provide a variety of technical assistance to manufacturers throughout the State. In FY 2005 these programs contributed to \$683 million in new and retained sales by Iowa firms and helped create almost 900 jobs.⁴⁷

Rensselaer Polytechnic Institute

A good example of how RPI builds effective industrial partnerships that result in technology transfer is the Institute's Center for Automation Technologies and Systems (CATS). Founded in

⁴⁶ "Iowa State University Economic Development Accomplishments and Highlights of Technology Transfer Activities FY 2005", Iowa State University, 2006.

⁴⁷ *ibid.*

1988, the CATS has a long established working relationship with industry that ranges from collaboration on basic research to manufacturing system design and product line development. The CATS was one of the first RPI centers established as part of the late President George Low's strategic vision to involve industrial partners in building the Institute's research base.

What you do has to make a difference to the industry's bottom line. It has to really impact their business with something that they can carry forward ... If it is something that is critical to (the industry) they will put the time and resources into it ... You need to be in their critical path.

- John Wen, Director, Center for Automation Technologies and Systems, Rensselaer Polytechnic Institute

In 2006 the CATS worked with over 30 companies, and served multiple functions as a clearinghouse, and conduit to faculty for problem solving, developing prototypes, testing and evaluation, and other services. The CATS program has generated a number of RPI patents, licenses and startups and in 2006 at least three of those startups were still in business. The CATS Director believes that the Center's success in commercializing its research is due to their ability to build long-term relationships with industry that are based on credibility and trust.

Advice from a Successful University Startup

Technological entrepreneurship is a rapidly developing field, but more could be done to keep pace. When you're in academia it's hard to keep pace with what industry wants and there's a big gap – that's where collaboration with companies is key. We've provided advice and developed an (engineering) program at RPI, and helped make sure that what is taught is relevant. It's a big investment on our part and on the Institute's part too; but if we waited a couple years, the technology would already be out of date. This is why we also support the co-op program ... You need that tight connection (between industry and academia) and close proximity helps ... It comes down to the university making the investment and commitment, and having faith in startups.

- Karthik Bala, Founder and CEO, Vicarious Visions

Alfred University

AU has been unusually successful in working with corporations and attracting corporate research funding. As we discussed in the previous section, the University developed a research strategy that centered on the ceramics industry, and did so in part to assist and advance the region's predominant industry. The majority of AU's industry research funding goes to the Center for Advanced Ceramic Technology (CACT).

The CACT performs about \$3-4 million research each year. Research is funded by the New York State Office of Science, Technology and Academic Research (NYSTAR), industry members, industry-sponsored research, and the federal government. Through the CACT's Industrial Affiliates Program, industrial members participate in research and technology transfer. Affiliates range from one-person startups to *Fortune 500* corporations. In 2006, 25 corporate affiliates were able to access research, faculty consultations, analytical testing, trouble shooting, and short courses tailored to the industries.

The CACT and other AU centers interact with industry on short-term and long-term projects. Short-term projects include testing and evaluation, problem solving, and trouble-shooting. Long-term projects are usually conducted over 12 months and involve non-proprietary or proprietary research. In non-proprietary research a graduate student often is involved with a faculty principal investigator. For small companies, the CACT and other AU centers also provide valuable resources such as fabrication and characterization facilities and for large companies, they provide added value research, testing and evaluation capacity.

Through the CACT Industrial Associates Program, industries sponsor a senior undergraduate student for their senior project. In this program, undergraduate ceramics engineering, materials science and glass science students are linked with New York companies for a summer or a summer plus a semester and participate in on-site industrial internships under the direction of a faculty advisor. According to the CACT Director, industries find this program the most useful of any CACT program.

University of North Carolina at Charlotte

In 2000 UNC Charlotte created a new institute – the Charlotte Research Institute (CRI) – that is intended to serve as a portal for industry-university technology partnerships and commercialization. CRI is located on the UNC Charlotte campus but is incorporated as a separate non-profit organization; it is an umbrella research organization that serves multiple and inter-disciplinary research including emerging areas such as bioinformatics, biomedical engineering systems, and translational research. At the writing of this report, CRI had completed two buildings that housed UNC Charlotte Centers in Precision Metrology, Optoelectronics and Optical Communication, “eBusiness” Technology (Institute), Motor Sports and Automotive Research, Biomedical Engineering Systems, and Bioinformatics.

CRI offers a variety of opportunities to engage faculty and use specialized facilities that are available at UNC Charlotte. CRI focuses on academic-business partnerships and provides services ranging from advisory consultation to on-site, side-by-side research with industry that is

intended to lead to commercialization. It also includes incubation space to capture startups resulting from the collaborative research. In 2007 CRI began operating the Five Ventures Business Plan Competition and a yearly conference that targets the biotechnology industry.

Facilitating Industrial Access and Input

One way that exemplars help corporations gain access to university resources, including research and technology transfer services, is to establish a central corporate relations office that receive and route corporate inquiries. RPI's Corporate Relations Office, for example, routinely routes corporations to appropriate research centers and helps regional entrepreneurs connect with Incubator and Technology Park services. Some institutions also have developed Web portals to help corporations navigate through the academic maze. ISU is one of the exemplars that did a particularly effective job of channeling industries to University services through a clearly identified "Point of Contact: Assistance to Business and Industry" that could be accessed on the University's Web site.

Many exemplars also involve the private sector in strategic planning activities and advisory boards. As part of UNC Charlotte's strategic planning process, the University organized an informal advisory committee composed of investment bankers and current and former CEOs to help the University hone in on key research areas for future development. Many members of this committee later became mentors to university-based startups. ISU also involved agriculture and manufacturing representatives on industrial advisory committees; these representatives provided on-going input on research strategies and educational curricula. Corporations also were actively involved in entrepreneurial development activities such as mentoring, and we describe these activities as part of the "Entrepreneurial Development" discussion below.

ENTREPRENEURIAL DEVELOPMENT

Many academic institutions offer entrepreneurship courses as part of their business programs, and increasingly as part of science, engineering and medical programs. In addition to entrepreneurship curricula, many institutions actively support entrepreneurial growth through a wide range of services and infrastructure. In recent years entrepreneurial development activities at academic institutions have grown substantially in scope and depth. These activities may include (but are not limited to)

- Business plan competitions.
- CEOs-in-residence.
- Commercialization assistance.
- Continuing entrepreneurship education.
- Enterprise/venture forums.
- Extension services that may include startups.
- Incubators and research parks.
- Management, marketing and other business services for startups.
- Mentoring.
- Networking.

- Seed capital investments and linkages.
- Seminars, workshops and “boot camps.”
- Student entrepreneurship societies.
- Student internships in startups and venture capital firms.

Exemplars for this and previous reports have shown that many academic institutions successful in launching startups as part of their technology transfer and commercialization efforts effectively link technology transfer with entrepreneurial development services in the institutions and/or with services in the community and state. These institutions usually have incubators and the institution’s entrepreneurial services often are based at the incubator or are associated with the incubator. Successful institutions also actively facilitate access to sources of investment capital, and provide networking opportunities. We address below some entrepreneurial activities sponsored by exemplars including examples of incubators, research parks, enterprise forums, mentoring and business plan competitions.

Incubators

Incubators are one of the most common and important forms of academic support for startups. Many academic-affiliated incubators not only house startups from the academic institution but also house at least as many non-affiliated startups from the community. These startups often seek the credibility that is associated with academic institutions and sometimes access to university researchers and laboratories. University-based incubators can range from a few offices located in a university department or laboratory to stand-alone buildings on the campus or grounds of a university research park. All exemplars for this report had incubators associated with the institution, and we briefly discuss several here.

Iowa State University

ISU has several incubators that provide offices, access to research laboratories, and linkages with university faculty and researchers. Two research centers – the Center for Crops Utilization Research and the Plant Sciences Institute – provide incubation space that is integrated into the laboratories and designed for entrepreneurs that work in research fields related to the laboratories. The Innovations Development Facility (IDF), an incubator in the Plant Sciences Institute, was started in 2001 with a \$.5 million loan from the State that was matched equally with private funding. The Institute’s goal of starting four businesses in five years, based on the Institute’s technologies, was met in the first year of operation. The incubation space is small (a little less than 200 square feet), providing just enough space for six groups of entrepreneurs. It gives the entrepreneurs the advantage of being part of a research laboratory environment, which is a familiar environment for faculty and researchers.

The Iowa State Innovation System (ISIS) program is made up of two incubators located in the ISU Research Park – one is a conventional mixed space incubator and the other is located in a separate building and includes a wet lab and office space. Early-stage tenants receive “strategy-driven” assistance almost on a daily basis. As startups mature, ISIS services become more focused on specific tasks and involve milestones. The ISU Pappajohn Center for Entrepreneurship operates in partnership with the Small Business Development Center and ISU

Research Park to provide business development and outreach services to incubator tenants. In addition, about 200 “entrepreneurial interns” work for tenants. The majority of the interns come from a variety of computer, engineering and science disciplines.

Springfield Technical Community College

We want to create a new paradigm in the community to encourage people to create their own businesses. We want to get students to create their own jobs and take charge of their futures.

- Thomas Goodrow, Vice President, Division of Economic and Business Development, Springfield Technical Community College

STCC has created an unusual entrepreneurial environment for a community college. It is one of the few (and may be the only) community college to have a research park and it has two incubators located in the STCC Technology Park – the Springfield Business Incubator and the Entrepreneurial Institute’s Student Business Incubator. The Incubators are co-located and work closely together.

According to the STCC Vice President of Economic and Business Development, the Springfield Business Incubator (SBI) by 2007 had supported 24 businesses and created 200 jobs in the Springfield region. SBI tenants are guided throughout their incubation period by the Scibelli Enterprise Center Advisory Board, a group of successful area business professionals who volunteer their time and expertise to mentor resident entrepreneurs. Partnerships with several near-by colleges provide residents with additional services. About six attorneys and six graduate business students from the Western New England College Schools of Law and Business give SBI residents free legal, business and marketing assistance. Marketing students from Springfield College develop market plans for SBI tenant businesses. Professionals from the University of Massachusetts-Amherst Family Business Center help critique business plans and provide additional advice to incubator residents. At the writing of this report, STCC also was discussing a potential partnership with the Pioneer Valley Life Sciences Institute (PVLISI) that would provide additional business support and training, and potentially involve collaboration on wet lab space.

University of Central Florida

Started in 1999, the UCF Technology Incubator in 2004 was named “Technology Incubator of the Year” by the National Business Incubation Association. Since the Incubator’s inception, it has helped about 90 companies from the University and the community. About one-fourth of the 90 companies have received some type of venture capital, and Incubator staff helped residents secure about \$6 million in SBIR awards and other government contracts.

Our motto is: it takes a community to raise a technology company.

- Carol Ann Dykes, Chief Operating Officer, University of
Central Florida Technology Incubator

The Incubator holds “Incubator Showcases” about four times per year in which Incubator residents present business plans to potential investors. The Incubator and UCF Venture Lab provide coaching to entrepreneurs in preparation for their presentations. In addition to Incubator staff, four “entrepreneurs-in-residence” are available to clients. The Incubator also has a network of service providers that staff can refer to resident entrepreneurs. Several service providers are available free to clients for about one-half day per month. In addition, four corporate attorneys provide some *pro bono* services to Incubator clients.

The Incubator is located in three buildings of the Central Florida Research Park. In addition, the Incubator rents space in a downtown Orlando office building located in a Historically Underutilized Business (HUB) zone. The UCF Technology Incubator also has partnered with the Seminole Technology Business Incubation Center to provide incubation at Seminole Community College.

Research Parks

Many university research parks are developed mainly as real estate investments. But some universities create research parks as part of a comprehensive strategy to nurture university-based and community entrepreneurs by providing greater proximity and access to university researchers, services and facilities. These research parks add value to and create synergy among university research, technology transfer, commercialization and entrepreneurial activities. The ISU Research Park and RPI Technology Park are examples of these “value-added” research parks.

Iowa State University

In 1987 ISU, the ISU Foundation, and state and local governments created the ISU Research Park as part of an effort to create an entrepreneurial environment around the University. By late 2006 the ISU Park had 43 tenant companies and five University centers that employed almost 800 people. Unlike many university research parks, ISU’s Park has focused on cultivating startups. According to Steve Carter, the Park’s Director, in 2006 about half of the tenant companies were startups or had been startups when they located in the Park and were bought by other companies.

The ISU Research Park has become a sign of the University’s commitment to entrepreneurial development. ISU’s technology transfer, commercialization, and entrepreneurial activities, and State and local commercialization funding and early-stage investments have worked together to create a solid entrepreneurial network visible at the Park. In 1992 the Small Business

Development Center relocated to the Park in order to provide business development services to Park tenants. In 1996 the ISU Pappajohn Center for Entrepreneurship was established to provide entrepreneurial services across the University, including serving tenants in the ISU Research Park.

The ISU Research Park and its technology incubator, the Iowa State Innovation System (ISIS) are the center of a comprehensive technology transfer network. It is a network that nurtures and carries technology from the lab to the marketplace. By supporting the creation and de-risking of the technology and by providing an environment for its business formation and growth, the ISU Research Park and ISIS are a vital link in the commercialization process.

- Iowa State University Research Corporation

Park staff work closely with ISU Office of Intellectual Property and Technology Transfer, and according to the Park Director, ISU's well-developed technology transfer program has contributed a number of the Park's tenants. The Park staff also work closely with the ISU Institute for Physical Research and Technology. Park staff work with the Institute's faculty inventors before they move into Research Park space and the Director believes that this work has paid off in greater retention. The Park Director credits the University's support and flexibility that have allowed him to focus on services and networking. In addition, he credits the State for contributing commercialization funds to the Institute, which has added value to entrepreneurial startups in the Park. The Director also credits the City of Ames and the Chamber of Commerce for creating a community venture capital fund that has provided early-stage capital for some Park tenants.

Rensselaer Polytechnic Institute

The RPI Technology Park grew out of a strategic vision for the Institute and the community. As part of that strategy, RPI first developed one of the nation's earliest university-based incubators, and with the very rapid success of the incubator, soon after developed the Technology Park. The Technology Park also was one of the nation's first university-related research parks. As part of the development process, RPI organized the Capital Regional Technology Development Council (now called the Council for Economic Growth), a community leadership organization to provide support for the Institute's entrepreneurial goals. The three-pronged entrepreneurial approach involving the RPI Incubator, RPI Technology Park and Council for Economic Growth has been successful in promoting technology transfer from RPI and fostering the growth of technology enterprises in the Upstate New York region.

We knew that if we didn't organize the community and the region, we wouldn't get anywhere ... We worked to create an entrepreneurial culture at RPI and in the region. Now we have \$100+ million firms like MapInfo that could go anywhere and chose to remain here.

- *Michael Wacholder, Director, Rensselaer Technology Park*

According to the Park Director, the Park evolved from an early focus on attracting and growing local firms to one that now focuses more on growing university startups and university-connected firms. Located close to RPI, a fundamental objective of the Park has been to develop interactions between tenant companies and the Institute. All companies located in the Park automatically become RPI "affiliates" and members of the "Venture Affiliates of RPI." The Park has a number of tenant companies that were started by RPI faculty and students such as MapInfo, a \$166 million software company that was started by four RPI students as a class project, and Vicarious Visions started by a RPI student. These companies continue to have close relations with university researchers, employ RPI interns, and hire RPI graduates. According to the Park Director, about 80 percent of the companies located in the RPI Technology Park have some direct connection to the university. By 2007 the RPI Technology Park was home to more than 60 companies employing 2,300 workers.

Seed and Venture Capital

The availability of seed and venture capital is critical in launching startups. Seed and venture capital are not only important to academic-based startups because they provide investment capital but also because they often provide valuable business and management expertise. Investors often hire or personally act as CEOs or CFOs for startups, at least on a temporary basis, in order to build management capacity. The added value brought by these investors is especially important for university startups that are formed by engineers and scientists who usually have little business experience. Seed and early-stage investments are particularly important to startups that normally require smaller and more "patient" capital than traditional venture capitalists provide. In addition, investors that are accustomed to working with universities are especially useful to academic-based startups that may require somewhat different handling than startups outside of academia.

The type of funding that is available to university startups ranges from university-based seed funds to local/state angel networks to state initiated "fund-of-funds."⁴⁸ As we mentioned in our discussion about technology transfer, it is important that the technology transfer office proactively establish on-going relationships with sources of investment capital, particularly those focused on seed and early-stage investments. We briefly cover three types of seed and early-

⁴⁸ For more information on seed funding see Capital Formation Institution, www.cfi-institute.org, National Association of Seed and Venture Funds, <http://www.nasvf.org>, and National Venture Capital Association, <http://www.nvca.org>.

stage investment tools used by academic-based startups: (a) enterprise forums, (b) university and community/state seed funds, and (c) business plan competitions, and provide examples under each category.

Enterprise Forums

One way that universities expose entrepreneurs to potential investors is through enterprise or venture forums. The forums give students and faculty the opportunity to present business plans to potential investors. Effective forums engage successful entrepreneurs, venture capitalists, and other business experts as mentors to give budding entrepreneurs help in refining business plans and preparing presentations. The MIT Enterprise Forum, which now operates in 18 states, and the Springboard Program sponsored by CONNECT (formerly part of the University of California, San Diego), established the processes that have been emulated by numerous universities and colleges throughout the country, including several exemplars covered in this report.⁴⁹ Many of the exemplars in this report sponsored enterprise forums or participated in forums sponsored by state and community organizations. Two examples are RPI and MSU.

The Venture B forum showcases startups from RPI and the region to potential investors. Fifteen firms, about half RPI-related, have received total investments of about \$60-70 million over eight years.

Rensselaer Polytechnic Institute: The Severino Center for Technological Entrepreneurship in the RPI Lally School of Management sponsors an investment forum – Venture B – that showcases startups from RPI and the region to potential investors. In these events, entrepreneurs typically seek investments of \$500,000 to \$5 million. The RPI Incubator takes the lead in training entrepreneurs to showcase innovations at the “Venture B” forums and arranging meetings with potential investors and alumni contacts. The forums are sponsored jointly with the Center for Economic Growth, a regional organization that provides incubation and acceleration services. Fifteen firms, about half RPI-related, have received total investments of about \$60-70 million over eight years. Other enterprise forums available to RPI entrepreneurs are UNYTECH which focuses on startups from seven universities in Upstate New York and the SmartStart Venture Forum run by the Center for Economic Growth.

Montana State University: MSU startups have access to early-stage financing through the Bridger Private Capital Network. The Network was jointly developed by TechRanch, an incubator associated with MSU, and the MSU Center for Entrepreneurship in the New West. The Network holds enterprise forums two to three times each year that showcase TechRanch and other entrepreneurs to potential investors. Members of an Advisory Board, established by the

⁴⁹ For more information on the MIT Enterprise Forum see www.enterpriseforum.mit.edu; for more information on CONNECT see www.connect.org.

Center for Entrepreneurship in the New West, provide “readiness exercises” that help prepare entrepreneurs to make presentations. TechRanch and the Center actively sought and attracted venture capitalists throughout the U.S. to participate in the regional Network that now has about 20 active investors. By FY 2006 the Network had invested about \$3 million in local deals.

University and Community/State Seed Funds

In the absence of sufficient local seed capital, academic institutions increasingly are starting internal seed capital funds. Some of these funds are intended to move university-based innovations closer to market readiness while others provide startups with small, equity-based capital. In addition, most states in which exemplars are located provide a variety of substantial entrepreneurial funding sources. ISU and UA provide examples of in-house, state-related and regional funds.

Iowa State University: ISU startups have a number of seed funding resources available to them. Through a small venture fund, the ISU Research Foundation provides about \$200,000 per year for faculty to develop near-market technologies, and from 1996-2005, they have funded about 78 projects. This fund is seeded by royalty income received from ISU inventions. In addition, startups have access to early-stage capital through the Wellmark Community Venture Capital Fund. The Fund was established by Wellmark Blue Cross and Blue Shield that committed \$5 million to assist Iowa startups. Through this program, entrepreneurs can borrow up to \$50,000 as debt, which may be converted into equity in the future. Wellmark draws the funds from savings generated by a reduction in the State’s insurance premium tax.⁵⁰

University of Akron: Northeast Ohio, as many regions, has suffered from a lack of seed capital. In response, the universities, State, regional organizations and private sector have created several angel and seed funds. Angel capital is available through the North Coast Angels and the Akron Regional CHange (ARCH) network, established by the University of Akron Research Foundation. These networks mentor as well as fund entrepreneurs in Northeast Ohio. JumpStart, Inc., a venture development organization in Northeast Ohio, offers seed capital averaging approximately \$300,000 and provides acceleration advice to university-related and other startups. The fund is supported, in part, by Ohio’s Third Frontier Pre-Seed Initiative. Based in Cleveland, BioEnterprise also helps Northeast Ohio biotechnology enterprises raise capital. BioEnterprise is a partnership of several health systems, hospitals and universities. The Summa Enterprise Group, a “center of innovation” subsidiary of Summa Health System, also offers seed capital to bio-related companies in Northeast Ohio.

Business Plan Competitions

Most exemplars sponsor business plan competitions. These competitions are an increasingly popular way to give entrepreneurial students a small amount of seed capital and more importantly, mentoring and exposure to investors. University business schools or student entrepreneurial societies often operate the competitions that involve engineering and science

⁵⁰ See Iowa State University case study for a more detailed explanation.

students competing for cash prizes to launch their businesses. Some universities encourage interdisciplinary teams of engineering/science students and business students. Most programs involve a series of mentored activities aimed at teaching students how to write business plans and present to potential investors. Volunteer business mentors from the community coach the students, and a panel of venture capitalists and other interested parties act as competition judges.

At RPI, the Tech Valley Business Plan Competition, an annual collegiate business plan gives college students throughout the region an opportunity to develop their ideas into a business. Winners of the plan receive a cash prize, the opportunity to receive seed funding based on implementation of their plan, and in-kind contributions of legal, patent, and financial services, and a one-year virtual membership in Rensselaer's Incubator Program. BYU's Business Plan Competition annually awards a total of \$130,000 in prizes to the top 16 student entrepreneur teams. The Competition is run by MBA students and a faculty advisor. Throughout the process, professionals from the BYU Entrepreneur Founders program and others mentor the teams. At UNC Charlotte, the Charlotte Research Institute sponsors Five Ventures,TM a business plan competition for faculty, staff and students at colleges and universities and other startups in the Charlotte region.

Small Business Innovation Research Assistance

Several exemplars provide assistance to help entrepreneurs and startups develop SBIR and STTR proposals and commercialize the results.⁵¹ A good example is MSU's TechLink that provides SBIR/STTR services to MSU startups and regional small businesses.⁵² For small businesses that want to develop SBIR Phase I proposals, TechLink reviews the proposals and advises the businesses on making improvements. For small businesses submitting Phase II proposals, TechLink provides commercialization experts to enhance the commercialization aspects of the proposal. They also arrange and provide a small amount of travel money to help businesses meet with federal agency program managers and prime contractors. For small businesses that already have Phase II SBIR awards, expert business planning consultants help identify and address licensing, manufacturing and other needs. In addition to MSU TechLink's services, the Montana SBIR Outreach program provides general workshops and state conferences, including STTR workshops on the MSU campus that network regional companies and University researchers. From FY 1999-2006, TechLink and the Montana SBIR Outreach program helped attract more than \$36 million in SBIR and related awards to Montana small businesses.

⁵¹The Small Business Innovation Research program is operated by 11 federal agencies that provide competitive awards, in three phases, to small technology enterprises to conduct feasibility studies, develop prototypes, and commercialize products, processes and services. The Small Business Technology Transfer program is operated by six agencies that fund competitive, phased awards to small technology enterprises in partnership with academic institutions and other non-profit research organizations. For more on SBIR and STTR programs see <http://www.sba.gov/aboutsba/sbaprograms/sbir/index.html>.

⁵²MSU's TechLink is a University unit that acts as a technology transfer intermediary between companies and federal laboratories and agencies.

Mentoring and CEO-in-Residence Programs

Mentors and CEOs-in-residence have become increasingly popular mechanisms in academic entrepreneurship settings to provide a “real world” link for faculty and student entrepreneurs. The most effective mentors and CEOs-in-residence often are successful entrepreneurs who have recently launched science and technology enterprises, particularly from academic institutions. In communities with few entrepreneurs, it is more difficult to find appropriate mentors, and in these communities, mentors tend to be business managers from major corporations. Alumni who have become successful entrepreneurs often provide a fertile mentor pool. Although entrepreneur alumni may reside outside of the university community, they often are willing to come back to their *alma matre* to deliver lectures, participate on advisory panels for enterprise forums and coach business plan competitions. BYU and ISU provide good examples of active mentoring programs.

