TEXAS
BUSINESS REVIEW
Bureau of Business Research • IC² Institute • The University of Texas at Austin
DECEMBER 2005

The Lab-to-Market Road

Assessing the Texas Advanced Technology Program

by Dr. James E. Jarrett

Bureau of Business Research
IC² Institute
The University of Texas at Austin

and Robert Meyer, J.D.

Bureau of Business Research
IC² Institute
The University of Texas at Austin

"I never perfected an invention that I did not think about in terms of the service it might