Brigham Young University’s 140 Entrepreneur Founders support the University’s Center for Entrepreneurship in teaching and mentoring students, providing research opportunities and funding the Center’s activities. They are guided by the University’s “three privileges – to LEARN, EARN, RETURN.™”

Brigham Young University

BYU’s Entrepreneur Founders program involves about 140 practicing entrepreneurs who support BYU’s entrepreneurship programs through financial support, mentoring, and program input. These successful entrepreneurs contribute substantial time to mentoring students who are starting their own businesses. They also assist BYU in developing teaching materials, provide research opportunities for faculty and students, and often lecture and teach at the University. Each entrepreneur is expected to donate \$15,000 and make additional annual contributions to help support activities sponsored by the Center for Entrepreneurship.

Iowa State University

Started in the mid-1990s, ISU’s Executive-in-Residence Program sponsors visiting executives to teach undergraduate classes, conduct graduate seminars, meet with members of the university community and make presentations in open forums. Mentors and Executives-in-Residence normally participate for little or no compensation as a community service, and sometimes to get a “first look” at innovations in which they or their firms may be want to invest or license.

Networking

Networking opportunities ranging from informal “get-togethers” organized by incubators and organizations to formal seminars. Networking opportunities are important in promoting

innovation, technology transfer and entrepreneurship. The Biotechnology Management & Entrepreneurship Seminar Series at the RPI Lally School, for example, provides a forum for exchange and local networking for RPI and community entrepreneurs. The evening series involves speakers on various aspects of biotechnology entrepreneurship issues in partnership with Cornell University and Syracuse University, and is co-hosted by CNY Medtech (a central New York association of medical technology firms). The series is intended to create a dialogue on entrepreneurship and management within the region's emerging biotechnology industry. An RPI student Entrepreneurship Club also holds monthly meetings in which successful entrepreneurs speak to students. About 75 students attend the meetings that are held in the RPI Incubator's IdeaLab.

Other networking events conducted by exemplars include ISU's Entrepreneurship Roundtable that sponsors dinners with successful entrepreneurs, and ISU's Entrepreneurship Day that provides a more extensive day of networking. RPI and ISU also offer a full week of instruction and networking opportunities through "boot camps."

PFI ACTIVITIES IN EXEMPLARS

Several exemplars covered in this report received NSF PFI awards. The awards enhanced the institutions' innovation, technology transfer, and entrepreneurial activities. We describe the activities of three exemplars – FAMU, MSU, and UCF.

Florida Agricultural and Mechanical University

In FY 2004 FAMU initiated and took the lead in a three-year, PFI award – The TechLink Project – that involved FAMU and eight additional HBCUs. The TechLink Project involved five components: (a) technology transfer education and training, (b) development of a virtual technology transfer office and network, (c) development and implementation of an Invention Camp for middle and high school students, (d) law clinics, and (e) a mentoring program.

The NSF/PFI grant was the impetus for the other (HBCU) universities to become aware of the role that they could play in technology transfer. The grant has been a tremendous boost in enhancing their level of readiness for moving into this arena.

- Rose Glee, Director, Technology Transfer, Licensing and Commercialization, Florida Agricultural and Mechanical University

Under a subcontract, Florida State University (FSU) was responsible for the TechLink's education and training component. The component was designed to provide a series of workshops and on-site assistance that progressively advanced the technology transfer knowledge

and operational capacity of the participating nine HBCUs. The training initially involved a “readiness assessment” to gauge the technology transfer knowledge of participants, and on-site visits to determine the institution’s organizational capacity to conduct technology transfer. FSU provided training modules ranging from a basic level that covered how to set up an office, develop policies and procedures, etc. to an advanced level that included prototyping, structuring deals, and identifying seed capital investments. Because John Fraser, the Director of FSU’s technology transfer operation and leader of the PFI training activity, had been recent President of AUTM, he also involved the TechLink participants in AUTM conferences, training workshops and special interest groups.

The PFI award also supported the development and operation of an “Invention Camp,” which is a free, week-long summer camp for middle and high school students designed to stimulate creativity and innovation and generate interest in the fields of math, science and engineering. Initiated in 2005, the Camp targets middle and high school students between the ages of 12 and 18 and teaches them how to generate ideas as well as protect and transfer their ideas to the marketplace. Over a three-year period, about 100 students from 25 middle and high schools from six states and several Florida counties have participated in the Camp. The Camp has attracted much media attention and has leveraged local financial support from business organizations, Rotary Clubs, and technology firms to sustain the program beyond the initial PFI funding. The Camp is being replicated at the other eight institutions participating in the PFI project.

The Director of FSU’s technology transfer operation, over many years, has mentored FAMU’s technology transfer Director. FAMU’s Director sought to replicate her rewarding mentoring experience through TechLink’s Mentoring Program. The Mentoring Program encouraged participating HBCUs to identify and establish relationships with mentors from more established university technology transfer offices. FAMU’s Director of Technology Transfer believed that developing a mentoring or “buddy” relationship was particularly important for enhancing technology transfer operations at HBCUs and similar institutions. She encouraged HBCUs to reach out to more established technology transfer offices, particularly those located close-by, to other state universities, and to organizations such as AUTM and LES. Other PFI supported initiatives included the design of a Virtual Technology Transfer Office (VTTO) system that is intended to electronically perform some of the manual tasks conducted by technology transfer staff, inventors, administrators, patent attorneys, and government agencies.

According to FAMU’s technology transfer Director, the PFI grant allowed FAMU and FSU to develop and implement technology transfer training sessions and tools for HBCUs that would not have been possible otherwise. Some of these activities have leveraged additional financial support from the community that has allowed PFI-initiated activities to continue beyond the grant completion.

Montana State University

A NSF PFI grant to MSU involved a partnership between the MSU’s Center for Entrepreneurship for the New West, TechLink, TechRanch, and the Montana Office of Economic Opportunity. TechLink is a University unit that acts as a technology transfer

intermediary between companies and federal laboratories and agencies; TechRanch is a non-profit incubator that was established by MSU and local stakeholders.

The MSU partnership was intended to train entrepreneurs and develop technology startups that would contribute to building a critical mass of startups in the region. The partnership provided small grants to the technology startups to help them develop business plans, assess market potential and protect IP. The PFI grant also was used to support Business School interns who worked in teams with university scientists to commercialize their innovations. In most PFI projects, students conducted market and competitor analyses on behalf of the university innovator. Other projects involved students from the MSU Center for Entrepreneurship for the New West working with scientists in conjunction with TechRanch and/or TechLink.

The PFI team accomplished its original goal of establishing 12 new companies and, by FY 2006, 10 of the 12 were still in business. By FY 2006 this activity had involved more than 80 students. An IA representative spoke with several students who participated in the PFI project. Students reported that their experiences had made them much more aware of “what it took to be an entrepreneur” and provided an opportunity to network in the “real world.” An additional benefit was that one-fourth of the students who participated in the program were hired by the startups and companies for whom they had worked.

University of Central Florida

In 2004 UCF established Venture Lab as a joint initiative between the Office of Research and Commercialization, the UCF College of Business Administration, and Orange County. Venture Lab provides faculty, students and local entrepreneurs with assistance in launching businesses around their research. A grant from the PFI program provided additional funding to develop entrepreneurial services and educational workshops. The Venture Lab’s educational workshops include topics such as SBIR proposals, technology transfer, patents, copyrights and trademarks, validating venture capital fundability, and other topics. Venture Lab also provides important assistance to link entrepreneurs with potential investors; this activity was discussed earlier under “Entrepreneurial Development: Linking Academic-Based Startups with Investors.”

According to Cameron Ford, the founding Director of the UCF Center for Entrepreneurship and Innovation, the PFI grant that supported Venture Lab development and activities has helped educate and mentor faculty and student entrepreneurs. He said that the PFI grant also indirectly led to the development of two graduate certificate programs – one in entrepreneurship and one in technology commercialization, and contributed to the development of a business plan competition, the UCF “Joust.”

More detail on PFI activities can be found in FAMU, MSU and UCF case studies in Part II.

PART II: CASE STUDIES

ALFRED UNIVERSITY

BACKGROUND AND VISION

Founded in 1836, Alfred University (AU) is the second oldest co-educational college in the United States and one of the earliest colleges to enroll African American and Native American students. AU is a very small institution with about 2,000 undergraduate and 500 graduate students. It is a private institution with state-sponsored programs in engineering and art and design. The University is located in the village of Alfred, New York about one hour from Corning and one and one-half hours from Rochester.

AU is internationally known for its ceramics research and its ceramics graduate program (MFA) is consistently ranked number one in the nation by *U.S. News and World Report*. The University also consistently ranks among the top 20 master's level institutions in the northern U.S. In addition, AU has a nationally recognized program in school psychology and offers a full range of programs in liberal arts and sciences, art and design, engineering, business, education, and psychology. AU focuses both on educational excellence and close faculty and student relationships as well as research excellence. The University emphasizes research at the undergraduate as well as the graduate level, and all undergraduates are required to complete a research project before graduation. For more than 100 years, AU has had a strong relationship with industry, particularly the ceramics industry and this relationship has mutually benefited the industries' and the University's education, and research and development.

AU is unusual in that its College of Ceramics and Art is a statutory unit of the State and is supported by the State University of New York (SUNY) system. This arrangement has allowed AU to have both private engineering and State-funded programs related to ceramics that together attracted world-class faculty and built state-of-the-art research facilities. AU has six research centers and is home to one of New York's 15 Centers for Advanced Technology (CAT) – the Center for Advanced Ceramic Technology, and for many years had a NSF Industry/University Cooperative Research Center (I/UCRC) – the Industry/University Center for Glass Research.

AU's former President, Edward Coll, who was President of AU from 1980 to 2000, has been credited with bringing substantial changes to AU and raising its international reputation. President Coll had a vision of changing AU from an educational institution to one that also excelled in research. President Coll actively attracted and engaged corporate heads and community leaders in AU's Board and raised funds that were used to attract top faculty and construct laboratories. In addition, Richard Ott, a former Provost in the 1980s made a commitment to make AU a research university and build up its ceramics research. He worked with the State of New York and used the alumni contributions brought in by President Coll to leverage State funding. He also fostered a partnership with Corning Inc. and AU, Corning and the State joined forces to create New York's "Ceramic Corridor." The State funding and philanthropic contributions expanded AU's research centers, particularly the Center for Advanced Ceramic Technology, and that expansion attracted greater industry-sponsored research. AU also successfully lobbied its U.S. Representatives to fund specific research projects and these projects were effective in enhancing AU's ceramics research base. AU

attracted federal funding from NSF, U.S. Department of Justice, U.S. Department of Energy and U.S. Department of Defense. In the early 1990s, AU attracted some of the world's top researchers in ceramics. The combination of AU's four funding sources – State, industry, philanthropic, and federal government – has allowed AU to greatly expand its research base in ceramics and related areas. These initiatives have provided greater opportunities for faculty and students to work with industry and have provided educational advantages and opportunities for spinoffs.

RESEARCH AND TECHNOLOGY TRANSFER

One of the reasons that AU has been successful in spinning off businesses is that we are very flexible in working with industry and owning the intellectual property. We've been able to negotiate and accommodate the industries. In addition, much of what we do doesn't fall under the intellectual property umbrella (but it results in commercialized innovations). Since we're small, we're able to work with industries in ways that many larger universities can't.

- Alastair Cormack, Dean of Engineering, Kazuo Inamori School of Engineering, Alfred University

In FY 2005 AU had research expenditures of a little more than \$8 million, a substantial achievement for a university with only about 300 faculty members. One-fourth of the total research expenditures came from industry, and this rate is several times higher than the national average.⁵³ State government provided another 28 percent of total research funding, and the federal government provided 30 percent.⁵⁴

The Kazuo Inamori School of Engineering (SOE) is responsible for about \$5 million in funding from a combination of industry, foundations, and State and federal governments. The SOE covers a wide range of engineering programs – biomedical engineering, ceramic engineering, electrical engineering, glass engineering science, materials science and engineering, and mechanical engineering. Its research ranges from basic science investigations to the development of products for commercialization. In addition to its research, the School offers industries short courses/workshops, conferences, and other professional development activities that promote local and regional workforce development and strengthen ties to industry. Undergraduate senior projects conducted for industries, often on-site, also forge strong ties to

⁵³ The national average in FY 2005 was 5.0 percent. Source: "Industrial Funding of Academic R&D Rebounds in FY 2005," NSF 07-311, National Science Foundation, January 2007.

⁵⁴ Table 33. R&D expenditures at private universities and colleges, ranked by all R&D expenditures for the first 100 institutions, by source of funds: FY 2005. NSF.

industries. Moreover, these activities sometimes lead to future research relationships and program funding. One of AU's industrial relationships with Kyocera Corporation led to a substantial donation to the School, and in 2005, the School was renamed in recognition of Kyocera's founder and Chairman, Kazuo Inamori.

In 2006 there were six AU research centers: (a) New York State Center for Advanced Ceramic Technology, (b) NSF Center for Glass Research, (c) Whiteware Research Center, (d) Center for Biosurfaces, (e) Center for Environmental and Energy Research, and (f) Rural Justice Institute. The New York State Center for Advanced Ceramic Technology is the largest center, and is responsible for the majority of the research funding and commercialization activities.

AU has filed numerous patents and has spun off at least six startups. Other startups in the region are connected to AU through research and service relationships. Unlike other universities that we cover in this report, most of AU's technology transfer activities are informal and involve advances in innovation that are transferred through flexible industrial cooperative relationships. Because AU is a very small institution, it does not have a technology transfer office and technology transfer and commercialization activities are conducted through the centers, mainly the Center for Advanced Ceramics Technologies. The centers also work on intellectual property issues with the SUNY Research Foundation. In addition, AU's Office of Sponsored Research reviews some intellectual property issues as part of the research agreements with industries. At the writing of this report, AU was completing a new intellectual property policy to insure that the University would meet federal guidelines and provide added protection for the University and industry. We cover the Center for Advanced Ceramic Technology's industrial relationships, and technology transfer and commercialization here. We also briefly discuss the Ceramics Corridor and Innovation Center, an incubator that houses several AU and other startups that have a relationship with AU.

From 2000-06, the AU Center for Advanced Ceramic Technology (CACT) has been credited with \$219 million in economic impact to New York State. This impact included several CACT startups as well as research and services that contributed to increased/retained sales by industries.

- Based on data from the New York Foundation for Science, Technology and Innovation, 2006 Annual Report

The Center for Advanced Ceramics Technology (CACT) performs about \$3-4 million research each year. Research is funded by the New York State Office of Science, Technology and Academic Research (NYSTAR), industry members, industry-sponsored research, and the federal government. Through the CACT's Industrial Affiliates Program, industrial members participate in research and technology transfer. Affiliates range from a one-person startup to *Fortune 500*

corporations. In 2006, 25 corporate affiliates were able to access research, faculty consultations, analytical testing, trouble shooting, and short courses tailored to the industries.

The CACT and other AU centers interact with industry on short-term and long-term projects. Short-term projects include testing and evaluation, problem solving, and trouble-shooting. Long-term projects are usually conducted over 12 months and involve non-proprietary or proprietary research. In non-proprietary research a graduate student often is involved with a faculty principal investigator. For small companies, the CACT and other centers also provide valuable resources such as fabrication and characterization facilities, and for large companies, the Center provides added value research, testing, and evaluation.

Through the CACT Industrial Associates Program, industries sponsor a senior undergraduate student for their senior project. In this program, undergraduate ceramic engineering, materials science and glass science students are linked with New York companies for a summer or a summer plus a semester and participate in on-site industrial internships under the direction of a faculty advisor. According to the CACT Director, industries find this program the most useful of any CACT program.

We do much that is not normally considered technology transfer (but nevertheless) is important in transferring research results and knowledge. One major company that our faculty and students worked with estimated that they will save \$10 million each year over the next 10 years. The work did not result in a license or intellectual property but it was enormously valuable to the company and the region.

- Vasantha R. W. Amarakoon, Director, Center for Advanced Ceramic Technology, Alfred University

The CACT officially has spun off at least five startups and has contributed to advancing several additional startups. One of these startups – Saxon Glass Technologies, Inc. – was started in 1996 when a large glass maker came to AU in search of a solution to their glass strength problems. After the successful demonstration of trial runs, two professors – Arun Varshneya, AU professor of glass science and engineering, and William LaCourse, AU professor of glass science – founded the business and located it in the Ceramic Corridor Innovation Center at Alfred (discussed below). Another AU startup – XYLON Ceramic Materials – develops ceramic high-performance products that have aerospace and biomedical industry applications. XYLON was recently acquired by Refractron Technologies Corporation in New York. Another startup – Nanoset LLC – was created by an AU electrical engineering professor along with several Rochester, New York-based partners. It maintained and utilized plasma fabrication facilities at the CACT. The company was issued eight patents in advanced plasma processes and became the only American producer of a specific ceramic product that was certified by the U.S. Food and

Drug Administration. In 2001, Ceralink Inc. was founded by an AU adjunct faculty member to promote new materials and processes for commercialization. Ceralink's Microwave Testing Center provides comprehensive microwave testing for companies.

According to the latest impact study, graduating businesses from the Ceramics Corridor Innovations Centers at Alfred and Erwin, New York, by 2003, had reported combined domestic and international sales of more than \$400 million.

Many of AU's startups have been housed in the Ceramics Corridor Innovations Center (CCIC) located at the University. CCIC was formed in 1992 as part of the New York "Ceramics Corridor" effort. This effort was spearheaded by Robert Ecklin, a former Executive Vice President from Corning Inc. who formed a regional leadership group called the Committee of 50. The Committee approached AU and together they formed Alfred Technology Resources (ATC), a non-profit organization to promote incubation in the region. Through a \$10 million New York State Urban Development Corporation grant/loan, ATC started the "Ceramics Corridor" program and launched CCIC.

CCIC has two incubator facilities – the Alfred Facility at AU and the Painted Post Facility in Erwin, New York, located close to the Corning Inc. Sullivan Research Park. Since its beginning, CCIC has helped more than 19 businesses, and according to its latest impact study, CCIC graduating businesses by 2003 had reported combined domestic and international sales of more than \$400 million.⁵⁵ The Alfred Facility includes office and light manufacturing space. It currently has about five tenants including XYLON Ceramic Materials and Saxon Glass Technologies. Tenants maintain close relationships with AU faculty researchers and students who perform many research and business services for the companies.

LESSONS FOR ACADEMIC INSTITUTIONS

A small university can benefit from developing a niche research area that serves specific industry or government needs: AU with only 2,500 students has built an international reputation in ceramics that has attracted \$8 million per year in research funding. AU's ceramic research, in part, was developed to serve the needs of the region's predominant industry.

State and industry funds can effectively leverage federal research funding: AU strategically used State funds and industrial partnerships to leverage federal research funding. Each source of funding was used for slightly different purposes – facilities and equipment, attracting top faculty

⁵⁵"Ceramics Corridor," First Quarter 2003.

and researchers, and professional development and services. The combination of funds from various sources together formed a strong base for AU's research and commercialization activities.

Hiring and promotion that favors industry experience can add value to commercialization activities: AU's hiring decisions take into account not only the strength of the faculty's research but also their industry experience and/or experience with a research center that has industry linkages. This focus has helped build AU's strong applied research centers and facilitated industry and commercialization relationships.

Technology transfer isn't just "intellectual property": Technology transfer in its broadest sense involves transferring of knowledge and innovation "know-how" that advances commercial products and processes in existing businesses, and generates ideas that lead to startups. These startups may or may not be directly or immediately connected to the university. Much of the value from research center interactions with industries is not reflected in technology transfer data but nevertheless is valuable in promoting the intended goals of technology transfer and commercialization partnerships – movement of innovations from the university to the private and public sectors.

WEB LINKS

Alfred University (general):

www.alfred.edu

Center for Advanced Ceramics Technology:

<http://cact.alfred.edu>

NSF Industry/University Center for Glass Research:

<http://cgr.alfred.edu>

Center for Environmental and Energy Research:

<http://cact.alfred.edu>

Ceramics Corridor Innovation Centers:

<http://www.ceramicscorridor.org>

BRIGHAM YOUNG UNIVERSITY

BACKGROUND AND VISION

Located in Provo, Utah, Brigham Young University (BYU) was founded in 1875 by The Church of Jesus Christ of Latter-day Saints (commonly known as the Mormon Church) and today continues to be supported by the Church. With 27,000 full-time students, BYU is one of the nation's largest private universities. BYU's religious oriented mission of education and service – “to assist individuals in their quest for perfection and eternal life”⁵⁶ – pervades all aspects of the institution's teaching, research, and technology partnerships.

BYU would seem an unlikely candidate to highlight in a report on technology transfer and commercialization, and yet it has one of the nation's highest patenting, licensing and startup rates relative to research expenditures. BYU's undergraduate business programs in the Marriott School of Management are highly rated and have received national acclaim.⁵⁷ BYU's supportive entrepreneurial environment, student mentored research, and creative technology transfer professionals appear to have contributed to the University's successful technology transfer and entrepreneurial outcomes.

RESEARCH AND RESEARCH MENTORING

BYU's research expenditures are modest but growing. In FY 2005 BYU had research expenditures of \$24 million, which are double BYU's expenditures in FY 1998.⁵⁸ The University conducts research in mechanical, civil, chemical and electrical engineering, biology, and agriculture. Although BYU is primarily an undergraduate institution, it has graduate programs in a number of science and technology areas and has graduate business and law programs. BYU's new supercomputer facility is used by students and faculty to conduct a wide range of research from language modeling to DNA sequencing. BYU is known for its creative works, and students and faculty have used the supercomputer facility and a virtual reality screening room for industrial design work and for testing and screening of sophisticated student animation projects. Students have created animated short films that have won “student Emmys” and “student Academy Awards.” Most universities rely on federal funding for research, and although federal funding represents the largest share of BYU's research budget, the University restricts federal funding, allowing only six full-time-equivalent faculty to be supported by federal research funding at any one time.⁵⁹

⁵⁶ BYU Mission Statement, November 4, 1981.

⁵⁷ *Business Week* in 2007 ranked BYU undergraduate business programs eighth overall, and *U.S. News and World Report* ranked the undergraduate accounting program fifth and undergraduate international business specialty 21st.

⁵⁸ Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005. NSF.

⁵⁹ Based on an interview with Lynn Astle, former Director, Technology Transfer Office, BYU, December 2005.

BYU differs from other universities in that faculty are fully supported by Church funding, which relieves some of the faculty pressure to secure research contracts. According to Brent Webb, Associate Academic Vice President for Research and Graduate Studies, less pressure and greater service orientation have freed faculty to be more creative and “a logical outcome has been greater commercialization.” BYU’s undergraduates also differ from undergraduates at other universities since almost all of BYU’s students have completed two-year religious missions, often in foreign countries, before or during their BYU education. Because of the mandatory two-year mission experience, many students speak other languages and have work experience. This factor likely has influenced the types of licenses being executed by the Creative Works Office, which has focused heavily on language and cultural software.

Many universities are trying to generate income (from their technology transfer activities). Our philosophy is totally focused on students and faculty, and encouraging faculty interaction with students ... We have smaller, more focused research and most of it involves undergraduate students working alongside faculty.

- Lynn Astle, former Director, Office of Technology Transfer, Brigham Young University

A major thrust of the University’s research involves student mentoring in science and technology as well as internships that provide real-world experience. According to Dr. Webb about two-fifths of BYU’s undergraduates are engaged in some research or extra classroom experience before they graduate. Most research centers at the University have both undergraduate and graduate students working alongside faculty, many of whom are participating in formal mentoring programs.

Gary Hooper, former Associate Academic Vice President for Research and Graduate Studies developed BYU’s student mentoring programs based on similar programs at the Virginia Institute of Technology, where he had been Vice President for Technology Transfer. Dr. Hooper said that he expects the mentored research projects to result in some products in addition to facilitating interaction between faculty and students. The programs are open to students from all disciplines and involve both student-initiated and faculty-initiated programs. In the first instance, undergraduate students submit proposals through the Office of Research and Creative Activities to locate faculty members who wish to mentor their proposed project. The University gives each student a \$1,500 scholarship to develop and participate in these projects. The second program – faculty-initiated mentoring – is a competitive program in which faculty members submit proposals and are funded up to \$20,000 per year to engage undergraduates in their research. Another faculty-initiated mentoring program – Mentoring Environment Grant – focuses specifically on environmental research.

To support student mentoring in the 2005-06 academic year, the University awarded \$549,000 to 375 undergraduates whose research proposals merited grants. BYU also gave \$1.56 million to 132 faculty members specifically for projects involving undergraduates. Most of the funding used for the mentoring programs is privately donated. BYU has found that there is a high correlation between the students who work on these mentored research projects and those students who later go to graduate schools. In addition, according to Dr. Webb, because of these activities, it is not unusual for undergraduate students to appear as co-inventors on patent applications, and several projects have led to the formation of startups by students.

TECHNOLOGY TRANSFER

BYU has an outstanding technology transfer record in patent applications, newly executed and active licenses, and startups. In FY 2005 BYU filed 64 patents, placing it first nationally relative to research expenditures. About two-thirds of the patents came from BYU's Ira A. Fulton College of Engineering and Technology and involved software design, engineering, and biotechnology. In addition, the University executed 18 licenses and had 115 active licenses, placing it second and first respectively relative to research expenditures. Many of the active licenses involved copyrights, and most of the licenses went to Utah companies.⁶⁰

Since BYU's technology transfer program started in 1987, the University has launched 55 startups. In FY 2006 about half of the startups were still in existence and about half of those businesses had remained in Utah.

BYU is especially strong in launching startups; and from FY 2004-05 the institution had launched nine startups. An example of a recent startup, and BYU's largest royalty source – Environmental Modeling Systems Inc. – was formed by three faculty members who developed environmental software. The startup dominates a small niche in software modeling of water flow for environmental purposes, and is a growing Utah company.

BYU's intellectual property services are divided among three professionals – one who directs the Technology Transfer Office (TTO), another who directs the Creative Works Office (CWO), and a copyright manager. The Directors of the TTO and CWO report to BYU's Associate Academic Vice President for Research and Graduate Studies. The TTO manages intellectual property and patents generated by BYU research related to science, engineering and technology. The CWO manages intellectual property that is "creative" in nature such as artistic and instructional innovations. The copyright management office is responsible for in-licensing instructional materials. A half-time student from engineering and the sciences is assigned to each of the three technology transfer professionals. The TTO additionally uses law students to perform patent

⁶⁰ Based on an interview with Lynn Astle, former Director, Technology Transfer Office, BYU, December 2005.

searches, occasionally draft provisional patent applications, and communicate with law firms regarding patent applications.

BYU is one of the few universities in the nation that has a separate office for the licensing of copyrights and software. When dealing with this type of innovation, you cannot use a traditional technology transfer model. You have to work with many more faculty members and create more mass to become self-sufficient.

- Giovanni Tata, Director, Creative Works Office, Brigham Young University

Started in FY 1996, the CWO focuses strictly on copyrighted materials such as software, videos, music, instructional materials, and other areas that according to the CWO Director “do not quite fit into the more traditional TTO approach.” In FY 2006, the Office was responsible for more than 100 active licenses involving copyrights. The CWO Director, Giovanni Tata said that BYU was a pioneer in the area of treating copyrighted materials as innovations. The CWO Director said that unlike the activities of the TTO, the CWO’s handling of copyrighted materials requires a much higher deal flow to produce revenue. This need for a higher deal flow necessitates interaction with a greater number of faculty members who have smaller projects.

The CWO is quite unusual in that it has established some facilities to advance and promote copyrighted licenses. It has set up a production facility that produces language software which is licensed by the University. The CWO also helps the School of Music with the promotion of a private music label. Because of the nature of their licensing activities, the CWO maintains close working relationships with the University’s Center for Instructional Design, and music and drama departments.

One early CWO success was the Computer Adaptive Placement Exam. Developed by faculty and students, the software determines a student’s language level for college placement; more than 600 universities now use the software. Other examples include “CultureGrams,” a Web-accessed database on international country reports that BYU licensed to ProQuest CSA; and two virtual chemistry labs that BYU licensed to Prentice Hall Publishing. The CWO in only three years became self-sufficient, and in FY 2006 was responsible for almost \$1 million revenue. The CWO not only has generated revenue but it also has stimulated and served student innovators. According to the CWO Director, the Office has involved many student innovators that have gained valuable entrepreneurial experience by taking their innovations to a commercial stage.

BYU has an intellectual property policy that strongly favors faculty innovators; 45 percent of royalties go directly to the innovator. The faculty innovators can elect to forgo the 45 percent and reinvest the returns in their research, in which case the University matches it equally. This arrangement provides a powerful incentive for innovators to reinvest their returns in BYU research. According to the Associate Academic Vice President for Research and Graduate Studies, a significant percentage of faculty innovators forgo the personal 45 percent income in order to leverage greater funds for their research. Another 27.5 percent of the royalties go to the innovator's college; and the remainder goes to the TTO or CWO. The TTO traditionally has passed on 15 to 20 percent to the Associate Academic Vice President to be used for student mentoring and other research related activities.

The TTO former Director Lynn Astle emphasized the importance of strong relations with individual faculty members. Because BYU has limited research expenditures, research projects tend to be small and focused. This manageable number of research projects has made it possible for technology transfer professionals to personally know and frequently interact with individual researchers. These personal relationships facilitate early detection of potential commercialization opportunities. Dr. Astle also credits BYU's successful technology transfer to the University's mentoring programs and an atmosphere that encourages student and faculty entrepreneurship for their successful technology transfer outcomes.

ENTREPRENEURSHIP

BYU's Center for Entrepreneurship in the Marriott School of Management has received national acclaim for its entrepreneurship activities.⁶¹ The Center has developed several programs to encourage entrepreneurship among students and faculty, and to engage successful alumni in activities.

BYU's Entrepreneur Founders program involves about 140 practicing entrepreneurs who support BYU's entrepreneurship programs through financial support, mentoring, and program input. These successful entrepreneurs contribute substantial time to mentoring students who are starting their own businesses. They also assist BYU in developing teaching materials, provide research opportunities for faculty and students, and often lecture and teach at the University. Each entrepreneur is expected to donate \$15,000 and make additional annual contributions to help support activities sponsored by the Center for Entrepreneurship.

Founded in 1993 by the Center for Entrepreneurship, BYU's Business Plan Competition annually awards a total of \$130,000 in prizes to the top 16 student entrepreneur teams. The Competition annually attracts about 150 student participants resulting in submission of 40 to 50 business plans. The Competition involves several business development steps that culminate in students presenting "elevator pitches" to investors. The Competition is run by about 25 MBA students and a faculty advisor. Throughout the process, professionals from the Entrepreneur Founders program and others mentor the entrepreneur teams.

⁶¹ BYU Center of Entrepreneurship was nationally ranked 12th by the *The Princeton Review and Entrepreneur* in October 2006.

LESSONS FOR ACADEMIC INSTITUTIONS

Modest research expenditures can lead to substantial technology transfer outcomes: BYU, with only \$24 million in research expenditures, has produced more than 100 active licenses and has generated annually two to four startups. These stellar outcomes are due in part to high copyright activity, but they also reflect a University environment that favors entrepreneurial development not only for its faculty but also for its students. The Administration's willingness to dedicate four professionals to technology transfer and creative works operations also shows its commitment to commercializing technological know-how. In addition, creative technology transfer directors have benefited students and faculty by working closely with them and acting "out of the box."

Involvement of undergraduate students in research can facilitate commercialization: According to the BYU Associate Academic Vice President for Research and Graduate Studies, some of the best ideas that BYU has licensed have come from undergraduate students. Through BYU's extensive mentoring programs, undergraduate students are encouraged to work alongside faculty in conducting research that can lead to commercialization.

Copyrighted technologies may need to be handled differently from product inventions: An office that licenses copyrighted software and materials may require a different type of operation than an office that handles product inventions. Offices that handle copyrights may require a greater deal flow to generate income and therefore may require working with greater numbers of faculty innovators.

Involving successful alumni can provide the funding and know-how to build a Center for Entrepreneurship: BYU's Center for Entrepreneurship resulted from national and local business leaders not only contributing their money but also their time. These business leaders participate in entrepreneurial activities such as mentoring, input into curriculum and involvement in business plan competitions. The BYU Entrepreneur Founders adds value not only to the Marriott School of Management but also to the entire University's entrepreneurial atmosphere.

WEB LINKS

BYU (general):
www.byu.edu

Office of Technology Transfer:
<http://techtransfer.byu.edu>

Office of Research & Creative Activities:
<https://orca.byu.edu/Content/ORCAMain.html>

Center for Entrepreneurship:
<http://marriottschool.byu.edu/cfe>

FLORIDA AGRICULTURAL AND MECHANICAL UNIVERSITY

BACKGROUND

Founded in 1887, Florida Agricultural and Mechanical University (FAMU) is a Historically Black College and University (HBCU) and one of eleven institutions that comprise the State University System of Florida. Starting in the 1970s FAMU rapidly expanded its education and research capacity. The University added a Sponsored Research Division, Medical Sciences Program, Business and Industry School, Graduate Studies, Research, and Continuing Education School, and a joint FAMU/Florida State University College of Engineering. Located in Tallahassee, Florida, FAMU by FY 2007 had grown to almost 12,000 students and was comprised of fourteen schools, colleges, and institutes.

FAMU conducts research in physical, chemical, and biological sciences, health care, food and agriculture, environmental health and safety, bioengineering and other areas, and has gained national attention for its research in pharmacology, physics, and environmental sciences. In FY 2006 FAMU's R&D funding totaled \$28.7 million, mainly from federal agency sources including the National Oceanic and Atmospheric Administration (NOAA), NSF, and NIH.⁶² In FY 2006 FAMU was awarded \$5 million from the NSF for a research center in science and technology and new academic programs in astrophysics and astrochemistry. FAMU also was the lead institution in a \$62.5 million grant from NOAA to develop the next generation of minority scientists. FAMU is an active member of the Florida Research Consortium that involves 11 Florida research institutions, making it eligible for a state-funded Center of Excellence.

TECHNOLOGY TRANSFER

FAMU's Office of Technology Transfer, Licensing and Commercialization (TTLC) was established in 1996 but the office did not become fully operational until 2000 when the University elevated the part-time Director to full-time status. In FY 2007 the staff of TTLC was comprised of a Director, an intellectual property manager, and an administrative assistant. For several years, the TTLC engaged a consultant to help develop the Office's technology transfer systems. In addition, three students from the School of Business and Industry assist TTLC by conducting marketing analyses and developing business plans. At the writing of this report, the Director was developing a new strategic plan that included a proposal to hire a licensing professional.

From FY 2003-06 FAMU processed 109 invention disclosures, mainly stemming from engineering, agriculture, and NIH-funded research conducted in the Pharmaceutical Drug Discovery Unit of the College of Pharmacy and Pharmaceutical Sciences. The University filed

⁶² Source: Office of Technology Transfer, Licensing and Commercialization, FAMU. NSF reported \$26 million in FY 2005 R&D expenditures: Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005, NSF.

44 patent, copyright and trademark applications, and 16 patents were issued. One copyright, two trademarks, and three of the patent applications filed were related to technology developed under a NSF Partnership for Innovation (PFI) project. Within the College of Pharmacy and Pharmaceutical Sciences, patents were filed mainly in the areas of cancer, opportunistic infections connected with AIDS, Parkinson's disease, schizophrenia, and anti-inflammatory drugs. Two of the 16 patents that FAMU researchers continue to develop were donated by The Boeing Company. From FY 2003-06, FAMU executed five licenses, one of which was related to the Boeing patents. Another license involved a faculty member in the College of Pharmacy and Pharmaceutical Sciences entering into an exclusive agreement with a New Jersey biosciences company. The license was based on FAMU's creation of compounds to treat some effects of Parkinson's disease. The drug discovery processes were translated by FAMU in collaboration with Harvard University and Princeton University.

FAMU also spun off four startups in photovoltaic/solar energy, drug discovery, virtual software systems, and radio frequency security technologies. Three of the four startups were housed in a FAMU-operated incubator located in the Innovation Park in Tallahassee, Florida. (See "Innovation Park".)

HBCUs have traditionally focused on teaching, research, and service and have not had the funding needed to support technology transfer infrastructure... In addition to the lack of funding, we have also had to change the universities' culture. Just as HBCU Presidents have recognized the importance of sponsored research offices, we now must assist them in becoming more aware of the added value of technology transfer and entrepreneurship.

- Rose Glee, Director, Technology Transfer, Licensing and Commercialization, Florida A&M University

In FY 2004 FAMU initiated and took the lead in a three-year, NSF/PFI award – The TechLink Project – that involved FAMU and eight additional HBCUs. The purpose of the TechLink Project was (a) to enhance the technology transfer infrastructure, (b) to assist in the development of a more diverse workforce by introducing minorities to the world of technology transfer, and (c) to contribute to the economic development of HBCU communities. In addition to FAMU, the HBCU universities involved were (in alphabetical order)

- Alabama Agricultural and Mechanical University (Huntsville, Alabama)
- Jackson State University (Jackson, Mississippi)
- Morgan State University (Baltimore, Maryland)
- Norfolk State University (Norfolk, Virginia)
- North Carolina Central University (Durham, North Carolina)
- South Carolina State University (Orangeburg, South Carolina)

- Southern University–Baton Rouge (Baton Rouge, Louisiana)
- Tennessee State University (Nashville, Tennessee)

The NSF/PFI grant was the impetus for the other (HBCU) universities to become aware of the role that they could play in technology transfer. The grant has been a tremendous boost in enhancing their level of readiness for moving into this arena.

- Rose Glee, Director, Technology Transfer, Licensing and Commercialization, Florida A&M University

The TechLink Project involved five components: (a) technology transfer education and training, (b) development of a virtual technology transfer office and network, (c) development and implementation of an Invention Camp for middle and high school students, (d) law clinics, and (e) a mentoring program. Under a subcontract, Florida State University (FSU) was responsible for the TechLink’s education and training component. Prior to the PFI project, FAMU’s TTLC Director had established a close working relationship with John Fraser, the Director of FSU’s Office of Intellectual Property Development and Commercialization (OIPDC), a well established and nationally respected technology transfer operation. Since Dr. Glee had already initiated the relationship with FSU’s OIPDC Director and he had played an important mentoring role in FAMU’s technology transfer operations, she asked FSU to participate as a major subcontractor.

The education and training component was designed to provide a series of workshops and on-site assistance that would progressively advance the technology transfer knowledge and operational capacity of the participating HBCUs. Prior to submitting the proposal, a preliminary survey of interest by HBCUs was conducted by FAMU. After the project was initiated FAMU also conducted a “readiness assessment” exercise to gauge the technology transfer knowledge of participants, document the level of institutional research activity, and assess the technology transfer-related administrative and management infrastructure. In addition, TechLink administrative teams conducted site visits to each participating university’s technology transfer “point person.” Each team was composed of two to three of the following persons: the FSU OIPDC Director, a FSU industrial engineering professor who had worked in technology transfer, a technology transfer consultant to FAMU, and the FAMU TTLC Director. FSU then developed training modules ranging from a basic level that covered how to set up an office, develop policies and procedures, etc. to an advanced level that included prototyping, structuring deals, and identifying seed capital investments. Because FSU OIPDC Director John Fraser had been President of AUTM, he also involved the TechLink participants in AUTM conferences, training workshops and special interest groups. The team also used some of AUTM’s training manuals as the basis for TechLink’s training materials. Beginning in FY 2004 FSU held four workshops each year for three years.

HBCUs have very modest research budgets for technology transfer activities ... but based on my work with the NSF/PFI project, my sense is that some HBCUs have technologies that warrant a serious look.

*- John Fraser, Director, Office of Intellectual Property
Development and Commercialization, Florida State University*

The TechLink team designed a Virtual Technology Transfer Office (VTTO) system, which is an Application Service Provider that is intended to electronically perform some of the manual tasks conducted by technology transfer staff, inventors, administrators, patent attorneys, and government agencies. The VTTO is designed to manage technology transfer functions such as patent and trademark processes, invention reporting to federal agencies, and some licensing and marketing processes. The VTTO was developed to reduce time and operating expenses, increase accuracy, and help understaffed technology transfer offices at institutions with limited resources. At the writing of this report, the VTTO was being tested and refined, and the FAMU TTLC Director hoped to make the system available, in the near future, to academic institutions through licensing arrangements.

Developed and instituted as part of the TechLink project, the Invention Camp is a free, week-long summer camp for middle and high school students designed to stimulate creativity and innovation and generate interest in the fields of math, science and engineering. Initiated in 2005, the Camp targets middle and high school students between the ages of 12 and 18 and teaches them how to generate ideas as well as protect and transfer their ideas to the marketplace. The Camp also introduces the students to careers in technology transfer, patent law, and business. Specific topics have included (a) developing ideas for invention and innovation, (b) approaches to innovation, (c) protecting and documenting ideas, (d) prototyping and manufacturing, (e) licensing or assigning the developments, and (f) establishing a business. After learning about the various steps involved in being an inventor, participants are placed into groups called Invention Teams (I-Teams) for one week and given a budget to create a product that they feel will be marketable. I-Team members must generate an idea for a product, conduct prior art searches, develop a prototype of the product, and develop a “mock” business and marketing plan that is presented to judges at the end of the week.

Over a three-year period, about 100 students from 25 middle and high schools in six states and several Florida counties have participated in the Camp. Due to its popularity, the Camp is being expanded to two weeks during the summer and is being considered as a year-round, after-school activity or a Saturday Academy. The Camp has attracted much media attention and has leveraged local financial support from business organizations, local Rotary Clubs, and technology firms to sustain the program beyond the initial NSF/PFI funding. The Camp is being replicated in the other eight institutions participating in the NSF/PFI project.

As part of the TechLink project, three of the participating universities have introduced their law school students to the technology transfer profession and engaged them in the university's technology transfer operations; the third institution also engaged MBA students in technology transfer operations. The TechLink's Mentoring Program encouraged participating universities to identify and establish relationships with mentors from more established university technology transfer offices. Based on her personal mentoring experiences, FAMU's Director of Technology Transfer believed that developing a mentoring or "buddy" relationship was particularly important for enhancing technology transfer operations at HBCUs and similar institutions. She encouraged HBCUs to reach out to more established technology transfer offices, particularly in near-by universities, and to organizations such as AUTM and LES. Since the inception of the TechLink project all participating institutions have become members of AUTM.

INNOVATION PARK

Innovation Park is a university-related research park located about three miles from the University in Tallahassee. FAMU is a partner in the Park with the Leon County Research and Development Authority (LCRDA) that operates the Park; other partners are FSU, Tallahassee Community College, City of Tallahassee, and County of Leon. Innovation Park has been in operation since 1978 and, in early 2007, was home to more than 45 businesses, R&D facilities, and organizations that employed more than 1,700 people. According to the FAMU TTLC Director, Innovation Park has been instrumental in establishing an important research "foot print" in the community. Moreover, the Park has provided a venue for FAMU's entrepreneurial services through the University's incubator located in the Park. The incubator offers office, laboratory and manufacturing space in two Innovation Park buildings. It offers a wide range of services intended to nurture startups including personal business counseling, consulting, business workshops and seminars, legal and financial services, networking, grant assistance, and marketing. Innovation Park also serves as the home for the FAMU-operated Small Business Development Center (SBDC).

The LCRDA awards Technology Commercialization Grants to Park tenants and other small businesses. Starting in 2005 LCRDA has awarded six grants of \$45,000 each for feasibility and prototype development. The Grants are funded from the Park's rents and real estate profits. At the writing of this report, the County of Leon was developing an "Accerlator" fund with an initial investment of \$5 million. The fund will invest in technology companies at various development stages. The State of Florida also provides a variety of entrepreneurial assistance such as a Phase 0 SBIR program that is operated by Enterprise Florida. In the past, the City of Tallahassee also has subsidized the relocation of selected businesses to the Park.

Included in the Park's entrepreneurial network are the FAMU SBDC, The Jim Moran Institute (JMI) for Global Entrepreneurship in the College of Business at FSU, the Leon County Economic Development Council, and TalTech Alliance. JMI provides consultation to entrepreneurs and owners of rapidly growing businesses with annual sales between one and ten million dollars. It also sponsors entrepreneurial showcases, roundtables, a mentoring program, and networking opportunities. The TalTech Alliance is a non-profit organization focused on

technology development in the Tallahassee area, and primarily provides networking opportunities for the region's entrepreneurs.

OTHER ENTREPRENEURIAL INITIATIVES

FAMU sponsors a university-wide business plan competition that offers small prizes as well as an Entrepreneurship Day to feature competition presentations. In FY 2006, 20 multi-disciplinary teams were formed and five were selected to make presentations. The FAMU winning team participated in several national business plan competitions. The FAMU team won first prize at the Ford HBCU Business Plan Competition and second prize at the Opportunity Funding Venture Challenge in Atlanta, Georgia.

The FAMU Entrepreneurship Club brings guest lecturers to campus and sponsors other networking activities, including those related to the business plan competitions. In addition, FAMU has formed Entrepreneurship Interest Groups in engineering, architecture, nursing, agriculture, computer and information systems, and journalism. Some of these groups have completed business plans for local non-profit organizations.

In 1999 a small NASA grant to the FAMU's School of Business and Industry involved business students in identifying expired NASA patents and developing business plans related to the patents. Under the NASA grant, students were taught how to conduct market analyses, technology evaluations, and financial evaluations. Business students today continue to provide TTLC with these services. In addition, the School of Business and Industry offers entrepreneurship courses in business plan development and marketing, and these courses train students that help TTLC with patent and other operations.

LESSONS FOR ACADEMIC INSTITUTIONS

A NSF/PFI grant can provide funding needed to enhance technology transfer operations: According to FAMU's TTLC Director, the NSF/PFI grant allowed FAMU and FSU to develop and implement technology transfer training sessions and tools for HBCUs that would not have been possible otherwise. Some of these activities have leveraged additional financial support from the community that has allowed PFI-initiated activities to continue beyond the grant completion.

Mentors from established technology transfer programs can be invaluable in helping new programs become operational: FSU's technology transfer Director has been instrumental in helping FAMU enhance its operations. Moreover, FAMU and FSU together transferred their know-how to assist eight additional institutions become more active in technology transfer.

Even given a lean budget, a committed technology transfer director can make a difference: In the case of FAMU, a creative, committed technology transfer Director took the initiative to seek funds that not only improved conditions in her own program but also assisted other HBCUs to do the same. Moreover, FAMU's technology transfer operation until recently only involved

the Director and a consultant, and yet it was able to generate several licenses and startups. However, additional support most likely would enable the Director to substantially increase the University's licensing activities.

Technology transfer can be promoted as a faculty service and local economic contribution:

One way to gain acceptance for technology transfer in academic institutions is to present it as a "value added" component that can positively impact the university's research and the region's economy. Although some technology transfer offices have generated millions of dollars, technology transfer is rarely a "cash cow." It is more likely to gain acceptance if presented to administrators and faculty as a way to increase faculty's entrepreneurial opportunities and contribute to local economic development.

WEB LINKS

Florida A&M University (general):

www.famu.edu

Office of Technology Transfer, Licensing and Commercialization, Florida A&M University:

<http://research.famu.edu/ttlcoffice/ttlchome.htm>

Innovation Park:

<http://www.innovation-park.com>

Office of IP Development and Commercialization, Florida State University:

<http://www.techtransfer.fsu.edu>

The Jim Moran Institute for Global Entrepreneurship, College of Business, Florida State University:

<http://www.cob.fsu.edu/jmi>

TalTech Alliance:

www.taltech.org

IOWA STATE UNIVERSITY

BACKGROUND AND VISION

Iowa State University (ISU) was founded in 1858 as the Iowa Agricultural College and Model Farm and in 1864 became the nation's first land-grant university. ISU is located in Ames, Iowa, a university town that is ranked as a one of the nation's most livable small towns. Historically ISU has played a state and national role in scientific and technological advances in agriculture, veterinary medicine, and engineering and many of the basic sciences related to these fields. ISU has a strong history of serving the State's agricultural and industrial communities, and developed one of the nation's first agricultural extension services and later one of the earliest industrial extension services.

Today the University has 26,000 students, about one-fifth of which are graduate students. ISU is classified as a research university⁶³ and includes seven colleges and about 80 research centers, half of which operate outside of the University's colleges. In addition to ISU's traditional research in agriculture and engineering, the University recently launched new research initiatives in key emerging areas including agricultural biotechnology, combinatorial science, plant and animal genomics, bioinformatics, materials science, bio-renewables, food safety and security, nondestructive evaluation, animal diseases, and information sciences. The Ames Laboratory, a U.S. Department of Energy federally funded research and development center (FFRDC), is located at and administered by ISU. ISU is a licensing powerhouse; in FY 2005, it executed more licenses than any university in the nation except the University of California system.

We are both a research university and an economic development university. At the center are strong agriculture and engineering research, and a balance between fundamental and applied research.

- John A. Brighton, Vice President for Research and Economic Development, Iowa State University

ISU, more than most universities, ties its technology transfer operations to economic development, entrepreneurial development, industry relations, and on occasion, extension services. The University's Strategic Plan 2005-2010 clearly defines "economic impact" as a goal, and this goal includes fostering an environment that encourages engagement in technology

⁶³ Iowa State University is classified as a Doctoral/Research University – Extensive by the Carnegie Foundation for the Advancement of Teaching.

transfer. An additional goal – “Improving Iowa Life” – promotes “partner(ing) with Iowans to strengthen their communities’ economies and entrepreneurial capacities.”⁶⁴

ISU STRATEGIC PLAN 2005-2010

Priority: Economic Impact

Goals: *Translate discoveries into viable technologies, products, and services to strengthen the economies of Iowa and the world.*

- Expand the use of intellectual property developed at Iowa State University.
- Strengthen educational and outreach programs aimed at Iowa’s economic, workforce, and technology development.
- Foster an environment that encourages faculty, staff, and students to engage in transfer of technology and entrepreneurial development activities.

ISU’s Office of the Vice President for Research and Economic Development encompasses economic development, technology transfer, entrepreneurship and some research departments in order to encourage coordination between these activities. The Office is responsible for a number of research centers, sponsored programs, ISU President’s research initiatives, Office of Intellectual Property and Technology Transfer, ISU Research Foundation, ISU Research Park, and Industry Relations. In this regard, ISU’s organizational structure is similar to that of Georgia Institute of Technology, and is unusual in its prioritization of economic development and recognition of the interconnectivity between research, technology transfer and entrepreneurial development.

In this case study we cover many of the activities encompassed by the ISU Office of the Vice President for Research and Economic Development. This includes the Office of Intellectual Property and Technology Transfer, the ISU Research Foundation, Inc., Institute for Physical Research and Technology, Industry Relations, Pappajohn Center for Entrepreneurship, and ISU Research Park and incubator.

⁶⁴ Strategic Plan 2005-2010, Iowa State University, 2005.

TECHNOLOGY TRANSFER

In FY 2005 ISU's research expenditures were \$210 million.⁶⁵ Life sciences including agriculture accounted for about half of all research expenditures; engineering and physical sciences accounted for a little more than one-fourth.⁶⁶ State and local government funding as a share of total expenditures was higher than the national average and this may reflect the State's commitment to research.⁶⁷

ISU ranked second nationally in the number of licenses and options executed, just behind the University of California (UC) system. This is remarkable achievement considering ISU's research expenditures are about seven percent that of the UC system.

ISU has an outstanding technology transfer record. In FY 2005 ISU executed 218 licenses and options, ranking second nationally just behind the University of California system. This is a tremendous accomplishment considering the University of California system has about \$3 billion in research expenditures compared to ISU's \$210 million. ISU ranked sixth nationally in the total number of active licenses, with 745 active licenses. ISU's record for launching startups also is quite impressive. In FY 2005 ISU launched five startups, placing it 22nd nationally.

As the case in many universities that have high licensing activity, most of the activity comes from a couple major discoveries. Over the past 10 years, an average of 85 percent of ISU's licenses and options were related to non-patented plant germplasm and patented Altered Fatty Acid (AFA) soybean varieties. In FY 2005 ISU's income from license activity leaped to \$4.9 million, almost doubling the University's income from the previous year. More than 40 percent of the license and option agreements in ISU's portfolio generated income; about 35 of the 317 licenses generating income produced about three-fourths of the total income.

The Office of Intellectual Property and Technology Transfer (OIPTT) conducts ISU's marketing and licensing activities, and advises startups based on university innovations. The Iowa State University Research Foundation, Inc. (ISURF), a nonprofit corporation, owns and protects the University's intellectual property (IP). Together, OIPTT and ISURF are composed of 13 professional staff, and the Director and Associate Director hold joint positions in OIPTT and ISURF. OIPTT and ISURF staffs work in teams involving an invention disclosure manager, IP portfolio manager, and licensing managers, who meet on a weekly basis to coordinate activities. The four licensing associates are responsible for specific science and engineering areas: (a) plant

⁶⁵ Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005. NSF.

⁶⁶ Table 36. R&D expenditures at universities and colleges, ranked by all R&D expenditures for the first 200 institutions, by science and engineering field: FY 2005. NSF

⁶⁷ Table 32. R&D expenditures at public universities and colleges, ranked by all R&D expenditures for the first 150 institutions, by source of funds: FY 2005. NSF.

varieties, (b) biotechnology/biological science, (c) chemistry and materials, and (d) engineering and physical sciences. Many of OIPTT's and ISURF's internal communication efforts focus on developing relationships with Department Chairs, mainly through formal presentations in Department Chair meetings, followed up by less formal communication. In addition, OIPTT recently stepped up its efforts to interact more directly with research faculty, and licensing associates now communicate with specific faculty at least one to two days per month.

We consider our office a service arm of the University ... We don't focus on the income but instead focus on businesses getting access to (ISU) technologies.

- Ken Kirkland, Executive Director, Iowa State University Research Foundation, Inc. and Director, Office of Intellectual Property and Technology Transfer

OIPTT licensing associates pro-actively seek industry partners to license innovations originating from research conducted by ISU faculty and staff including those from the Ames Laboratory, a FFRDC managed by ISU. Licensing associates contact individual companies that they identify as potential customers. In addition, OIPTT and ISURF professionals participate in industry associations such as BIO and the Iowa Biotechnology Association to network with industries. In order to generate interest in ISU technologies, OIPTT additionally has developed a user-friendly Web site in which companies sign up and receive emailed technology briefs in specific science and engineering fields. Started in 2004, this site only one year later had registered several hundred individuals.

In addition to the licensing associates' activities, OIPTT works closely with ISU's Industry Liaison and Ames Laboratory's Office of Sponsored Research Administration, who actively work with companies throughout the U.S. The Liaison conducts industry mixers in which University entrepreneurs participate and helps faculty inventors identify and market to potential corporate customers. The Office of Sponsored Research Administration at the Ames Laboratory routinely involves OIPTT in meetings with corporations that visit the Laboratory, which is a major corporate attraction.

Licensing managers make a special effort to inform Iowa firms about licensing opportunities, and if possible license to Iowa firms. In FY 2005 more than one-third of all University licenses, including those involving plant germplasm went to Iowa firms. In keeping with OIPTT's service orientation, the Office also has executed open source licenses including one generated by ISU's Virtual Reality Center. The OIPTT Director said that by providing open source virtual reality tools, it has attracted considerable research funding as well as created good will.

In 2005 ISU launched five startups. The five startups represented a jump from previous years in which one or two startups were typically launched. The ISURF and OIPTT Director, Ken Kirkland attributed this increase, in part to a new push from the State legislature and ISU Board of Regents who would like to see greater economic development returns in terms of business creation and jobs. Discussing the relative returns from licensing to startups or to established firms, Dr. Kirkland commented “if we license to a startup we’re not going to get the same kind of licensing fees ... on the other hand (the startups) tend to be very focused on the particular technology and will likely make sure that the technology is commercialized.” ISURF is just starting to take an equity stake in companies. The Director said that the main difficulty that they have encountered in taking an equity stake has been valuing the company.

ISU startups have a number of entrepreneurial resources available to them. Through a small venture fund, ISURF provides about \$200,000 per year for faculty to develop near-market technologies, and from FY 1996-2005, they have funded about 78 projects. For University-related startups, ISURF also covers (a) up to \$5,000 for the company to consult with patent attorneys or other professionals; (b) first year rent in the Plant Science’s Institute incubator or at the ISU Research Park; and (c) expenses for selected innovators to present at venture capital forums. Starting in 2005, OIPTT also provides a service to help Iowa companies develop Small Business Innovation Research (SBIR) and Small Technology Transfer Research (STTR) proposals. These activities are funded by royalty income received from ISU inventions. In addition, the State and the ISU Research Park have funds available to assist university-related entrepreneurs. (See discussion of the Wellmark Community Venture Capital Fund under “ISU Research Park and Incubator.”)

In addition to the entrepreneurial activities funded by royalty income, the Office of the Vice President for Research and Economic Development uses about \$750,000 per year of royalty income to attract and retain research-oriented faculty. The Office of the Vice President reported that from FY 1999–2005, \$4.5 million used for faculty hires has resulted in almost \$60 million in additional research funding.

ENTREPRENEURIAL DEVELOPMENT

There are a number of ISU programs and offices that provide business and entrepreneurial assistance. The ISU Research Park and the Pappajohn Center for Entrepreneurship provide ISU startups with infrastructure and business development assistance. Other programs that we cover here are company services provided by the Institute for Physical Research and Technology and incubation services that are part of the Plant Sciences Institute. We do not cover in this case study the Center for Industrial Research and Service (CIRAS) that provides Iowa industries assistance in engineering and product development, process management practices, quality systems, government procurement, and productivity improvement.

Innovation Development Facility of the Plant Sciences Institute

The Innovations Development Facility (IDF) of the Plant Sciences Institute (PSI) focuses on the development and commercialization of plant sciences research, including the creation of startups

based on the research. IDF has two components: incubation space housed in the Roy J. Carver Co-Laboratory, and a Public/Private Partnership Program for private sector companies to collaborate with ISU scientists. ISU is world renown for its research in germ plasma, with over 200 faculty and 30 departments. Although the Laboratory is primarily a research organization, it is involved in economic development through its business incubator. Started in 2001, the incubation facility was funded with a \$.5 million loan from the State that was matched equally with private funding. The Laboratory's goal was to start four businesses in five years based on the Laboratory's technologies; this goal was met in the first year of operation. The incubation space is small (a little less than 200 square feet), providing just enough space for six groups of entrepreneurs. It gives the entrepreneurs the advantage of being part of a research laboratory environment, which is a familiar environment for faculty and researchers. Tenants must be faculty, students or researchers at ISU or connected with ISU.

Several of the Facility's tenants have come through the SBIR route and the Facility's part-time manager works with tenants on securing SBIRs. The Facility has established a Board of Mentors composed of people who are in well established business positions in Iowa and who provide entrepreneurs with advice. Some of these people are former presidents and CEOs of major corporations such as Pioneer Electronics. Stephen Howell, Director of the PSI said that they were surprised at how willing and active mentors were with the Plant Sciences entrepreneurs. Resident entrepreneurs have access to laboratory equipment, University facilities, and other fee-for-services at University rates including highly-sought genomic, proteomic, and plant laboratories.

There has to be a culture within the university that says (commercialization) activities are worthwhile. Although promotion and tenure are generally not geared to this, (the Plant Sciences Institute) looks well on and encourages these activities.

- Stephen Howell, Director, Plant Sciences Institute, Iowa State University

The PSI Director said that the Facility's entrepreneurs benefit from a close working relationship with the Office of Industrial Relations and with the Pappajohn Center for Entrepreneurship. In addition to entrepreneurial activities in the Pappajohn Center, there is an entrepreneurial program in the College of Agriculture. A Board of Plant Sciences, which involves industry leaders, provides input and exchange on current research activities. In addition, one business member on the Board within PSI actively works on attracting financial investments to the State and introduces startups to potential investors. The Institute provides industries with "a menu of research," visits industries and presents "posters" of research, and in collaboration with the Office of Industrial Relations, invites corporate researchers to the Institute in order to pro-actively develop research collaborations.

The Facility also provides a development pipeline to the ISU Research Park, and several Facility “graduates” have located businesses in the Park. One such graduate – Exseed Genetics – became a subsidiary of BASF, and is located in the Park. A similar incubator to one in PSI is located in the Center for Crops Utilization Research. This incubation space houses entrepreneurs in a facility that gives them access to a large pilot plant located in the same building.

Institute for Physical Research and Technology Company Assistance

The Institute for Physical Research and Technology (IPRT) is a network of scientific research centers that conduct inter-disciplinary research. IPRT Company Assistance involves three major functions: (a) technical assistance, (b) contract research, and (c) commercialization assistance. IPRT’s technical assistance provides Iowa manufacturers with materials-related research and non-destructive testing on a short-term, no-cost basis. For longer-term projects, Iowa companies contract with IPRT for R&D on product and process development and improvements. In this case, companies pay an equal match, with Iowa companies paying a match up to \$15,000.

IPRT’s Technology Commercialization Acceleration Program (TCAP) helps entrepreneurs and early-stage companies develop new products and processes. For very early stage businesses, TCAP conducts proof-of-concept research on a cost-shared basis. This may involve matching the business with a faculty researcher or providing other research services. In the case of a startup, TCAP works with them in three phases: (a) product development, (b) market research and customer feedback, and (c) business model development. Market research and customer feedback is tied into product development and development of the business model. IPRT also provides contracting services for about 20-25 large companies per year, many of which are “Fortune 500” level companies. Services to larger companies often involve product improvements and testing, and these companies typically match university investments 3:1.

IPRT provides seed funding to faculty members through a competitive process. Seed funding is provided for very early-stage R&D and is intended to move the R&D closer to commercialization. Five projects are usually each funded about \$20,000 to \$25,000. In FY 2004 and FY 2005, seven of the 10 projects resulted in startups, and about half developed intellectual property processed by ISURF. (See “Technology Transfer.”) Beginning in FY 2006, two additional faculty or scientific researchers per year have been funded about \$50,000 to \$75,000 through the Iowa Values Fund that finances early-stage, proof-of-concept research.⁶⁸ These funds must be equally matched by non-state monies. IPRT’s company assistance programs are supported by the Iowa State Legislature through a line item to the Iowa Department of Economic Development.

⁶⁸ In May 2005 the State Legislature passed the Iowa Values Fund which provided \$50 million over 10 years to three state universities (\$2 million/year to ISU; \$2 million/year to the University of Iowa, and \$1 million/year to the University of Northern Iowa). Most of the funding – \$1.4 million per year – goes for research, and the remainder is devoted to economic development infrastructure. A small amount has been set aside for seed capital.

IPRT works closely with the Industrial Liaison, ISURF and the Pappajohn Center for Entrepreneurship. Representatives of these programs meet regularly to discuss projects that may need additional business assistance, intellectual property protection, and partners and customers. IPRT is increasing its connections to several private sector associations and networks, including

- Advanced Manufacturing Research Collaboration Cluster, particularly in biomaterials.
- Bio Science Alliance.
- Entrepreneur Network, a group of private organizations in Iowa that work to attract venture capitalists.
- Information Technologies of Iowa.

The former TCAP Director, Carey Novak believed that their program was successful because the staff “got out of the university and talked to industries” in order to understand and effectively respond to the industries’ needs.

ISU Research Park and Incubator

What we are building (at ISU Research Park) is largely a network of experts to help entrepreneurs ... and when you're operating in Central Iowa you have to reach a little further and work a little harder to develop a network.

- Steve Carter, Director, ISU Research Park

In 1987, ISU, the ISU Foundation, and state and local governments created the ISU Research Park as part of an effort to create an entrepreneurial environment around the University. Unlike many university research parks, ISU’s Park has focused on cultivating startups. According to Steve Carter, the Park’s Director, in 2006 about half of the 43 tenant companies were startups or had been startups when they located in the Park and were bought by other companies.

In 1992 the Small Business Development Center (SBDC) relocated to the Park in order to provide business development services to Park tenants. In 1996 the ISU Pappajohn Center for Entrepreneurship was established to provide entrepreneurial services across the University, including serving tenants in the ISU Research Park. The Park Director said that the ISU Research Park’s development benefited from the early leadership of Leonard Goldman, a consultant that helped plan the Park and later became its first director, and Wayne Moore, ISU’s Vice President of Business and Finance, who promoted the Research Park, as well as other key people in the community and State. The Park also benefited from a couple early successes such as Engineering Animation and Metabolic Technology, a faculty startup that captured State and media attention.

Park staff work closely with OIPTT, and according to the Park's Director, ISU's well-developed technology transfer program has contributed a number of the Park's tenants. The staff also work closely with IPRT faculty inventors, often before the inventors move into incubation space in the Park. The Park's Director believes that this early intervention with inventors has paid off in greater business retention. Mr. Carter credits the University for providing the flexibility and support that have allowed him to build services and networking. In addition, he credits the State for contributing funds for commercialization services through IPRT, which has added value to entrepreneurial startups in the Park. He also credits the City of Ames and the Chamber of Commerce for creating a community venture capital fund to provide early-stage capital for some Park tenants.

The Iowa State Innovation System (ISIS) program is made up of two incubators located in the Park – one is a conventional mixed space incubator with about 6,000 square feet, and the other is located in a separate building and includes 4,500 square feet of wet lab and office space. Early-stage tenants receive “strategy-driven” assistance almost on a daily basis. As startups mature, ISIS services become more focused on specific tasks and involve milestones. The Pappajohn Center for Entrepreneurship operates in partnership with the SBDC and ISU Research Park to provide tenants with business development and outreach services. In addition, about 200 “entrepreneurial interns” work for tenant companies. The majority of the interns come from a variety of computer, engineering and science disciplines.

In addition to ISU entrepreneurial resources, startups in the ISU Research Park and throughout the State have access to early-stage capital through the Wellmark Community Venture Capital Fund. The Fund was established by Wellmark Blue Cross and Blue Shield that committed \$5 million to assist Iowa startups. Through this program, entrepreneurs can borrow up to \$50,000 as debt, which may be converted into equity in the future. Wellmark will draw the \$5 million from savings generated by a reduction in the State's insurance premium tax. In 2002, the Iowa Legislature passed, and Governor signed, a bill that reduced the State's insurance premium tax from two percent to one percent phased in over a four-year period through 2007. As part of this change in law, Wellmark, along with several other insurance companies, voluntarily agreed to support a plan to commit \$60 million of the projected insurance premium tax reduction for economic development in Iowa.

The ISU Research Park has become a sign of the University's commitment to entrepreneurial development. ISU's technology transfer, commercialization, and entrepreneurial activities, and the State and local commercialization funding and early-stage investments have worked together to create a solid entrepreneurial network visible at the Park. By late 2006, the ISU Park had 43 tenant companies and five University centers that employed almost 800 people. In 10 years, more than 130 companies have been Park tenants. The Park is a 230-acre development with over 270,000 square feet of building space. It is managed by the ISU Research Park Corporation, a not-for-profit corporation operating under a Board of Directors appointed by ISU and the ISU Foundation. The Corporation manages the Research Park and ISIS.

Pappajohn Center for Entrepreneurship

The Pappajohn Center for Entrepreneurship is one of four such centers in the State. Other centers are located at University of Iowa, University of Northern Iowa, and the Northern Iowa Area Community College. The Center was established in 1996 and funded by a wealthy entrepreneur, John Pappajohn, to encourage entrepreneurship and provide entrepreneurial services to the university community and external community. The Center acts as a gateway to assist ISU faculty, researchers and students become connected to the “entrepreneurial world” and to assist Iowa businesses and entrepreneurs gain access to ISU resources. Unlike entrepreneurship centers at many universities, the ISU Pappajohn Center works together with the SBDC in the ISU Research Park to provide business plan development and market research services. They also work with the SBDC to connect entrepreneurs to accounting, legal, and marketing resources in the State. The Center interacts with some research centers such as IPRT and with OIPTT to assist startups emerging from that Office.

The Pappajohn Center sponsors numerous activities for budding ISU student entrepreneurs, including:

- The Pappajohn Iowa Business Plan Competition – a statewide competition designed to stimulate entrepreneurial activity by providing students with prize money (\$25,000 for first prize) to develop innovations through startup activity.
- The Iowa Venture Capital and Entrepreneur Conference – an annual conference for entrepreneurs, investors and entrepreneurial students to network, hear presentations and attend workshops on business plan development, deal structure, and venture capital, etc. The Conference is sponsored by the Pappajohn Centers, in partnership with the Iowa Department of Economic Development and Equity Dynamics.
- The Pappajohn/Kauffman Grant Program – funds student entrepreneurs across all disciplines, particularly encouraging those in science and engineering to engage in entrepreneurship. The program is supported by the Ewing Marion Kauffman Foundation.
- Entrepreneur Forums – held every other month, the Forums involve presentations by guest speakers who are successful entrepreneurs, venture capitalists, and others, followed by roundtable discussions.
- Entrepreneurship and Innovation Learning Community – involves students who aspire to be entrepreneurs, living together in a residential community. The students take entrepreneurship courses, attend workshops, manage a small seed fund available only to Community entrepreneurs, receive mentoring, and participate in entrepreneurial networking activities.
- Okoboji Entrepreneurship Institute – is a week-long “boot camp” that involves students from ISU and other state universities participating in advanced study of entrepreneurship that includes an entrepreneurial simulation; seminars with successful entrepreneurs, business, and community leaders; networking and mentoring. The Institute is a joint effort of the State Board of Regents, the Iowa Department of Economic Development, the Pappajohn Entrepreneurial Centers and the Iowa Lakes Corridor Development Corporation.

LESSONS FOR ACADEMIC INSTITUTIONS

Close ties between research and technology transfer can contribute to outstanding licensing success: ISU promotes close ties between research and technology transfer from personal interaction with researchers to incubation space being housed in research facilities such as the Plant Sciences Institute. Close relationships between research and technology transfer allows licensing agents to learn about potential “commercializable” research early-on which helps insure that intellectual property is captured and marketed.

Coordinating technology transfer with entrepreneurial development benefits startups: ISU provides a good example of an organizational structure and good communication that promote coordination between technology transfer and entrepreneurial development. Particularly in a large university such as ISU, regular communication between a technology transfer office, incubators, the research park and entrepreneurship programs is important in moving startups through the early development stages.

Elevating economic development to a core goal usually promotes stronger technology transfer, and often encourages the launching of startups: When economic development is a major university goal, the university usually promotes technology transfer as an integral part of the economic development process. Moreover, often the technology transfer focus shifts to favor launching startups. In economic development terms, startups are a seed that, if nurtured properly, continues to grow and create jobs as well as generate business returns.

Using royalty income to attract top research faculty can result in substantial research income: From FY 1999–2005, ISU invested \$4.5 million from royalty income to hire research faculty. Those faculty hires attracted almost \$60 million in additional research funding. Moreover, the increased research funding may generate even higher returns as licenses from new research funding generate additional income.

A small seed capital fund for faculty can be useful, particularly in a rural state: In a state with little venture capital and virtually no seed capital, the university investing in or providing small seed grants can make the difference in moving research to a commercial stage.

Industry input can be a double-edged sword: Industry input in research activities can be important in encouraging universities to address “real world” needs. On the other hand, in some cases industries may unduly influence the direction of research away from basic research that may yield important new discoveries. Since technology transfer stems from research, industry influence on research also affects technology transfer outcomes. When dealing with industries, universities must strike a careful balance.

WEB LINKS

ISU (general):

www.iastate.edu

Office of the Vice President for Research and Economic Development:

www.vpresearch.iastate.edu

**Office of Intellectual Property and Technology Transfer (OIPTT) and
Iowa State Research Foundation, Inc. (ISURF):**

www.techtransfer.iastate.edu

ISU for Business and Industry:

http://www.vpresearch.iastate.edu/bus_ind_help.html

Institute for Physical Research and Technology (IPRT):

www.iprt.iastate.edu

IPRT Company Assistance:

<http://www.iprt.iastate.edu/assistance/index.html>

ISU Research Park:

www.isupark.org

ISU Pappajohn Center for Entrepreneurship:

www.isupjcenter.org

Center for Industrial Research and Service (CIRAS):

www.ciras.iastate.edu

MONTANA STATE UNIVERSITY

BACKGROUND AND VISION

Located in rural Bozeman, Montana State University (MSU) has risen from its beginnings as a land grant agricultural college to a top tier research university.⁶⁹ By FY 2005 MSU had over \$100 million in research expenditures, more than doubling its research expenditures in seven years.⁷⁰ Research in agriculture, engineering and physical sciences has steadily grown, and the University's strong licensing activity, in part, is a reflection of this growth.

We're a public university, and as a public university one guiding factor should be how successful we are to the companies we partner with ... a major goal is to start local companies and for them to hire our students and grow the economy.

- Thomas J. McCoy, Vice President for Research, Creativity and Technology Transfer, Montana State University

According to Thomas McCoy, Vice President for Research, Creativity and Technology Transfer, MSU's present technology transfer and entrepreneurial activities were borne out of necessity. In the late 1980s, State and University leaders began to recognize that Montana had too few technology businesses which weakened its tax base and contributed to a "brain drain" problem; that is, university students left the State for jobs elsewhere soon after they graduated. In order to address these problems, the State in 1991 developed an Action Plan. Although the State never implemented the Action Plan, Robert Swenson, MSU's then Vice President for Research decided to use the Plan as a roadmap for building MSU research, technology transfer, and entrepreneurial capacity. As part of Dr. Swenson's plan, the State agreed to return the University's indirect costs to the Office of the Vice President which he used as seed money to attract top faculty in targeted research areas such as lasers and optics. The buildup of research later provided the pipeline for executing licenses and launching startups.

Dr. Swenson established MSU's Technology Transfer Office in 1991 as part of the University's thrust to build and leverage research capacity. As part of the effort to build entrepreneurial capacity, in 1996 MSU established the Montana Manufacturing Extension Center (MMEC) to assist manufacturers in Montana, and TechLink, a University unit that acts as a technology transfer intermediary between companies and federal laboratories and agencies. In the late 1990s, MSU partnered with local stakeholders to establish a non-profit incubator, initially called

⁶⁹Previously classified as "research intensive," the Carnegie Foundation for the Advancement of Teaching changed its classifications in 2006 and MSU gained the classification of top tier research institution.

⁷⁰MSU's R&D expenditures in FY 1998 were \$52.3 million and in FY 2005 were \$109.5 million. Source: Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures. FY 1998-2005.

Tech Hatch, that later became the present TechRanch. This incubator hired its first full-time director in 2001, John O'Donnell, a corporate manager and entrepreneur. At the same time, Richard Semenik, MSU Dean of the College of Business created The Center for Entrepreneurship for the New West, a center designed to provide entrepreneurship education and services. From the beginning, the Center and TechRanch coordinated the development of their programs to ensure that each organization would complement and leverage the other's activities. The two organizations developed a close partnership that continues today.

Thomas McCoy, Vice President for Research, Creativity and Technology Transfer, said that startups coming through MSU's technology transfer program have largely been the result of the combined entrepreneurial infrastructure and services provided by the Technology Transfer Office, TechRanch, TechLink, and MilTech, a defense manufacturing program jointly operated by TechLink and the MMEC. These programs were designed to leverage each other's resources and together provide an array of technology transfer and entrepreneurial services that filled many of the earlier technology transfer and entrepreneurial gaps at MSU and in Montana.

TECHNOLOGY TRANSFER

MSU has an impressive record in executing licenses and launching startups. In FY 2005 MSU executed 27 licenses, placing it 10th nationally relative to research expenditures. In the same year, MSU had 108 active licenses, most of which were in agriculture, particularly (a) infectious diseases, (b) thermophiles (heat-loving bacteria), and (c) plant pathology. MSU launched seven startups from FY 2003-05 in agriculture, engineering, chemistry, physics and other areas.

MSU's Technology Transfer Office (TTO) is a small office of only two professionals. TTO's activities are greatly supplemented through partnerships with TechRanch and TechLink that provide additional licensing, commercialization, and business development assistance. For several years the TTO Director split her time between the TTO and TechLink. The TechRanch Director frequently visits MSU research laboratories as well as the TTO, and the TTO Director meets monthly with the TechRanch Director to discuss potential startup referrals as well as licensing opportunities from TechRanch's corporate contacts. The Director credits TechRanch and TechLink for MSU's startups and for improving the entrepreneurial climate in the University and the region.

We've heard (at national technology transfer meetings) that if you can license a technology, you're crazy to do a startup. But we like to build companies ... Our overriding philosophy is economic development for Montana.

*- Rebecca Mahurin, Director, Technology Transfer Office,
Montana State University*

In addition to technology transfer functions, the TTO acts as MSU's point of contact for corporations that wish to interact with the University. The TTO maintains a corporate database of more than 400 corporations and is responsible for all corporate interactions with the University, except for corporate contact with the Manufacturing Extension Program and TechLink. The Office helps businesses gain access to University facilities, directs them to researchers, and arranges consulting services. It also works with corporations and organizations to arrange sponsored research.

TECHLINK

TechLink was established in 1996 as part of MSU's efforts to enhance technology transfer, commercialization and entrepreneurship. TechLink is funded mainly by the U.S. Department of Defense (DOD) and the U.S. National Aeronautic and Space Administration (NASA) to link companies with federal laboratories for research, technology transfer, technology transition (technology transfer to government agencies for government purposes), and commercialization. TechLink is a unit of MSU and is located in MSU's Advanced Technology Park along with TechRanch and the Center for Entrepreneurship for the New West.

The idea for TechLink evolved from discussions between MSU and the staff for Montana's U.S. Senator Burns. The original concept involved TechLink facilitating partnerships between Montana companies and the 10 NASA Regional Technology Transfer Centers (RTTCs). TechLink started with an initial NASA appropriation of \$4 million over four years (FY 1996-2000). In 1999, through a U.S. Congressional appropriation of \$1 million per year, TechLink's services were extended to DOD. Starting in FY 2002, TechLink expanded its DOD technology transition activities to cover nine Western and Northwestern rural states. In FY 2004, TechLink became a permanent part of DOD's budget, and by FY 2006, DOD was funding about 90 percent of TechLink's activities.

TechLink has 10 technology transfer professionals that primarily conduct scouting and licensing activities. In addition to its work with MSU and referrals, TechLink screens all DOD patents and assists companies that it identifies as having the greatest commercial potential. The staff meets periodically to select technology companies for commercialization and technology transition assistance. Through TechLink's partnership with MilTech, a program in the Montana Manufacturing Center, it helps Montana companies transition technologies to DOD. Key TechLink activities include helping companies (a) license federal technologies, (b) establish Cooperative Research and Development Agreements (CRADAs) with federal agencies, (c) obtain R&D funding from the agencies for technology development, mainly through the SBIR program, and (d) sell back advanced technologies to the federal agencies. By 2007, TechLink had established more than 510 technology agreements between companies and more than 80 federal laboratories and research centers. According to TechLink sources, TechLink was responsible for brokering more than one-third of all licensing agreements between DOD and industry nationwide over the past four years.

An example of the way in which TechLink assists companies can be seen in its relationship with Visual Learning Systems (VLS), a successful client that is located in Missoula, Montana. In this case, a computer science professor approached TechLink to help him market remote sensing detection technology to NASA. TechLink suggested and helped the professor develop successful SBIR Phase I and Phase II proposals. They additionally identified the Jet Propulsion Laboratory (JPL) in California as a possible customer for his technology, met with researchers at JPL, and subsequently worked with JPL to develop a CRADA. TechLink and JPL later worked in tandem to secure commercialization funding and eventually licensed the technology to a major corporation. By late 2006 VLS was a fast growing company employing 30 workers.

One of the most popular programs is TechLink's SBIR Program. TechLink reviews SBIR Phase I proposals and coaches small businesses to improve their proposals. For small businesses submitting Phase II proposals, TechLink provides commercialization experts to enhance the commercialization aspects of the proposal. They also arrange and provide a small amount of travel money to help small businesses meet with DOD program managers and prime contractors. For small businesses that already have Phase II SBIR awards, expert business planning consultants help identify and address licensing, manufacturing and other needs. The Montana SBIR Outreach program also provides general workshops and state conferences, including Small Business Technology Transfer (STTR) workshops on the MSU campus that network regional companies and University researchers. From FY 1999-2006, TechLink attracted more than \$36 million in SBIR and related awards to Montana small businesses and more than \$84 million to companies in its nine-state Western region.

TechLink also conducts outreach in Montana for NSF's Experimental Program to Stimulate Competitive Research (EPSCoR). Part of the EPSCoR effort has been to assist MSU in attracting nationally recognized researchers and to facilitate corporate collaboration with MSU.

TECHRANCH

TechRanch is a not-for-profit, technology incubator and "accelerator" located in MSU's Advanced Technology Park. From 2000-06 more than 40 companies have been TechRanch residents or affiliates and TechRanch reports that these companies have generated 200 jobs. In late 2006 TechRanch housed nine resident companies and additional affiliates. About one-third of resident and affiliated companies came from MSU. Examples of resident and affiliated companies include a bioinformatics company that spun off from MSU, a joint defense-related venture involving a MSU startup and a major defense contractor that were partnered through TechLink, and an Internet-based company founded by a local high-tech executive.

TechRanch has developed an array of business services and entrepreneurial resources. TechRanch's residents and affiliates (entrepreneurial clients that receive services but are not resident) have available marketing, business planning, financial planning, and recruiting assistance. Many of these services are provided by student interns from MSU's Center for Entrepreneurship in the New West, which is co-located with TechRanch. In addition, TechRanch has created the TechRanch Service Provider Network that includes professionals in

marketing, law, communication strategies, accounting/bookkeeping, and graphic design. TechRanch pre-qualifies the professionals and matches them with startups.

Early-stage financing is available through the Bridger Private Capital Network, an enterprise forum that was jointly developed by TechRanch and the Center for Entrepreneurship in the New West. TechRanch and the Center actively sought and attracted venture capitalists throughout the U.S. to participate in this Network. Forums are held two to three times each year that showcase TechRanch and other entrepreneurs to potential investors. Members of an Advisory Board, established by the Center for Entrepreneurship in the New West provide “readiness exercises” that help prepare entrepreneurs to make presentations. The Network of about 20 active investors by FY 2006 had invested at least \$3 million in local deals. Other capital is available through Montana Growth Capital which provides stand-alone financing and participates in joint financing with banks. Montana Growth Capital is intended to reach out to businesses that are rural, minority-owned or technology oriented.

THE CENTER FOR ENTREPRENEURSHIP FOR THE NEW WEST

In 2001 the College of Business at MSU created the Center for Entrepreneurship for the New West and a minor program in Entrepreneurship and Small Business Management called the Alderson Program. Although the Center has been operating only a short time, by 2006, it already was ranked in the top 10 nationally by *Entrepreneurship* magazine.

The creation of The Center (for Entrepreneurship for the New West) was important because this is a state in which the economy is almost entirely dependent on small businesses ... The Center works closely with TechRanch and TechLink, and that partnership has been key (to our success).

- Richard Semenik, Dean, College of Business, Montana State University & Executive Director, Center for Entrepreneurship for the New West

A NSF/PFI grant to MSU involved a partnership between the Center for Entrepreneurship for the New West, TechLink, TechRanch, and the Montana Office of Economic Opportunity. The partnership was intended to train entrepreneurs and to develop technology startups that would contribute to building a critical mass of startups in the region. The partnership accomplished its original goal of establishing 12 new companies and, by FY 2006, 10 of the 12 were still in business.

About one-third of the PFI funding was used for seed grants of \$15,000 to each of the 12 companies. Although a small grant, the Directors of the Center and TechLink felt that the

funding made a difference by giving entrepreneurs the money towards market research, intellectual property protection, and incubator rent. The PFI grant also was used to support Business School interns who worked in teams with university scientists to commercialize their innovations. In most PFI projects, students conducted market and competitor analyses on behalf of the University innovator. In one project, a group of students worked with MSU scientists to identify supply chains that would result in commercial uses for oil high in Omega-3 derived from indigenous Montana plants. In another project, a scientist working on a Ph.D. at MSU developed a coating for medical instruments that was licensed by a Montana company. Students worked with the scientist to secure a SBIR Phase II award, helped determine product pricing, and contacted suppliers on behalf of the inventor. At the writing of this report, the University was conducting negotiations with a French cosmetic company to potentially license the technology. Other projects involved students from the Center working with scientists in conjunction with TechRanch and/or TechLink. By FY 2006 this activity had involved more than 80 students. An Innovation Associates representative for this report spoke with several students in the program. Students who participated in the project said that their experience made them much more aware of “what it takes to be an entrepreneur” and provided an opportunity to network in the “real world.” An additional benefit was that one-fourth of the students who participated in the program obtained jobs with the startups and companies for whom they had worked.

The Center also works with the Advisory Network developed by TechRanch to coach entrepreneurs. The Network is composed of 25 to 30 former entrepreneurs, MSU faculty, retired successful business people, and others. As we mentioned in our discussion on TechRanch, the Advisory Network helps prepare entrepreneurs to present at investor forums. (See TechRanch.) The Center also established an Affiliates program in which established businesses can participate in Center seminars and other activities. Other Center programs are:

- Mentoring Program - funded by a \$100,000 endowment, this program has provided scholarships for students to interact with entrepreneurs.
- Entrepreneurship Club – part of the national network “Students in Free Enterprise,” the club members conduct entrepreneurship projects with a community orientation.
- Entrepreneurship Day – involves presentations by entrepreneurs before a panel of experienced entrepreneurs; about 60 high school and college students from all disciplines participate.
- Entrepreneurship University – is a one-day event for entrepreneurs and small business owners.

The minor program in Entrepreneurship and Small Business Management is open to all academic disciplines. The program works in collaboration with the Colleges of Engineering and Agriculture, with the intention of being “a vehicle for entrepreneurial training which focuses on the commercialization of university-based innovations and inventions.”⁷¹ In the Alderson Program for Entrepreneurship students complete 30 credit hours for a minor in entrepreneurship. The final course – the Entrepreneurial Experience – involves student internships with entrepreneurs, particularly resident entrepreneurs at TechRanch and with MSU faculty inventors.

⁷¹ MSU Center for Entrepreneurship for the New West Web brochure.

MONTANA MANUFACTURING EXTENSION CENTER/MILTECH

We view innovation as a continuum; we take it from the viewpoint of the client ... the innovation may not be cutting-edge from the NSF's standpoint, but for a manufacturer, it may be a big leap and this can make a tremendous difference.

- *Steve Holland, Director, Manufacturing Extension Center, Montana State University*

The Montana Manufacturing Extension Center (MMEC) located at MSU operates the U.S. Economic Development Administration (EDA) University Center and the Manufacturing Extension Partnership (MEP) for Montana. Both programs are geared to helping manufacturers enhance innovations and efficiencies. In addition, the MMEC works with TechLink on the MiLTech program.

Started in 2004, MilTech was funded through a \$1.75 million DOD Congressional earmark. The program identifies companies with technologies that can be marketed to DOD and, in some cases, works with the companies to accelerate technology development for DOD. In some cases, MilTech identifies technologies at federal laboratories and TechLink and MEP engineers work together with the laboratories to develop CRADAs and transfer the technologies. TechLink's role in MilTech has evolved somewhat, and their activities now include acting as "talent scouts" for DOD by informing them about companies that can help DOD gear up and manufacture equipment needed for the Iraq war effort. By late 2006 MilTech had worked with 15 companies. Since DOD pays for much of the MEP staff time involved in MilTech, MEP's funding has been significantly leveraged through this program.

For the MEP program, work for clients most often involves (a) efficiency related assistance such as lean manufacturing, (b) quality-related assistance such as certifications and registrations, particularly for suppliers that have increasing requirements from OEMs, and (c) implementation of management tools such as activity-based accounting. The MMEC sometimes partners with the Small Business Development Center (SBDC) on business planning and training and SBIR assistance. In addition, the State Economic Development Advisory Council operates a micro-loan program, and the MEC works with them on behalf of economic development clients.

LESSONS FOR ACADEMIC INSTITUTIONS

Identify entrepreneurial gaps in the community and build infrastructure and services to fill the gaps: MSU's Center for Entrepreneurship for the New West, in conjunction with TechRanch identified gaps in management training, angel/seed capital, and entrepreneurial mentoring and built programs to fill these gaps.

Don't wait for the resources to appear to get started: Richard Semenik, Dean of the MSU College of Business said that if the College had waited for the resources to establish the Center for Entrepreneurship in the New West, it never would have been established. Dr. Semink recommended to other deans who wanted to start an entrepreneurial center to bootstrap it, build its credibility, and then seek financial resources to support it.

Support and flexibility from university leadership is critical: MSU's President and Vice President for Research, Creativity and Technology Transfer have strongly supported MSU's technology transfer and entrepreneurial initiatives. Moreover, they have given programs like TechLink the leeway to experiment and evolve. Some of the technology transfer efforts have not been successful, but others have been successful and have resulted in federal recognition and funding.

The SBIR program is vital for small technology businesses in rural areas: The SBIR program is vital in places where there is little seed funding for small technology businesses. Moreover, "Phase 0" programs that help small technology businesses develop proposals, and programs that help Phase II candidates develop commercialization plans, can contribute to increasing SBIR awards to rural states.

Political support from Washington can make a critical difference in a rural state: A Congressional earmark provided the initial funding for TechLink which later developed into permanent agency funding. Although Congressional earmarks have become politically sensitive, working closely with Congressional staff to support specifically targeted initiatives may result in funding for technology transfer and entrepreneurial activities that may not otherwise be funded.

WEB LINKS

Montana State University (general):

www.montana.edu

MSU Center for Entrepreneurship for the New West:

<http://www.montana.edu/cob/centernewwest/index.htm>

MSU Economic Development:

<http://tto.montana.edu/econdevelopment.html>

MSU Technology Transfer Office:

<http://www.montana.edu/wwwvr/tto/about-tto.html>

TechLink:

<http://www.techlinkcenter.org>

TechRanch:

<http://www.techranch.org>

RENSSELAER POLYTECHNIC INSTITUTE

BACKGROUND AND VISION

Rensselaer Polytechnic Institute (RPI) is one of the nation's oldest engineering schools and is nationally recognized for its excellence in engineering education and R&D, and related fields. *U.S. News & World Report* consistently ranks RPI among the top 50 U.S. universities and the Institute's College of Engineering, in the nation's top 20. In 2007 four of the Institute's engineering programs were ranked in the top 26: (a) mechanical, (b) biomedical, (c) computer, and (d) electrical, electronic, and communications.⁷² RPI is a small, private institution of about 6,300 students, 20 percent of whom are graduate students. The Institute is located in the City of Troy, in Upstate New York, an area characterized by traditional industry; a branch campus is located in Hartford, Connecticut.

RPI is a groundbreaking institution in establishing university-industry collaboration, interdisciplinary research centers, and entrepreneurial infrastructure. These initiatives were the vision of the late George Low who was President of RPI from 1976-1984. Through his "Rensselaer 2000" plan, President Low set out to positively impact the region's economy by expanding research capacity, technology transfer and commercialization, and technology startups. In the late 1970s and early 1980s, the Plan led to the establishment of university-industry cooperative research centers: Interactive Computer Graphics, Manufacturing Productivity and Technology Transfer, and Integrated Electronics. The first center served as a model for NSF Engineering Research Centers. These centers also formed the basis of President Low's proposal to then New York Governor Carey to establish New York State's Center for Industrial Innovation (CII) housed at RPI (now called the George M. Low Center for Industrial Innovation) and the statewide program of Centers for Advanced Technology. The "Rensselaer 2000" plan also led to the development, in 1981, of one of the nation's first university incubators and one of the first university-related research parks – The Rensselaer Technology Park.

Today, RPI's President Shirley Ann Jackson continues to expand and diversify RPI's education and research through the current "Rensselaer Plan." This strategic Plan calls for enhancing RPI's research portfolio and leveraging research strengths in focal areas within the disciplines of biotechnology and information technology. As part of this thrust, RPI has established a new Biotechnology and Interdisciplinary Studies Center. The Center will become home to a new Gen*NY*sis Center for Bioengineering and Medicine funded by New York State and the federal government. The Center also will support the creation of a new Center for Quantitative and Computational Bioscience that will bring together major corporate and academic researchers. In addition to enhanced research, the "Rensselaer Plan" calls for greater "technological entrepreneurship" and emphasizes intellectual property and commercialization, and creating and supporting new ventures.

⁷² 2007 *U.S. News and World Report*.

For more than 175 years, Rensselaer has exhibited a unique strength in its ability to translate scientific discoveries into practical application, a process that we refer to as “technological entrepreneurship.” Historically and consistently, faculty, students, and alumni have successfully developed technologies, created innovations, and formed business ventures to bring ideas into practice to create value.

Today, the Incubator program, Rensselaer Technology Park, and the Severino Center for Technological Entrepreneurship are national models. Looking ahead, rapid technological change and an emerging global marketplace present outstanding continuing opportunities for scientific and technological entrepreneurship.

- Excerpted from the “Rensselaer Plan,” Rensselaer Polytechnic Institute, 2007

TECHNOLOGY TRANSFER

For a relatively small university, RPI’s research expenditures are exceptionally strong. In FY 2005 the Institute’s research expenditures were \$66 million, a 70 percent increase from only seven years earlier.⁷³ Engineering research was responsible for more than 70 percent of the research expenditures, and the federal government funded more than two-fifths of all research.⁷⁴

RPI has an exceptional number of patents and is strong in executing new licenses and launching startups. In FY 2005 RPI applied for 73 patents, placing it fourth nationally relative to research expenditures. It executed 14 licenses, and had 40 active licenses. From FY 2003-05 RPI launched eight startups, and it consistently launches between two and four startups each year.

Created in 1990, RPI’s Office of Technology Commercialization (OTC) until FY 2001 was staffed by only one full-time employee. The Office underwent significant changes, and by FY 2006 had increased its staff to eight full-time employees and one part-time employee. The OTC Director said that the “Rensselaer Plan” provided the justification for increasing the staff, and RPI’s President Jackson fully supported enhancement of technology transfer activities.

⁷³ Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005. NSF.

⁷⁴ Table 36. R&D expenditures at universities and colleges, ranked by all R&D expenditures for the first 200 institutions, by science and engineering field: FY 2005. NSF and 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.

In FY 2006 OTC's staff was divided between patenting and licensing activities, and between physical sciences and life sciences. The staff included a business administrator who is shared with RPI's Incubator. OTC uses a case management approach, and about half of the staff perform case management functions.

The OTC Director said that in the last couple years OTC has moved from a focus of "passive disclosures" to "active deal flow." As part of this new focus, RPI staff have enhanced their internal connections with researchers and entrepreneurial programs, and their external connections with potential corporate clients. The OTC also has added an information database and expanded its focus on marketing and technology bundling. The Director believes that these changes have contributed to OTC increasing the number of invention disclosures and increasing its new licenses.

Technological entrepreneurship is an idea that overlays everything we do at RPI as a way to educate tomorrow's leaders. We also take a global perspective and want our students to have that perspective.

- Omkaram (Om) Nalamasu, former Vice President for Research, Rensselaer Polytechnic Institute

OTC has close working relations with the Institute's entrepreneurship programs. In 1996 RPI created a virtual group – the Rensselaer Technological Entrepreneurial Council (RenTEC) – that brought together the OTC with the Incubator, RPI Technology Park, and the Lally School of Management and Technology. OTC and the RPI Incubator are now part of Intellectual Property, Technology Transfer and New Ventures, and the Executive Director of this unit reports directly to President Jackson. In addition, an Intellectual Property Task Force involving research center directors and others was formed to address and revise the Intellectual Property Policy and Procedures.

There also is a close relationship between OTC and the Office of Sponsored Research. The OTC meets weekly with the Office of Sponsored Research to insure that the language in research contracts will support commercialization at later stages. OTC additionally works with the Institute's Corporation and Foundation Relations, which facilitates relationships between the Institute and corporations. In addition, the RPI Alumni Relations Office has an affinity group of patent attorneys that have provided advice to OTC. OTC has fostered these relationships, including holding off-site RPI alumni receptions as part of the American Intellectual Property Law Association (AIPLA) conference.

COMMERCIALIZATION RELATIONSHIPS WITH INDUSTRY

RPI has a long history of inter-disciplinary research centers and industrial research partnerships that have contributed to commercialization of RPI research. One of the best examples of how RPI has built effective industrial partnerships resulting in commercialization is the Center for Automation Technologies and Systems (CATS). Founded in 1988, the CATS has a long established working relationship with industry that ranges from collaboration on basic research to manufacturing system design and product line development. The CATS was one of the first RPI centers established as part of the late President George Low's strategic vision to involve industrial partners in building the Institute's research base. Originating from the Center for Manufacturing and Technology Transfer, CATS received designation and funding from New York as one of the State Centers for Advanced Technology (CAT). Recently, RPI was awarded a second CAT from New York State in Future Energy Systems that will follow the same path to establish long-term corporate partnerships. Both Centers receive funding from a combination of industry, and State and federal government.

In 2006 the CATS worked with over 30 companies, and served multiple functions as a clearinghouse, and conduit to faculty for problem solving, developing prototypes, testing and evaluation, and other services. The CATS program has generated a number of RPI patents, licenses and startups and in 2006 at least three of those startups were still in business. An example of a recent relationship involved the Center's work with an electronic manufacturing firm located in Oregon. The firm approached the Center to reduce the vibration settling time related to laser drilling. After the CATS presented a computer simulation, the manufacturer shipped their production equipment to the Center where research was conducted that resulted in a prototype which demonstrated substantially reduced "settling time." In addition, the CATS explored with other centers the application of the technology to biological and satellite (homeland security) uses. The CATS Director believes that the Center's success in commercializing its research is due to their ability to build long-term relationships with industry that are based on credibility and trust.

Technology transfer is a contact sport ... it involves building personal relationships in business through the years. RPI had an early start in this area but you still have to educate some industries that aren't used to working with universities, and you have to offer some flexibility.

- Richard Siegel, Director, Nanoscale Science and Engineering Center, Rensselaer Polytechnic Institute

RPI is one of six original NSF sites for a Nanoscale Science and Engineering Center (NSEC). The RPI Center is supported by NSF, industry, and the New York Office of Science Technology and Academic Research (NYSTAR). The Center's industrial partnerships include major

corporations such as Eastman Kodak, ABB, IBM, Albany International, Intel, Sealed Air, and Phillip Morris. In 2006 the Center had already produced more than 30 patent applications and had spun off two businesses, one that remained in the area. One of the startups, Nanophase Technologies Corporation, became a publicly held company. The NSEC Director served on RPI's Intellectual Property Task Force, and his experience in building successful relationships with corporations was very important in updating RPI's Intellectual Property Policy and Procedures. These documents now govern the work of the Office of Sponsored Programs and the Office of Technology Commercialization when negotiating agreements.

RPI TECHNOLOGY PARK

We knew that if we didn't organize the community and the region, we wouldn't get anywhere ... We worked to create an entrepreneurial culture at RPI and in the region. Now we have \$100+ million firms like MapInfo that could go anywhere and chose to remain here.

- Michael Wacholder, Director, Rensselaer Technology Park

The RPI Technology Park is one of the nation's first university-related research parks. It grew out of a strategic vision for the Institute and the community. To that end, RPI conducted an analysis of the potential economic impact to the community of establishing a research park. RPI subsequently developed one of the nation's first university-based incubators, and with the very rapid success of the incubator, soon after developed the Technology Park. As part of the development process, RPI organized the Capital Regional Technology Development Council, a community leadership organization to provide support for the Institute's entrepreneurial goals. The RPI endowment initially funded development of the Park's Phase I infrastructure and operations. The multi-tenant buildings constructed by the university were funded through conventional financing and/or Industrial Revenue Bonds. Unlike many university parks that have separately incorporated, the RPI Technology Park remains a division of the Institute and the Park Director reports directly to the Institute's President. The Park is administered by the Director and staff of five.

According to the Park Director, Michael Wacholder, the Park evolved from an early focus on attracting and growing local firms to one that now focuses more on growing university startups and university-connected firms. Located close to RPI, a fundamental objective of the Park has been to develop interactions between tenant companies and the university. All companies located in the Park automatically become RPI "affiliates" and members of the "Venture Affiliates of RPI." The Park has a number of tenant companies that were started by RPI faculty and students such as MapInfo, a \$166 million software company that was started by four RPI students as a class project, and Vicarious Visions started by a RPI student. These companies continue to have close relations with university researchers, employ RPI interns, and hire RPI

graduates. According to the Park Director, about 80 percent of the companies located in the RPI Technology Park have some direct connection to the university.

VICARIOUS VISIONS

Karthik Bala and his brother Guha in 1991 started Vicarious Visions as a “hobby” that turned into a \$15+ million game software business. Mr. Bala as a high school student began developing software and chose to attend RPI because of its Incubator and entrepreneurial support. “I had to decide between the sunny skies of California and the grey skies of Troy, NY and selected Troy because there was genuine interest and enthusiasm about helping entrepreneurs at RPI.” He continued developing the business in a dorm room, later moved it to the Incubator, and after hiring 10 students, moved it to the RPI Technology Park. While in the Incubator, Mr. Bala was introduced to Mike Marvin of MapInfo, a \$166 million RPI spinoff located in the Technology Park. Mr. Marvin mentored the young Bala and provided seed capital. Other entrepreneurs in the Incubator provided peer support, and meetings arranged between the Incubator manager and venture capitalists provided “a lot of critical feedback, tough love” (and subsequent funding).

In 2005 Vicarious Visions joined Activision, located in Los Angeles, but decided to stay in the Upstate New York region, where it has attracted talent from around the world. Vicarious Visions has maintained strong ties to RPI, and Mr. Bala now is mentoring other aspiring RPI entrepreneurs, regularly employs RPI interns, and about half of Vicarious Vision’s 170 employees have come from RPI. He also worked with RPI to develop a four-year engineering degree in game development. Mr. Bala’s parting words for other academic institutions were “it comes down to making the investment, commitment and having faith in startups.”

- Excerpted from discussions with Karthik Bala, January 2006

By 2007 the RPI Technology Park was home to more than 60 companies employing 2,300 workers. The tenant companies represent diverse technological fields that mainly reflect the strengths of the university. The Park has become a bridge between the community and the university through its entrepreneurial activities, a children’s museum located in the Park, and pro-active personal services that link university researchers and interns with Park tenants. The Institute’s diverse entrepreneurial initiatives have been credited with attracting more entrepreneurial faculty, endowments to RPI from successful Park tenants, and improvements in the local economy.

RENSELAER INCUBATOR PROGRAM

The RPI Incubator was launched in 1980 as an integral part of the Institute's entrepreneurial strategy. It is one of the nation's earliest and most successful university-related incubators. By 2007 the RPI Incubator had graduated over 250 startups with more than three-fourths still in business or successfully acquired by leading national and international corporations.

The RPI Incubator is located on the Rensselaer campus. At the writing of this report 18 companies are residents. There are an additional 22 affiliates located throughout the New York Capital Region, the United States, Canada, Denmark, Brazil, India, France, and the Ukraine. The Incubator Program offers an extensive suite of business services including infrastructure-based support, mentoring, business development, fund-raising events, and networking opportunities. Affiliates are part of the "virtual incubator" and have access to all facilities including a conference room and equipment. Incubator residents and affiliates are about equally divided among students, faculty, and entrepreneurs from the community.

Many of the Incubator's services are provided to entrepreneurs in conjunction with the Center for Economic Growth and the Severino Center for Entrepreneurship. The Incubator takes the lead in training entrepreneurs to showcase innovations at the "Venture B" series (see the Severino Center), arranging meetings with potential investors and alumni contacts, and hosting the RPI Entrepreneurship Club. The Incubator Director's future plans call for the Incubator's designation as an "International Soft Landing Zone" through the National Business Incubation Association. It also calls for closer collaboration with other Rensselaer schools and departments to foster entrepreneurship within academic settings, collaborating with other State facilities for international incubation with access to New York City and other strategic markets, and building relationships to support initiatives aimed at international incubation and emerging opportunities in the global economy.

SEVERINO CENTER FOR TECHNOLOGICAL ENTREPRENEURSHIP AND THE OFFICE OF ENTREPRENEURSHIP

Established in 1988, the Severino Center for Technological Entrepreneurship (SCTE) in the RPI Lally School of Management offers a wide variety of entrepreneurial education and services, including opportunities for students and faculty to attract investments. SCTE received a boost in 1999 when Paul Severino, a RPI alumnus and successful entrepreneur, and his wife donated \$5 million to endow the Center. The Center sponsors a business plan competition and investment forum – Venture B – that showcases startups from RPI and the region to potential investors. In these events, entrepreneurs typically seek investments of \$500,000 to \$5 million. The RPI Incubator provides counseling to some of the company presenters prior to their participation in the forum. Fifteen firms, about half RPI-related, have received investments of about \$60-70 million over eight years. The forums are sponsored jointly with the Center for Economic Growth.

RPI holds a Business Plan Competition each spring and awards a total of \$50,000. There also is a statewide competition sponsored by RPI that is open to other universities in New York. RPI students have won several of the statewide competitions. One of the statewide competition winners was Bullex, a company that developed fire training simulations, was started by RPI engineering and management students with help from the Severino Center. In 2005 this startup finished in the Top 5 of the *Fortune Small Business Competition*.

The Center's Biotechnology Management and Entrepreneurship Seminar Series provides a forum for exchange and local networking for RPI and community entrepreneurs. The evening series involves speakers on various aspects of biotechnology entrepreneurship issues in partnership with Cornell University and Syracuse University, and is co-hosted by CNY Medtech (a central New York association of medical technology firms). The series is intended to create a dialogue on entrepreneurship and management within the region's emerging biotechnology industry. A RPI student Entrepreneurship Club also holds monthly meetings in which successful entrepreneurs speak to students. About 75 students attend the meetings that are held in the RPI IdeaLab.

The RPI Entrepreneurship Intern Program provides entrepreneurship experience in a 12-week, hands-on program with startups and other technology companies. The Center matches interns and companies and introduces them at Center-sponsored breakfasts. Some of the companies are based in the RPI Technology Park such as MapInfo that hires about 25 MBA students each semester. Students receive \$5,000, half of which is paid by the company and half by the Severino Center. Students work on everything from marketing to product assessments. RPI's "adVENTURE in Entrepreneurship" is a "boot camp" held in late August for one week each year. Held at the RPI Technology Park, this training involves about 50 new RPI students and is intended to introduce them to the world of entrepreneurship early enough to influence their career direction.

In addition to the Severino Center's many activities, the RPI Office of Entrepreneurship sponsors an annual competition called "Change the World Challenge" that is intended to stimulate RPI students to use science and engineering to improve human life and offer an innovative and sustainable solution to that challenge. Created in 2005 by Rensselaer alumnus Sean O'Sullivan, the competition is intended to support entrepreneurship education and inspire ideas to improve the human condition by providing a \$1,000 case award for ideas that will make the world a better place. The competition is supported by a \$1 million donation from O'Sullivan, one of the founders of MapInfo, a global software company that was started by four RPI students and is now located in the RPI Technology Park.

In 2006 Rensselaer established the newly created position of Vice Provost for Entrepreneurship. The position is intended to strengthen Rensselaer's culture of entrepreneurship and lead Rensselaer's efforts to infuse the study, research, and practice of entrepreneurship across the RPI curriculum, with an emphasis on educational programs.

CENTER FOR ECONOMIC GROWTH

The Center for Economic Growth (CEG) was originally the Capital Region Technology Development Council, founded by the late RPI President Low as part of RPI's three-pronged regional entrepreneurial initiatives – the Rensselaer Incubator, RPI Technology Park, and Council. The Council is a not-for-profit organization located in Troy, New York. The Council advances regional entrepreneurs and technology businesses and continues to work closely with RPI by sponsoring joint entrepreneurial activities with the Severino Center for Technology Entrepreneurship, the Incubator, and the Technology Park.

CEG's Business Acceleration Program provides a variety of services to startups. The Program engages over 100 volunteers from the community including RPI. Services range from critiquing business plans to helping the businesses assess markets and accelerate the adoption of their technologies by federal agencies.

In 2005 CEG started a new incubator located at the Watervliet Arsenal near Troy, New York. The incubator called the Watervliet Innovation Center (WIC) houses several RPI startups and has several additional RPI Associates that receive WIC services. WIC focuses on Homeland Security firms and provides firms with extensive services through the Business Acceleration Program. WIC also has formed a relationship with the Chesapeake Innovation Center in Annapolis, Maryland and several other incubators that house startups working on Homeland Security technologies. WIC is supported, in part, by funding from the U.S. Department of Defense.

An example of the working relationship between RPI and CEG involves Bullex, a RPI startup that won several business plan competitions. (See Severino Center discussion.) RPI's technology transfer office filed the company's patents and executed a license to the company. The company became an Associate of WIC and through WIC's Business Acceleration Program received assistance in setting up its factory, identifying vendors, meeting potential customers, and developing marketing materials. The regional Manufacturing Extension Program also assisted the company.

The Venture B forums, originally started by the Rensselaer Incubator, are now conducted by CEG in partnership with RPI's Severino Center. CEG also participates in the Tech Valley Angel Network. The Network involves 25-30 angels who provide investments to regional firms, including those from RPI. The SmartStart Venture Forum, originally started at the Albany Law School, also is now operated by CEG. UNYTECH is another venture forum available to regional university startups in Upstate New York. The forum is open to entrepreneurs from Cornell University, RPI, Rochester Institute of Technology, SUNY-Albany, SUNY-Buffalo, Syracuse University, and University of Rochester.

LESSONS FOR ACADEMIC INSTITUTIONS

Visionary leaders can set into motion far-reaching institutional cultural changes: The visionary President George Low set into motion a long-lasting infrastructure and environment that created inter-disciplinary and industry collaborative research, and built an entrepreneurial infrastructure. Subsequent Presidents such as Roland Schmitt and the current Shirley Ann Jackson built on and added greater research, commercialization and entrepreneurship breath and depth to the original strategic plan, further enhancing RPI's national research prominence and positively impacting the region's economy.

Universities benefit from entrepreneurial “return-on-investments” in many ways: Some of the Institute's entrepreneurial investments have not returned licensing royalties but in some cases have resulted in even greater returns. These returns have included anonymous donations of over \$300 million dollars, countless hours of mentoring to future entrepreneurs, development of new academic programs, and connections with cutting-edge industries.

Once a small research university has solidly established itself as a leader in a specific field(s), it can benefit by leveraging core research into associated disciplines: RPI has set out to achieve \$100 million in research expenditures, in part, by branching into cutting-edge innovation areas that leverage its core research strengths. Areas such as nanotechnology and computational bioscience should bear substantial research and commercialization rewards.

Technology transfer and entrepreneurship go hand-in-hand: Technology transfer that involves the launching of startups must have access to and strong connections with entrepreneurial infrastructure and services. Incubators and technology parks, and their associated services and networking are critical elements for launching and retaining startups in the university's community.

Flexibility in industry dealings is critical: RPI, as other universities, has experienced many evolutions regarding its relationships with industries. It is important that academic institutions focus on building long term relationships with industry, as RPI has traditionally done, instead of focusing on the “bottom line” of licenses and license income. Industry “pay back” is often much greater than what appears on balance sheets, and involves student experiences and hiring opportunities, as well as making academia current on rapidly changing technological advances and understanding future workforce requirements.

WEB LINKS

Rensselaer Polytechnic Institute (general):

www.rpi.edu

RPI Research:

<http://www.rpi.edu/research>

Office of Technology Commercialization:

<http://www.rpитеchnology.com/index.php>

Center for Automation Technologies and Systems:

<http://www.cats.rpi.edu>

Center for Biotechnology and Interdisciplinary Studies:

<http://www.rpi.edu/research/biotech/index.html>

Nanoscale Science and Engineering Center:

<http://www.rpi.edu/dept/nsec>

RPI Technology Park:

www.rpитеchpark.com

Rensselaer Incubator Program:

www.incubator.com

Severino Center for Technological Entrepreneurship:

http://www.lallyschool.rpi.edu/programs/index.cfm?p=5&inc=severino_home

Center for Economic Growth:

www.ceg.org

New York State Office of Science, Technology and Academic Research/

New York State Foundation for Science, Technology, and Innovation:

www.nystar.state.ny.us

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

BACKGROUND AND VISION

Founded in 1967 on the historical site of the Springfield Armory, the Springfield Technical Community College (STCC) is the only technical community college in the Massachusetts public education system. STCC offers a broad range of associate degree and certificate programs in healthcare, engineering technologies, and business/computers. The College is highly engaged in the community and works closely with local and national industries, including Ford, Intel, and Microsoft, on developing relevant workforce programs.

STCC has a strong commitment to entrepreneurial and economic development. It is one of the few community colleges in the nation to have developed a technology park and has an active incubator. Moreover, STCC has taken the lead in entrepreneurial education in community colleges and has become a national model in this area. The College became especially active in forging industry partnerships and entrepreneurial development in the mid-1990s when Digital Equipment closed its plant, leaving more than 1,000 workers without jobs. In response, the then STCC President Andrew Scibelli launched several programs to retrain employees and worked with local industry to identify and address future employment needs. In order to lessen the community's reliance on major industries, STCC embarked on developing entrepreneurship education and entrepreneurial infrastructure. STCC established the Scibelli Enterprise Center, and with the Commonwealth of Massachusetts, created the Technology Park that eventually replaced the community's lost jobs. STCC now is forging the way for other community colleges to partner with emerging technical industries and promote entrepreneurship.

EMERGING INDUSTRY PARTNERSHIPS

In 1997 the NSF established a National Center for Telecommunications Technologies (NCTT) at STCC. The Center is one of 14 NSF Advanced Technological Education Resource Centers of Excellence, each one organized around a specific technology focus. NCTT is charged with leading a national collaborative of business and education partners to develop and disseminate relevant, industry-driven curriculum to teach and train ICT technicians and technologists. The Center designs and disseminates curriculum and creates regional partnerships throughout the country to capture emerging ICT technologies. STCC also is the lead institution in the 10-college, 12-campus Verizon New England Next Step program that provides corporate-specific curriculum in telecommunications technology to Verizon employees throughout New England.

STCC partnerships with industry focus mainly on helping identify and meet industry needs for workforce development, retraining, and certification. STCC's Center for Business and Technology, founded as part of the College's Division of Economic and Business Development, plays a major role in working with industries. It provides credit and non-credit programs ranging from computer certifications to software workshops, to management development and health education updates. Some programs are open to the public; others are customized and taught specifically for area businesses.

Based on a Pioneer Valley Planning Commission recommendation, STCC in 2005 took the lead in convening a series of local industry forums in manufacturing, financial services, health care, and dental services. These forums focused on identifying industries short- and long-term needs and developing strategies to meet those needs.

STCC has had long-standing partnerships with regional and national industries including Ford Motor Company and Intel Corporation. For the Ford Asset Program, STCC has provided instructional units and certified instructors and in return, Ford's managers have mentored some of STCC's entrepreneurial students. In addition, the STCC Center for Business and Technology has partnered with the regional National Machine Tool Association to collaboratively develop skills training for their employees.

In collaboration with the hospital industry in the area, STCC has developed some cutting-edge technical education and workforce development programs. STCC developed the SIMS Medical Center – a virtual hospital that involves 12 patient simulation units – to provide state-of-the-art simulated training. STCC administrators believe that the SIMS Medical Center is the only one of its kind in the country. In 2007 STCC was partnering with another community college to create the SIMS Academy. This Academy will expand the use of virtual hospitals and provide continuing education for medical center employees.

ENTREPRENEURSHIP INITIATIVES

We want to create a new paradigm in the community to encourage people to create their own businesses. We want to get students to create their own jobs and take charge of their futures.

- Thomas Goodrow, Vice President, Division of Economic and Business Development, Springfield Technical Community College

STCC is a national leader in entrepreneurship education and services. STCC's suite of entrepreneurial infrastructure and services are intended to "inject the community with new energy and economic possibilities." The College's entrepreneurial resources include (a) the STCC Technology Park, (b) the Scibelli Enterprise Center and the Center's Springfield Business Incubator, and (c) the Entrepreneurial Institute that oversees the Young Entrepreneurial Scholars Program, the Student Venture Program and the Student Business Incubator. In 2001 STCC started the National Association for Community College Entrepreneurship (NACCE), a national membership organization that promotes entrepreneurship and best practices in community colleges across the nation. The Association was started with a grant from the founder of Friendly Ice Cream Corporation and later received grants from the Ewing Marion Kauffman and Coleman Foundations.

STCC Technology Park

In 1996 the Commonwealth of Massachusetts created the Springfield Technical Community College Assistance Corporation (STCCAC), a nonprofit corporation, to develop and manage a technology park adjacent to the STCC campus. The Corporation converted a former Digital Equipment Corporation site into a new technology park, and it became the first and one of the few technology parks in the nation that is associated with a community college. The Park is located on a 15-acre site that provides space for technology-based and light-manufacturing companies. In 2001 the Park was selected by the Economic Development Administration, U.S. Department of Commerce as the sole national winner of the Award for Excellence in Urban Economic Development. In 2002 the International Economic Development Council also recognized the Technology Park with its Economic Development Award for a Revitalization Program.

In 2007 the Park was home to 18 tenant companies employing more than 750 workers. Many of these companies were affiliated with the telecommunications industry. The incubator facilities located in the Scibelli Enterprise Center within the Park house an additional 21 small businesses employing about 110 workers. An Economic Impact Report showed that the Park by 2003 had created more than 2,000 direct and indirect jobs. In addition, tenant companies have invested in the Technology Park more than \$300 million in equipment and technology.

The Technology Park is home to the Scibelli Enterprise Center's Springfield Business Incubator, the National Center for Telecommunications Technologies, the STCC Department of Mechanical Engineering Technology, and the Verizon New England Next Step Program. The partnership between STCC and the Technology Park facilitates STCC's faculty and staff, providing tenant companies with business expertise and up-to-date technical assistance. The partnership also has made it possible for hundreds of STCC students to gain practical work experience at technology-based companies in the Park.

In 2006 the Park brought online the largest photovoltaic installation in Western Massachusetts. The installation will serve as a demonstration center and, in addition to incubation facilities and STCC training programs, is expected to attract renewable energy companies to the Springfield region.

Scibelli Enterprise Center and Springfield Business Incubator

Opened in 1999, the Scibelli Enterprise Center (SEC) is located in a renovated historic building on the STCC Technology Park. The SEC's 34,000-square-foot facility offers incubation space, shared services, and *pro bono* consulting services to incubator residents as well as services to other area entrepreneurs. The Center has brought under one roof the U.S. Small Business Administration branch office, the Massachusetts Small Business Development Center Network, SCORE, and The Western New England College's School of Law and Business Center for Advancing Entrepreneurship. Stephen Spinelli, a co-founder of Jiffy Lube International and Executive Director for the Arthur M. Blank Center for Entrepreneurial Studies at Babson College, serves as a special advisor to the Center and its Entrepreneurial Institute.

The SEC houses and administers the Springfield Business Incubator (SBI) that is designed to guide, educate, and support startups. In 2007 SBI housed 11 businesses and four business support organizations. SBI includes office space, central services, and meeting facilities including a video-conferencing center that is available to area business clients. SBI tenants are guided throughout their incubation period by the SEC Advisory Board, a group of successful area business professionals who volunteer their time and expertise to mentor resident entrepreneurs. Partnerships with several near-by colleges provide residents with additional services. About six attorneys and six graduate business students from The Western New England College's Schools of Law and Business give SBI residents free legal, business, and marketing assistance. Marketing students from Springfield College develop market plans for SBI tenant businesses. Professionals from the University of Massachusetts-Amherst Family Business Center help critique business plans and provide additional advice to incubator residents. At the writing of this report, STCC also was discussing a potential partnership with the Pioneer Valley Life Sciences Institute (PVLSI) that would provide additional business support and training, and potentially involve collaboration on wet lab space. The PVLSI is a partnership between the Bay State Health Care hospital system and the University of Massachusetts-Amherst.

SBI's resident entrepreneurs represent a wide range of technological fields. They range from a tenant who has developed a business to transfer European surveillance software to a business that provides translation services. Deborah King, Director of SBI, said that one of the advantages of having an incubator at a community college is that it creates opportunities for students to get "real life" experience and also helps shape education at the College. She referred to one incubator resident who had started a digital photography business and had helped STCC develop a curriculum in that area to provide the business with better trained workers. According to the STCC Vice President of Economic and Business Development, by 2007 the Springfield Business Incubator had supported 24 businesses and created 200 jobs in the Springfield region.

STCC Entrepreneurial Institute

The STCC Entrepreneurial Institute was started in 1996 to meet the growing demand for entrepreneurial education. The Institute operates under the Division of Economic and Business Development and is located at the SEC. The Institute is intended to serve as a "one-stop shop" for a wide range of entrepreneurship education and student business incubation services, and serves over 2,000 individuals each year. By 2007 more than 16,000 students had participated in the Entrepreneurial Institute's programs.

The Institute's entrepreneurship education involves a broad range of programs from non-degree courses to collaboration with the School of Business and Information Technology's two-year associate degree in Entrepreneurial Studies. The Institute also offers educational programs to serve the area's K-12 educators interested in teaching entrepreneurship, and operates the Young Entrepreneurial Scholars (YES!) program for high schools in the region. By 2007, 25 high schools were participating in the program. The Institute provides entrepreneurial training and assists students in developing business plans.

From the community college perspective, there are all different kinds of innovation and they are not all high-tech ... there needs to be a greater recognition of the value of these types of innovations.

*- Diane Sabato, Director, Entrepreneurial Institute,
Springfield Technical Community College*

Operating within the Entrepreneurial Institute, the Community Foundation of Western Massachusetts Student Business Incubator is intended to provide a supportive environment for entrepreneurial startups created by high school and college students. Mentors provide individual, ongoing coaching to the young entrepreneurs. Students also are offered information resources, technical assistance, and sometimes introductions to potential investors. To enroll in the Student Business Incubator, students submit a preliminary business plan and are interviewed by a panel of faculty and staff. The Entrepreneurial Institute staff guide students throughout their business development; and coordinate individualized support services and mentoring.

STCC also participates in the Pioneer Valley Technology Innovation Development Exchange (PVTIDE), an initiative that brings together education, business, government and non-profit organizations with a common interest in innovation as a key element in technology-based and workforce development. The University of Massachusetts-Amherst Schools of Engineering and Business lead this initiative.

LESSONS FOR ACADEMIC INSTITUTIONS

Innovations come from many different sources: Most innovations are not “high-tech” and usually involve incremental advancements that are important in moving technology forward. These technological advancements come from many sources including community college faculty and students. While these types of innovations are often undervalued compared to technological breakthroughs at research universities they nevertheless are critical contributions to the innovation landscape.

Through partnerships with near-by universities, community colleges can provide a variety of entrepreneurial services: Partnerships between STCC and University of Massachusetts-Amherst, Springfield College and The Western New England College have provided legal and business advisors to STCC incubator tenants. STCC’s linkages with regional institutions have added value to the College’s already extensive entrepreneurial services.

Community college engagement can impact local economic development: Engagement and leadership from STCC, spearheaded by STCC's former President, resulted in a Technology Park that has helped revitalize Springfield's economy. The College's expanding entrepreneurial services and innovate workforce development programs are further contributing to the region's economic future.

WEB LINKS

Springfield Technical Community College (general):

www.stcc.edu

Entrepreneurial Institute:

<http://www.eship.org>

Technology Park:

<http://techpark.stcc.edu/index.html>

Scibelli Enterprise Center:

<http://sec.stcc.edu>

Center for Business and Technology:

<http://cbt.stcc.edu>

STCC Economic and Business Development:

<http://ebd.stcc.edu>

National Association for Community College Entrepreneurship:

<http://www.nacce.com>

NSF Advanced Technological Education (ATE) Program:

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5464&org=DUE&from=home

UNIVERSITY OF AKRON

BACKGROUND AND VISION

Founded in 1870 as Buchtel College, The University of Akron (UA) grew in Northeastern Ohio alongside the region's tire and rubber industries and more recently the region's polymer fabrication industry. Northeast Ohio boasts the highest concentrations of plastics processors in the nation, and *Newsweek* magazine recently named the Akron one of 10 national "High Tech Havens."⁷⁵

UA's College of Polymer Science and Polymer Engineering is the nation's largest single center of polymer education,⁷⁶ and its polymer science and polymer engineering programs consistently rank in the top five by the *U.S. News & World Report* magazine. UA's industrial/ organizational psychology program also consistently ranks in the top 10.⁷⁷ Moreover, UA has been recognized as one of 12 Carnegie Cluster Leaders in the U.S. for its excellence in teaching. In 2007 the University had 23,000 students; about one-fourth of those students were in UA's graduate schools and that population is growing. UA's Law School is one of the few in the nation to offer an LL.M. in intellectual property.

UA embarked on a \$300 million renovation program – "New Landscape for Learning" – that by early 2007 greatly expanded the University's laboratories, teaching and cultural facilities, and created more than 30 acres of additional green space. The University added several new degree and certificate programs including computer engineering, intellectual property law, e-commerce, international business, and a new Ph.D. program in integrated bioscience.

As part of its community commitment, the University spearheaded the University Park Alliance. The Alliance is a University partnership with the City of Akron, Summa Medical Center, and local organizations. Supported by the Knight Foundation, the Alliance is revitalizing a 40-block neighborhood and commercial area that surrounds the campus.

In "Charting the Course," University President Luis M. Proenza's vision for UA focuses on leveraging the University's competitive advantage in science and engineering, specifically in polymer-related fields. The strategic plan emphasizes several goals:

- Enhancing science and engineering capacities, particularly polymers, biomedical engineering, and chemical engineering.
- Enriching the culture of the community.
- Enhancing community "well being" through education in areas such as nursing.
- Increasing the University's impact in regional economic development.

⁷⁵ "Greater Akron's Competitive Advantages," Akron Chamber of Commerce (January 2007).

⁷⁶ Source: Office of Technology Transfer, The University of Akron.

⁷⁷ *U.S. News & World Report*, 2005.

The University of Akron grew up alongside the rubber and polymer industries and in large measure was responsible for its diversification. Our long-term comparative and competitive advantage lies in our continuing relationships with industry.

- *President Luis M. Proenza, The University of Akron*

President Proenza's commitment to expanding the University's research and leveraging its core strengths has paid off. UA has increased its research expenditures by 72 percent in 10 years, rising from \$15.6 million in FY 1995 to \$26.8 million in FY 2005.⁷⁸ In FY 2006 polymer research comprised about 35 percent of the total research expenditures and represented the majority of collaborative industry research. Additionally, UA's planned National Polymer Innovation Center, its new Polymer Engineering Center, and its participation in multiple state-funded Third Frontier projects are fueling the University's research expansion and collaborative industry research efforts.⁷⁹

Not only is President Proenza committed to expanding research, but he also promotes technology transfer. To that end, he hired an impressive team of professionals with nationally renowned research and technology transfer records, and reorganized technology transfer and commercialization activities. As a result, UA's patents, licenses and startups increased substantially. These activities are discussed in the following section.

TECHNOLOGY TRANSFER AND COMMERCIALIZATION

UA has an impressive technology transfer record in filing patents and launching startups. In FY 2005 the University filed 42 patent applications, and 12 patents were issued to more than 20 faculty and researchers. Nationally, UA placed in the top 10 for both patent applications and patents issued in FY 2005, relative to research expenditures. In 1999 technology transfer activities in Ohio universities received a boost when the State revised its statutes to allow faculty to own businesses. This change has contributed to increased startup activity at UA and other universities throughout Ohio. From FY 2000-05 UA launched 14 startups. In FY 2005 alone, UA launched four startups, placing it sixth in the nation, relative to research expenditures.

⁷⁸ Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005. NSF; and Table B-32. Total R&D expenditures at universities and colleges, ranked by fiscal year 2002 total R&D expenditures: fiscal years 1995-2002, NSF.

⁷⁹ The State of Ohio in February 2002 initiated the Third Frontier Project, a 10-year, \$1.6 billion initiative to expand the State's high-tech research capabilities and promote innovation and startups. For more information go to http://www.ohiochannel.org/your_state/third_frontier_project/index.cfm.

In 2007, upon recommendations from the Governor's Commission on Higher Education and Economy, UA was ranked first in the State of Ohio for successful technology transfer to Ohio businesses and industry.

UA has a small but impressive team of professionals. In 2001 President Proenza recruited renowned researcher George R. Newkome as UA's Vice President for Research. Prior to his arrival at UA, Dr. Newkome was responsible for the rapid growth in research and technology transfer at the University of South Florida. Dr. Newkome then brought to UA Kenneth Preston to head the Office of Technology Transfer. Dr. Preston had considerable industrial experience as a Vice President and Senior Counsel at TRW. George Newkome and Kenneth Preston were joined by Wayne Watkins, a well-known leader in technology transfer, who with the late Wayne Brown, administered the private Utah Innovation Center that led to the nationally prominent Wayne Brown Institute Venture Accelerator Program in Utah. Finally, Newkome recruited two former industry executives for the University of Akron Research Foundation, Gordon Schorr and Barry Rosenbaum, to augment the University's technology transfer and commercial expertise as Senior Fellows of the Research Foundation. Both Drs. Preston and Watkins serve as Associate Vice Presidents for Research and report to George Newkome in his capacity as Vice President for Research and Dean of the Graduate School. With this small team of professionals, UA's Office of Technology Transfer (OTT) has a good balance between industrial and technology transfer expertise.

In December 2001 the University of Akron Research Foundation (UARF) was created as a not-for-profit organization to provide intellectual property (IP) management services for the University. UARF receives and disposes of equity in University startups, and creates and holds for-profit companies as wholly-owned subsidiaries. Returns on investments may be reinvested or expended for the benefit of the University. UARF also manages the post-award processes for the University's industry-sponsored research agreements. By combining some technology transfer functions and sponsored research functions, UARF intends to protect IP and improve commercialization potential earlier in the research process. UARF administrators believe that UARF's handling of research agreements also has reduced contract-related bureaucracy and facilitated industrial collaborations. Professional staff time is split between the University's Office for Research, OTT, and UARF.

In 2005 UARF expanded its activities by creating both non-profit and for-profit corporations to commercialize non-core IP derived from industry partners. UARF's approach distinguishes between different types of innovations – discrete inventions, platform technologies, emerging technologies, and enabling technologies – and separately addresses the distinct needs of each as it examines gaps, identifies market space, and determines license or startup approaches. In addition and in response to requests from local companies seeking to outsource more in-house research or those with limited internal research capacity, UARF subcontracts R&D activities to both the University and the private sector.

In traditional organizations, whether university or corporate, the rules of engagement require first drawing lines in the sand, across which the potential partners may not cross. Our intent is to blur the distinction between education and enterprise – to first enter into the dance and work to make each other successful. Sometimes there just are no lines.

- *Gordon Schorr, Senior Fellow, University of Akron Research Foundation*

UARF also focuses on building collaborative relationships with industry for wealth creation in Northeast Ohio and accomplishes this by working either directly or through the for-profit subsidiaries that it establishes. UARF, through one of its for-profit subsidiaries, University Innovation Ventures (UIV), also assists several Fortune 500 companies in strategically realigning their product development and facilitates networking among companies to maximize each company's commercial potential. In one case, UIV added value to a company's material development by applying technology developed at UA and by identifying a third party to conduct the material characterization. In another case, UARF executed a license with a major consumer products company, which included bringing "open innovation" to Northeast Ohio by hosting and introducing the concept to a wide audience from companies and other universities in the region.

Another unusual way in which UARF interacts with industry is its agreement with a local corporation, OMNOVA Solutions Inc., to house a University polymer pilot plant and provide incubation space for a University startup – Akron Polymer Systems, Inc. – and several other startups from the community. At the pilot plant, UA prepared polymer samples and conducted evaluation and testing for corporations including UA startups. OMNOVA also had access to the plant for its own purposes. UA gained from this arrangement by inexpensively leasing space in a suitable facility. The company gained because it could use the advanced equipment in the pilot plant as well as take a "first look" at new technologies developed by startups in the incubation space. Because of the successful relationship, UARF plans to locate future incubation space, laboratories, and pilot plants in external corporate facilities.

One of UARF's goals is to involve students in the innovation and commercial development process and to support their participation in both product and business plan development projects. UARF and OTT plan to engage law students in preparing provisional patent filings. These students are from UA's IP program, conducted jointly between the School of Law, the College of Business and OTT. Further, UARF directly involves students in the technology transfer process.

We've taken the approach that we are here to create enterprises and to create value for the region in whatever way we can ... we know there will be a long-term strategic payoff to the University and the region.

*- Barry Rosenbaum, Senior Fellow, University of Akron
Research Foundation*

UA's startups have numerous University and community resources assisting them. The University, in conjunction with the City of Akron, hosts the Akron Small Business Development Center (SBDC) that helps startups to develop business plans, apply for federal Small Business Innovation Research awards, and improve business capacity. A new Business Legal Services Clinic at the UA School of Law provides inexpensive legal and business assistance. The College of Business Administration's Fitzgerald Institute for Entrepreneurial Studies also offers assistance as well as entrepreneurship education.

UARF is building a reputation as a central conduit for industries to access UA innovation and community services. When warranted, it refers companies to other universities and a variety of community resources. Support services provided by UARF, and its for-profit affiliates, to emerging enterprises include networking, management, marketing, technology mining and development, grants and capital development, IP management, and administrative and facility support. UARF recently established the Akron Innovation Campus (AIC) by acquiring two four-story buildings adjacent to the University campus to house UARF-related innovation operations and emerging enterprises. The AIC fills a long-standing need for proximate office space to support UA spinoffs, industry research partners, and related innovative and collaborative enterprises for the greater University community.

Northeast Ohio, as in similar regions, requires more seed capital. In response, several organizations recently started to fill that gap. JumpStart, Inc., a venture development organization in Northeast Ohio, offers seed capital averaging approximately \$300,000 and provides acceleration advice. Several foundations, private venture capitalists, and other public and private investors support JumpStart. Based in Cleveland, BioEnterprise also helps Northeast Ohio biotechnology enterprises raise capital. BioEnterprise partners with The Cleveland Clinic, University Hospitals, Case Western Reserve University, and Summa Health System. The Summa Enterprise Group, a "center of innovation" subsidiary of Summa Health System, offers seed capital to bio-related companies in the region. Angel capital is available through the North Coast Angels and the Akron Regional Change (ARCH) network (established through UARF), which help to fund and mentor entrepreneurs in Northeast Ohio. The Akron Industrial Incubator also provides services as well as space for entrepreneurs. Team NEO, Polymer Ohio, and NorTech provide additional networking.

OTHER INDUSTRY AND COMMUNITY OUTREACH

UA has a history of engagement with regional industries. In addition to the UARF services already mentioned, the University reaches out to industry in several ways. It seeks industry's advice in UA's strategic planning and organizes community and industry advisory boards. The University provides laboratory support services for industry, particularly instrumentation and technical assistance for chemical characterization, process improvements, material performance, quality control and product development. In addition, UA established a Library Services Consortium to which industry members donate their library collections and, in turn, gain access to the Consortium's full range of resources, including a central database of scientific and engineering information.

The University's Industrial Assistantship Program engages graduate students in technology and engineering as they work 20 hours per week at local participating industries. Industrial partnerships also contribute to UA's outstanding performance in national student engineering competitions such as the Society for Automotive Engineering competitions, where UA won more awards than any other university. UA's Industrial Assistantships, management of corporate libraries, and pilot plant program were put into place as part of UA's strategy to develop closer relationships between the University and local industry.

Networking of the region's universities has facilitated collaboration on research projects and in some cases, technology transfer. In Northeast Ohio, The University of Akron, Case Western Reserve, Cleveland State University, Kent State University, Youngstown State University, and the Northeast Ohio College of Medicine, hold monthly meetings to exchange information.

UA also participates in NorTech, a technology-based economic development organization in Northeast Ohio focused on developing and promoting technology sectors that are critical to the community. UA President Proenza is a member of the NorTech Board, and the University, along with other universities, contributes to the region's strategic planning and innovation initiatives.

In 2001 UA played an integral part in establishing an industry association for polymers – the Ohio Polymer Strategy Council. UA is also active in PolymerOhio, an industrial membership organization that works closely with academic institutions to provide internships, technical troubleshooting, grant writing, problem solving forums, and other activities designed to grow polymer businesses in the State of Ohio.

THE AKRON INDUSTRIAL INCUBATOR

The Akron Industrial Incubator was created through a partnership between UA, City of Akron, Akron Development Corporation, and Ohio's Thomas Edison Program.⁸⁰ Since 1983, the

⁸⁰ Ohio's Thomas Edison Program provides an array of entrepreneurial and research funding and services including the Edison Incubators, Edison Centers, Ohio Venture Capital Fund Program. For more information see <http://www.odod.state.oh.us/tech/edison>.

Incubator has provided space and services to the community's entrepreneurs. The Incubator was converted from an old, industrial building donated by The B.F. Goodrich Company. In 2007 the Incubator was one of the largest in the U.S., spanning more than 200,000 square feet.

Approximately two-thirds of the space is devoted to manufacturing, assembling and distribution, and about one-third is comprised of offices, laboratories and conference facilities designed for technology-intensive firms. By 2007 there were 25 resident companies, including eight startups in polymers and materials, information technology, biotech, and manufacturing controls.

Services to Incubator resident companies include access to laboratories, voice-over IT, daily consulting, seed capital, conference facilities, some *pro bono* legal services, and linkages to UA research and services. Additional services are offered through linkages with the UA's OTT, NorTech and the UARF's ARCHAngel Network. Incubator's Director, Michael LeHere, teaches management classes in the UA Fitzgerald Institute for Entrepreneurial Studies and interacts frequently with OTT and the UA Business Administration college staff. Students from UA's College of Business Administration Taylor Institute for Direct Marketing provide market research for resident firms. The Incubator also networks with other state-supported Edison Technology Incubators in the region.

Further Incubator plans include becoming an "accelerator" for UA's commercialization activities by offering specialized laboratories and prototype development assistance. The Incubator's Director also plans to expand the Incubator's international focus. The Incubator houses several international startups and Dr. LeHere has, along with City of Akron, established contacts that are expected to increase commercial opportunities in Germany, Israel and China for Incubator residents.

Dr. LeHere believes that the commitments from UA and the private sector have been invaluable in providing IP and business development services for Incubator residents. Essential ongoing, financial support from the City of Akron has also contributed to the success of the Incubator.

LESSONS FOR ACADEMIC INSTITUTIONS

The university president's vision can be a critical factor in promoting successful technology transfer: UA's President Proenza set the course for building research capacity and translating that capacity into innovative commercialization outcomes. Through his strategic leadership, the University has experienced substantial increases in federal research funding and subsequently, increased patents and startups.

Focus on building and leveraging core strengths: UA's strategy of building and leveraging research excellence in polymers and related science and engineering fields has contributed to increased research funding and technology transfer outcomes.

Establishing long-term, industrial relationships is a sound strategy: UARF works flexibly with corporations and has been willing to forego immediate rewards in order to build relationships for future opportunities. This strategy has been used successfully by technology transfer powerhouses such as Stanford University and Massachusetts Institute of Technology, and will likely bear fruit for UARF.

Engagement in local economic development can make a more attractive university for faculty and students: UA's pro-active engagement in improving not only campus buildings and grounds but also the infrastructure and green space around the University has made UA more desirable to prospective students and top faculty. It also sends a message to local business and industry about the University's commitment to the community.

WEB LINKS

University of Akron (general):

www.uakron.edu

University Park Alliance:

www.upakron.com

Office of Technology Transfer:

<http://www.uakron.edu/research/tt>

University of Akron Research Foundation:

<http://www.uakron.edu/research/uarf>

Office of the Vice President for Research:

<http://www.uakron.edu/research>

The Akron Industrial Incubator:

<http://www.ci.akron.oh.us/aii>

UNIVERSITY OF CENTRAL FLORIDA

BACKGROUND AND VISION

The University of Central Florida (UCF), formerly called Florida Technological University, was established in 1963 as one of Florida's 11 state universities. Located outside of Orlando, UCF serves an 11-county area in east central Florida. In 2006 UCF had 47,000 students, about 15 percent of whom were graduate students.

UCF MISSION

The UCF is a public, multi-campus, metropolitan research university, dedicated to serving its surrounding communities with their diverse and expanding populations, technological corridors, and international partners. The mission of the University is to offer high-quality undergraduate and graduate education, student development, and continuing education; to conduct research and creative activities; and to provide services that enhance the intellectual, cultural, environmental, and economic development of the metropolitan region, address national and international issues in key areas, establish UCF as a major presence, and contribute to the global community.

Since 2000 UCF has experienced tremendous expansion in research and entrepreneurship. The President of UCF since 1992, John Hitt, has been credited by senior administrators for much of the change that has taken place. President Hitt led a strategic planning process that resulted in *Charting the Course*, a plan that guided the University from 1996-2001, and a subsequent plan – *Pathways to Prominence* – that laid out the University strategy from 2002-07. The latter plan involved focus groups and reviews by academic and administrative units resulting in 12 strategic initiatives.

Central to the plans were initiatives to increase research expenditures and expand UCF's role in economic development. As a result, UCF invested in the formation of the Center for Optics and Photonics and expansion of several other research centers including the Center for Research and Education in Lasers, the Institute for Simulation and Training, and the Florida Solar Energy Center. It invested in attracting top research faculty in targeted areas and provided matching funds that generated substantial increases in federal research funding to UCF. One of University's five goals targeted in *Pathways to Prominence* – to "become America's leading partnership university" – provided the impetus for several commercialization and entrepreneurial initiatives. The University worked closely with the Florida High-Tech Council, City of Orlando

and Orange County to establish the UCF Technology Incubator and Central Florida Research Park to capture and retain spinoffs from the University's research activities.

TECHNOLOGY TRANSFER AND ENTREPRENEURIAL INITIATIVES

In FY 2007 UCF's research expenditures were \$121 million, more than triple its \$36 million research expenditures in FY 1998.⁸¹ A little more than half of the expenditures were in engineering and physical sciences, with an additional 30 percent of expenditures in environmental and other sciences.⁸² Research in engineering, education and optics were responsible for most of the rapid rise in research expenditures. Expansions in nanoscience and biomedical sciences also attracted additional research funding.⁸³

Along with the rise in research expenditures has been a rise in patent applications. In FY 2005 UCF filed 80 patent applications, placing it nationally in the top 15 relative to research expenditures. In addition, 29 patents were issued that year, placing it ninth nationally. Joseph Giampapa, Associate Director of the Office of Technology Transfer, said that the rapid increase in research expenditures has led to increases in patent applications. Although license executions lag behind, they should increase substantially in the near future. From FY 2001-05, UCF launched nine startups.

We believe that to have successful technology transfer, you have to have a strong research base. Much of our research is very applied, especially in optics, lasers, modeling and simulation. We attract companies because of the research ... and Orlando now is creating many entrepreneurs partly because of the industry-related research that we do here.

- Thomas O'Neal, Associate Vice President for Research and CEO, University Technology Incubator, University of Central Florida

The UCF Office of Technology Transfer (OTT) is part of the UCF Office of Research and Commercialization which also encompasses Venture Lab and the Technology Incubator. The Vice President of the Office of Research and Commercialization reports to the UCF Executive Vice President and Provost. OTT is comprised of an Associate Director and four professionals – two licensing associates, a life sciences associate, and a life sciences patent attorney. Three to five business and law students provide additional assistance with assessing markets and

⁸¹ Office of Research, University of Central Florida.

⁸² Table 36. R&D expenditures at universities and colleges, ranked by all R&D expenditures for the first 200 institutions, by science and engineering field: FY 2005. NSF.

⁸³ "Impact," UCF, Fall 2005.

developing provisional patent applications. The UCF Research Foundation, Inc., the University's non-profit research arm, can take equity in startups. OTT is closely linked with Venture Lab, the UCF Technology Incubator, the Central Florida Research Park, and the academically-oriented Center for Entrepreneurship and Innovation in the College of Business. OTT and these entities meet every two weeks to discuss their portfolios and coordinate activities.

Venture Lab

In 2004 UCF established Venture Lab as a joint initiative between the Office of Research and Commercialization, the UCF College of Business Administration, and Orange County. A grant from the NSF Partnership for Innovation (PFI) program provided additional funding to develop entrepreneurial services and educational workshops, and Kirstie Chadwick, the Venture Lab Director brought in other funding from a local entrepreneur. Venture Lab provides faculty, students and local entrepreneurs with assistance in launching businesses around their research. It was developed based on a similar model at Georgia Institute of Technology.⁸⁴

UCF hired a serial entrepreneur well known in the community to head the program. By late 2006 there were five additional coaches and three to five graduate business interns. The Venture Lab coaches help entrepreneurs move through pre-business development steps. They provide assistance with business plan creation and mentor entrepreneurs to “pitch” their plans to investors through enterprise forums. Through linkages with OTT and external service provider networks, Venture Lab also assists entrepreneurs with licensing and patent advice, market research, product validation, and financing. The Venture Lab conducts educational workshops on Small Business Innovation Research (SBIR), technology transfer, patents, copyrights and trademarks, validating venture capital fundability, and other topics. In conjunction with the Kauffman Foundation, Venture Lab provides periodic educational workshops for angel investors. These workshops focus on sharing best practices, conducting due diligence, and other topics of interest to active and potential angels. They are intended not only to educate angels but also to network and encourage them to form angel groups. At the writing of this report, Venture Lab and the Incubator were in discussions with a financial institution to potentially start an early-stage fund at the University.

According to Cameron Ford, the founding Director of the UCF Center for Entrepreneurship and Innovation, the PFI grant that supported Venture Lab development and activities has helped educate and mentor faculty and student entrepreneurs. He said that the PFI grant also indirectly led to the development of two graduate certificate programs – one in entrepreneurship and one in technology commercialization, and contributed to the development of a business plan competition, the UCF “Joust.” In just three years, total undergraduate and graduate enrollment in entrepreneurship courses topped 600 students spanning colleges across the UCF campus.

⁸⁴ See case study on Georgia Institute of Technology in *Accelerating Economic Development through University Technology Transfer* (www.InnovationAssociates.us).

UCF Technology Incubator

Started in 1999, the UCF Technology Incubator in 2004 was named “Technology Incubator of the Year” by the National Business Incubation Association. The Incubator was started in response to faculty asking Thomas O’Neal, the Associate Vice President for Research and Commercialization and Founding Director of Incubator, about the University resources available to start a business. In addition, a consulting report contracted by the Metropolitan Orlando Economic Development Commission recommended that the community enhance its entrepreneurial infrastructure and connect that infrastructure to the universities. The Incubator initially was funded by the UCF Office of the Vice President for Research, Center for Research and Education in Lasers, School of Electrical Engineering and Computer Science, and School of Business Administration; the Florida High Technology Council; and the Technology Research and Development Authority. The Scottish Technology Research Institute also provided funding for the first two years in order to use the Incubator as a “stepping off” place for Scottish firms to the U.S. market. The Incubator is a unit of the UCF Office of Research and Commercialization.

Since the Incubator’s inception, it has helped about 90 companies from the University and the community. About one-fourth of the 90 companies have received some type of venture capital. The Incubator holds “Incubator Showcases” about four times per year, in which incubator residents present business plans to potential investors. The Incubator and Venture Lab provide coaching to entrepreneurs in preparation for their presentations. Incubator staff also have helped incubator residents secure about \$6 million in SBIR awards and other government contracts.

The Incubator has four “entrepreneurs-in-residence” that are available to clients. Entrepreneurs-in-residence devote between one-half and one day per week to assisting Incubator clients. The Incubator also has developed a network of service providers that it refers to resident entrepreneurs. Several service providers are available free to clients for about one-half day per month. In addition, four corporate attorneys provide *pro bono* services to Incubator clients for a total of one to two days per month.

The Incubator is located in three buildings of the Central Florida Research Park – The University Tech Center, which is the main incubator and has office space for about 10 companies; the Bennett Center, which spans 48,000 square feet and includes laboratory and production facilities; and an additional facility that has laboratory space for a large biomedical startup. In addition, the Incubator rents space in a downtown Orlando office building located in a Historically Underutilized Business zone. The UCF Incubator also has partnered with the Seminole Technology Business Incubation Center to provide incubation at Seminole Community College.

Some of the Incubator is being geared as an “accelerator” of UCF innovations. To that end, in FY 2006 the State of Florida provided funding to the Nanoscience Technology Center to develop a nanofabrication center that will be located in the Incubator. The Center provides \$200,000 per year to the Incubator for commercialization services. By 2007, three of the Center’s nano-businesses were located in the UCF Technology Incubator.

The Incubator operating manager for the Research Park location, Carol Ann Dykes, said that being part of the University has provided the Incubator with additional credibility and visibility and has made it easier to tap into University resources. In addition, the Incubator's being part of the Office of Research and Commercialization has facilitated linkages to research facilities and the use of graduate business interns. Ms. Dykes said that the Office has given the Incubator much operational flexibility and this has been important in its outreach to the community.

UCF is extremely partner oriented, and you can see it in the Incubator. We have strong support from Orange County, Seminole County, the City of Orlando, the City of Winter Springs, the Florida High-Technology Corridor, and professional service providers such as IP attorneys and accounting firms. This University and this community really get it – that it takes a community to grow a company.

- Carol Ann Dykes, Research Park Site Manager, University of Central Florida Technology Incubator

The Incubator works closely with a number of organizations in the city and region, particularly the Florida High Technology Council. The Council is an organization that represents a 23-county technology “corridor” and focuses on leveraging universities to attract and grow technology businesses. The universities involved in the Council are UCF, the University of South Florida, and the University of Florida. The Council has sponsored strategic planning and has funded initiatives such as the UCF Technology Incubator. In addition, partnerships with the City of Orlando enabled the Incubator to open its downtown facility, and the City has provided funding to help the downtown operations. The Incubator Director, Thomas O’Neal said that the downtown facility has allowed some Incubator clients to increase their visibility and access to potential customers. At the writing of this report, the Director and the City were discussing the creation of a separate incubator targeted to minority entrepreneurs.

In 2007 the Incubator had more than 50 clients, seven of which were UCF startups. Incubator clients represented a wide variety of fields including educational software, energy, information technology, biomedical, lasers, scientific instrumentation, advanced materials, and others. By 2007, 21 companies had successfully “graduated” including one that was started by two UCF faculty and was preparing to go public. UCF’s evaluations show that businesses graduating from the Incubator have generated more than \$150 million in revenues, have attracted more than \$150 million in investments, and have been responsible for creating more than 850 jobs.

LESSONS FOR ACADEMIC INSTITUTIONS

Leadership and strategic planning can lead to substantial growth: UCF's leadership and strategic planning processes laid the groundwork for implementing initiatives that more than tripled research funding in less than 10 years and strengthened the entrepreneurial infrastructure.

Universities that want to engage in economic development need to identify and address market needs: UCF and the region identified commercialization and entrepreneurial needs through university and regional planning processes involving focus groups and other means. In response, UCF developed the Technology Incubator and Venture Lab to fill entrepreneurial gaps identified through these processes. UCF also is now working to develop more angel and seed capital. These initiatives are beginning to pay off by increasing the number of entrepreneurs at the University and in the Orlando community.

Partnerships between the university and regional organizations can effectively leverage community resources: Several administrators said they viewed entrepreneurship initiatives at the University as a team effort with regional government and organizations such as the Florida High-Tech Council, City of Orlando and Orange County. These entities funded regional planning studies and partnered with the University in funding the Incubator, Venture Lab and Research Park. They continue to play a role in supporting and expanding UCF entrepreneurial activities.

When institutional programs grow quickly they must clearly define roles and leverage other programs: UCF's entrepreneurial programs rose quickly and at the same time. Some senior administrators' advice includes: identify and clearly define the new organization's role in relation to existing organizations, leverage each organization's resources, and build linkages to related organizations.

WEB LINKS

University of Central Florida (general):

www.ucf.edu

Office of Research and Commercialization:

<http://www.research.ucf.edu>

Office of Technology Transfer:

<http://tt.research.ucf.edu>

Research Foundation:

<http://www.research.ucf.edu/ResearchFoundation/index.html>

Venture Lab:

<http://www.venturelab.ucf.edu>

Technology Incubator:

<http://www.incubator.ucf.edu/index.html>

Central Florida Research Park:

<http://www.cfrp.org>

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

BACKGROUND AND VISION

The University of North Carolina at Charlotte (UNC Charlotte) is the fourth largest of 16 institutions in the University of North Carolina system. It was founded in 1946 to serve returning World War II veterans and for many years offered only the first two years of college courses. By 2007 the University had more than 21,000 students and was comprised of seven professional colleges offering doctoral, master's and 85 bachelor's programs.

UNC Charlotte has developed research strengths in a number of areas including biomedicine, optics, metrology, and energy and environmental sciences. In 2006 the NSF designated the UNC Charlotte Center for Precision Metrology in the Lee College of Engineering as an Industry/University Cooperative Research Center. By 2007 UNC Charlotte had 15 research centers and was developing a new Bioinformatics Center to provide computational research and education programs.

In the mid-1990s UNC Charlotte conducted a strategic planning process to focus its mission and target research areas for growth. As part of UNC Charlotte's planning process, the University involved academic heads and faculty, and organized an informal advisory committee composed of investment bankers and current and former CEOs. After the planning process, many members of this committee stayed involved with the University and participated in other advisory roles including mentoring to University startups.

The University clearly understands the strong connection between research excellence and economic development, and realizes the importance of a research university as an engine of economic development and in establishing "knowledge clusters." Our mission in this area is to foster long-term strategic industry-academic relationships in order to achieve objectives of public dissemination of information and improved economic development of the region and the state of North Carolina. These relationships inherently promote commercially based leading-edge innovation through collaboration in research, and further enable the transfer of new technological advances to the private sector.

- Excerpted from Strategic Plan for Research (2002 Update of 1998 Plan), University of North Carolina at Charlotte

The University's Strategic Plan for Research involved increasing its doctoral programs and expanding its research capacity in targeted areas. The strategy also emphasized technology transfer, commercialization, and economic development. It called for fostering strategic, long-term industry-academic partnerships to achieve the objectives of knowledge dissemination and improved economic development. The Plan further recognized the important role of the Office of Technology Transfer and the Charlotte Research Institute in working closely with industry to cultivate key partnerships with UNC Charlotte researchers.

In 1998 UNC Charlotte also participated in a community strategy sponsored by the Charlotte Chamber. This effort involved focus groups and an economic development study. The study recommended that an effort be undertaken to increase UNC Charlotte research capacity and simultaneously stimulate entrepreneurship and economic growth in the Charlotte region. In response, in December 2000 UNC Charlotte established the Charlotte Research Institute (originally called the Charlotte Institute for Technology Innovation). The Institute embodied the goals of both the community's and the University's strategic plans.

We are extremely strategic at UNC Charlotte. Each of our research centers was formed because the University targeted and made the investment to grow a specific area strategically. We hired star faculty and focused on applied research with industry. This resulted in our Centers on optics and bio-informatics. We've also had good relationships with businesses in Charlotte and this led to our building up areas like cyber security and metrology ... (As a result), the University went from barely having master degree programs to now doing excellent research in a number of emerging areas.

- Stephen R. Mosier, Vice Chancellor for Research & Federal Relations, University of North Carolina at Charlotte

In 2006 UNC Charlotte launched the "Open for Business" project, funded by the UNC System. This initiative is intended to address industry needs, make the University's research and services more accessible to industry, and create a model for university-industry collaboration. At the writing of this report, UNC Charlotte was conducting a survey of local industry needs as part of its effort to develop new business services. According to the Vice Chancellor for Research and Federal Relations, UNC Charlotte's "Open for Business" plans include

- Developing a unified integrated university portal for businesses.
- Creating a Center for Entrepreneurship in the Belk College of Business.
- Implementing a marketing campaign directed to business.
- Developing a package of research and technical advisory services for corporations, particularly in the areas of mechanical engineering and optics.

UNC Charlotte has modest but rapidly growing research expenditures. In FY 2005 UNC Charlotte had research expenditures of \$16 million, almost two and one-half times its research expenditures only seven years earlier.⁸⁵ The federal government provided about 68 percent of all funding awards in FY 2005, and most came from NSF, Department of Education, National Institutes of Health, and Department of Defense.⁸⁶ Most awards that year went to research in biology, special education and child development, and physics and optical sciences. Centers receiving the highest level awards were Centers for Precision Metrology, (Global Institute for) Energy and Environmental Systems, Optoelectronics and Optical Communication, and Math, Science, and Technology Education.⁸⁷

TECHNOLOGY TRANSFER

UNC Charlotte has outstanding technology transfer outcomes, particularly in patents and startups. In FY 2005 UNC Charlotte filed 56 patent applications, placing it first nationally relative to research expenditures. In FY 2005 it had 28 active licenses. Despite modest research expenditures, UNC Charlotte has generated a substantial number of startups in the past several years. From FY 2000-05, the University has launched 19 startups; and in FY 2005 alone, it launched three startups, placing it third nationally relative to research expenditures.

For several years (FY 2002-05) the University of North Carolina at Charlotte kept pace or exceeded the University's more famous Chapel Hill neighbor in launching startups.

UNC Charlotte's technology transfer operations got a late start. The University's Office of Technology Transfer (OTT) has operated only since 1998, and its present office only since 2000. In 2006 OTT operated with an annual budget of about \$500,000 and a staff of four professionals including the Director, two licensing associates and a business manager.

Former OTT Director Mark Wdowik⁸⁸ said that OTT takes a pro-active stance in establishing relationships with businesses. The former Director, who had worked for local industry, believes that UNC Charlotte's strong technology transfer activities are based on the University's efforts to build effective relationships with potential commercial partners. One initiative intended to enhance these relationships was the creation of a generic "master R&D agreement" that expedites corporate agreements and lessens potential obstacles to licensing later in the process.

⁸⁵ Table 27. R&D expenditures at universities and colleges, ranked by FY 2005 R&D expenditures: FY 1998-2005. NSF.

⁸⁶ Proposal and Award Statistics, September 29, 2005, University of North Carolina – Charlotte.

⁸⁷ Ibid.

⁸⁸ Mark Wdowik was OTT Director from 2000 to 2007.

I was much more willing to just do a patent than to actually do a startup, but (the former OTT Director) encouraged us to go further and form a startup. They helped us with the business plan and referrals, and we could not have done it without them. They also convinced us to do research partnerships that had the possibility of intellectual property coming from it; they brought in industries to meet with us and expedited the agreements to make it happen.

*- Mark Clemens, Vice Chair for Research, Biology
Department, University of North Carolina at Charlotte*

OTT focuses on launching startups rather than licensing to established corporations, and uses a “cradle to grave” approach. To assist startups, OTT formed a Commercialization Committee that involves about 30 mentors from corporate and investment communities. The Committee is divided into “early-stage” and “late-stage” groups to address the specific needs of startups at different stages. OTT staff and mentors help startups develop business plans and prepare for meetings with potential investors and customers, at times accompanying them to the meetings. They also help prepare UNC Charlotte entrepreneurs to present at enterprise forums and UNC Charlotte’s Five Venture business plan competition. OTT sponsors the Five Venture business plan competition which involves teams of student entrepreneurs from throughout the Charlotte region. At annual events, the selected teams present business plans before 20 judges from the Charlotte investment and business community.

OTT also actively identifies business managers that can replace researchers as CEOs for faculty-based startups. By placing experienced entrepreneurs and business managers in these CEO positions, it often increases the startups survival rates. In addition, OTT refers startups to other business development resources such as the Ben Craig Center, a near-by, community-based incubator, and the Small Business Technology Development Center located at The Ben Craig Center.

The former OTT Director said that OTT was not only in the business of patenting and licensing, but also in the business of building industry-research relationships that could potentially lead to commercialization outcomes. In one case, OTT helped a startup that was not large enough to successfully compete for a federal contract by introducing the CEO to faculty members. The introduction led to a joint, federal research contract that resulted in a commercial product. Mark Clemens, Vice Chair for Research in the Biology Department, said that the former OTT Director had also introduced biology researchers to industry contacts in order to foster long-term research relationships.

OTT has established close relationships with department heads and researchers. In the College of Information Technology (IT), OTT has helped create at least five startups, including one in data mining and two related to genomics. IT startups have been launched from the e-Business

Institute, the Software Solutions Laboratory and other laboratories. The College has established some of its own technology transfer and entrepreneurial services including a full-time Executive-in-Residence. The Dean of the College, Mirsad Hadzikadic, said that the Executive-in-Residence has provided significant help in developing IT startups and establishing industry contacts. Moreover, Dr. Hadzikadic believed that the presence of an Executive-in-Residence alone sent “a powerful message to faculty that industry relationships are important.” The College also started the Five Ventures business plan competition that is now operated by OTT. Dr. Hadzikadic said that OTT has worked closely with the College and others in helping them decide whether to license or develop a startup, and for startups, to help them find seasoned executives and locate investment funding.

The former OTT Director was active in the Charlotte business community and participated on about 25 community boards. In addition, OTT actively engages in regional economic development efforts such as organizing “town meetings” in Kannapolis, North Carolina, where UNC Charlotte plans to locate some of its researchers.⁸⁹ OTT also has drawn from the experience of its neighbors in the North Carolina Research Triangle, and has worked with the Triangle’s Council for Entrepreneurial Development (CED) to promote UNC Charlotte innovations statewide and nationwide. The former OTT Director believes that networking and “connectivity” in the Charlotte community and elsewhere in the State was critical to their success.

OTHER COMMERCIALIZATION AND ENTREPRENEURIAL RESOURCES

Charlotte Research Institute

In 2000 UNC Charlotte created a new institute – the Charlotte Research Institute (CRI) – that is intended to serve as a portal for industry-university technology partnerships and commercialization. CRI is located on the UNC Charlotte campus but is incorporated as a separate non-profit organization in order to facilitate and expedite research contracting with industry. CRI is an umbrella research organization that serves multiple and inter-disciplinary research including emerging areas such as bioinformatics, biomedical engineering systems, and translational research. At the writing of this report, CRI had completed two buildings that housed UNC Charlotte Centers in Precision Metrology, Optoelectronics and Optical Communication, “eBusiness” Technology (Institute), Motor Sports and Automotive Research, Biomedical Engineering Systems, and Bioinformatics.

CRI offers a variety of opportunities to engage talented faculty and use specialized facilities that are available at UNC Charlotte. CRI focuses on academic-business partnerships and provides services ranging from advisory consultation to on-site, side-by-side research with industry that is intended to lead to commercialization. It also includes incubation space to capture startups

⁸⁹ Kannapolis is located 30 miles north of Charlotte and is the site of the North Carolina Research Campus – a joint venture between Dole Foods, Duke University and the University of North Carolina system. For more information go to: <http://www.cityofkannapolis.com/businessdevelopment/home.html>.

resulting from the collaborative research. CRI is expected to eventually house offices, laboratories, conference centers, and incubation in over one million square feet of space.

CRI takes a proactive approach to promote applied research and business partnerships among the academic and business communities. With an endowed funding program, CRI supports new research initiatives and scholarly activity that are intended to lead to industrial application and commercialization. In addition, each year CRI promotes dozens of research and innovation events.

In 2007 CRI began operating the Five Ventures Business Plan Competition and a yearly conference that targets the biotechnology industry. CRI also has developed strong partnerships with the North Carolina Biotechnology Center and the North Carolina Research Campus in Kannapolis.

The Ben Craig Center

The Ben Craig Center is an incubator located a couple miles from the UNC Charlotte campus. The Center was created in 1986 by UNC Charlotte in collaboration with the North Carolina Technological Development Association, First Union National Bank and other private parties. It provides incubation space, mentoring, education, networking and early-stage investment opportunities for UNC Charlotte and community entrepreneurs.

In 2007 the Center housed about 15 enterprises in about 50,000 square feet of office space. The Center provides entrepreneurs with a wide range of advisory services and networking opportunities. It matches each resident company with a CEO mentor that advises the company. The mentors are business volunteers and Board members from the community including major corporations such as Wachovia Bank, Lending Tree, DBS Systems, Digital Optics and Duke Energy. In addition, the Center's Advisory Panel annually critiques resident entrepreneurs' business plans and provides strategic advice. Accelerator Services provide entrepreneurs with additional, specialized consulting services for a fee. The Center's Carolina Angel Forum provides an opportunity for resident and other entrepreneurial companies to showcase business plans to potential investors. Resident and other entrepreneurs also can attend CEO Luncheons that involve facilitated discussion on entrepreneurial issues and networking. The Center's educational workshops provide entrepreneurs with expert speakers and instructional education. Entrepreneurs also have access to the services of the federal Small Business and Technology Development Center (SBTDC), which is located at The Ben Craig Center.

The Center and UNC Charlotte maintain a partnership and several faculty and administrators serve on the Center's Board. UNC Charlotte also regularly refers University startups to the Center and to the SBTDC located at the Center. The Center reports that, by 2007, it had graduated more than 100 companies. These companies have contributed to creating more than 1,000 jobs in the region, generating more than \$104 million to the economy.

LESSONS FOR ACADEMIC INSTITUTIONS

Strategic planning can contribute to increases in research funding and technology transfer outcomes: UNC Charlotte undertook a strategic planning process that led to increased research funding in strategically targeted fields. It also laid the groundwork to enhance the Office of Technology Transfer in order to commercialize research results. The combination of factors has contributed to UNC Charlotte becoming one of the nation's top producers of patents and startups relative to research expenditures.

The University's commitment to regional economic development has encouraged the launching of startups: UNC Charlotte has chosen to focus on launching startups to generate entrepreneurial growth in the Charlotte region rather than focusing on licenses to existing corporations. This strategy has already resulted in at least 19 startups, most of which have remained in the Charlotte region.

"Cradle-to-grave" services are important in launching startups in areas with little venture capital or entrepreneurial presence: Services that help university-based entrepreneurs such as introductions to potential investors and customers can make a significant difference to a startup that would not otherwise easily have access to these services.

Technology transfer, particularly in smaller institutions, often involves broader tasks than patenting and licensing: In order to build up deal flow, technology transfer professionals in institutions with modest research expenditures often help build industry relations and facilitate industry-university research partnerships. This more pro-active, "comprehensive approach" to technology transfer often pays off by forming research relationships that feed the pipeline leading to commercialization.

WEB LINKS

University of North Carolina at Charlotte (general):

www.uncc.edu

(Office of) Vice Chancellor for Research & Federal Relations:

<http://www.research.uncc.edu>

Office of Technology Transfer:

<http://www.ott.uncc.edu>

Charlotte Research Institute:

<http://www.charlotterearchinstitute.com>

The Ben Craig Center:

<http://www.bencraigcenter.com/site/index.cfm>

APPENDIX

National Advisory Committee
(in alphabetical order)

Dinah Adkins

President and CEO
National Business Incubation Association

Richard C. Atkinson, Ph.D.

President Emeritus
University of California

Robert D. Atkinson, Ph.D.

President
Information Technology and Innovation Foundation

Chris W. Busch, Ph.D.

SBIR and Business Consultant

C. Michael Cassidy

President and CEO
Georgia Research Alliance

Jeffrey Finkle

President and CEO
International Economic Development Council

John A. Fraser

2006 President, Association for University Technology Managers
Assistant Vice-President for Research and Economic Development, and
Executive Director of the Office of Intellectual Property Development and Commercialization
The Florida State University

Patricia G. Green, Ph.D.

Provost
Babson College

James Jacobs, Ph.D.

Associate Director
Community College Research Center, Teachers College
Columbia University

Randall Kempner

Vice President, Regional Innovation
Council on Competitiveness

H. Martin Lancaster, Ph.D.

President
North Carolina Community College System

John Petersen, Ph.D.

President
University of Tennessee

Trudie Kibbe Reed, Ph.D.

President
Cookman-Bethune College

Phillip Singerman, Ph.D.

Managing Director and General Partner
Toucan Capital Fund II
and former Assistant Secretary, U.S. Economic Development Administration

Louis Tornatzky, Ph.D.

Professor and Chair, Industrial Technology
California Polytechnic State University

Charles W. Wessner, Ph.D.

Director, Technology, Innovation, and Entrepreneurship
The National Academies

National Organizations and Programs Surveyed
(in alphabetical order)

American Association of Community Colleges

American Association of State Colleges and Universities

American Council on Education

Association of American Universities

Association of Independent California Colleges and Universities

Association of University Research Parks

Association of University Technology Managers

Council on Competitiveness

Hispanic Association of Colleges and Universities

International Economic Development Council

National Association of Independent Colleges and Universities

National Association for Equal Opportunity in Higher Education

National Association of State Universities and Land Grant Colleges

National Business Incubation Association

National Science Foundation - Advanced Technology Education Program

Selected Interviewed Participants*
(in alphabetical order)

Alfred University

Vasantha R.W. Amarakoon, Director, Center for Advanced Ceramic Technology
Alastair Cormack, Dean, Kazuo Inamori School of Engineering
William Hall, Provost and Vice President for Academic and Statutory Affairs
Harry Stevens, Director, Center for Glass Research

Brigham Young University

Lynn Astle, Director, Technology Transfer Office
A. Brent Strong, Director, Advanced Composites Manufacturing and Engineering Center
Giovana Tata, Director, Creative Works and Intellectual Property Services
Brent W. Webb, Associate Academic Vice President for Research and Graduate Studies

Florida Agricultural and Mechanical University

Seth Ablordeppy, Professor of Medical Chemistry, Drug Discovery Research Unit,
College of Pharmacy
Colin Benjamin, Professor of Engineering Management, School of Business and Industry
Rose Glee, Director, Technology Transfer, Licensing and Commercialization
John Fraser, Director, Office of Intellectual Property Development and
Commercialization, (Florida State University).

Iowa State University

John Brighton, Vice President for Research and Economic Development
Steven Carter, President, ISU Research Park
Debra Covey, Director, Industrial Relations, Ames Laboratory
Ronald Cox, Director, Center for Industrial Research and Service
Steven Howell, Director, Roy J. Carver Co-Laboratory
Kenneth Kirkland, Director, Office of Intellectual Property and Technology Transfer,
Iowa State University Research Foundation
Carey Novak, Director, Technology Commercialization Program

Montana State University

Steven Holland, Director, Montana Manufacturing Extension Center
Rebecca Mahurin, Director, Technology Transfer Office
Thomas J. McCoy, Vice President for Research
John O'Donnell, Director, Tech Ranch
Richard Seminick, Dean, College of Business
Will Swearingen, Executive Director, TechLink

Rensselaer Polytechnic Institute

Douglas Cumming, Director, Severino Center for Technological Entrepreneurship
Paul Fredette, Associate Director, Office of Technology Commercialization
Jeff Lawrence, Executive Vice President/Technology, Center for Economic Growth
Robert Linhardt, Senior Constellation Chair of Biocatalysis and Metabolic Engineering, Center for Biotechnology and Interdisciplinary Studies
Om Nalamasu, Vice President for Research
Chuck Rancourt, Director of Patents, and Licensing
Mike Shimazu, Associate Director, Center for Automation Technologies and Systems
Dick Siegel, Professor and Center Director, Nanotechnology Center
Larry Sturman, Director, Wadsworth Laboratories, NY State Department of Health
Michael Tentnowski, Director, Rensselaer Incubator Program
Michael Wacholder, Director, Rensselaer Technology Park
John Wen, Professor/Center Director, Center for Automation Technologies & Systems

Springfield Technical Community College

Mary Breeding, Assistant Vice President, Center for Business and Technology
Steven Budd, Vice President for Development
Thomas Goodrow, Vice President, Division of Economic and Business Development
Deborah King, Director, Springfield Business Incubator
Diane Sabato, Director, Entrepreneurial Institute
Gordon Snyder, Executive Director, National Center for Telecommunication Technology

University of Akron

Michael D. LeHere, Director, Akron Industrial Incubator
George R. Newkome, Vice President for Research and President of the University of Akron Research Foundation (UARF)
Kenneth C. Preston, Associate Vice President for Research and Director of Technology Transfer
Luis M. Proenza, President
Barry Rosenbaum, Senior Fellow, UARF
Gordon Shorr, Senior Fellow, UARF
Wayne Watkins, Associate Vice President for Research and Director of the Akron Commercialization Center

University of Central Florida

Carol Ann Dykes, Chief Operating Office, University Technology Center
Cameron M. Ford, Founding Director, Technology Enterprise Institute
Joseph Giampapa, Associate Director, Office of Technology Transfer
Tom O'Neal, Associate Vice President for Research and Chief Executive Officer,
University Technology Center

University of North Carolina at Charlotte

Mark Clemens, Vice Chair for Research, Biology Department
Mirsad Hadzikadic, Dean, College of Information Technology
Stephen R. Mosier, Vice Chancellor for Research and Federal Relations
Mark S. Wdowik, Executive Director, Office of Technology Transfer
Robert Wilhelm, Executive Director, Charlotte Research Institute

**Note:* This list does not necessarily include all those interviewed.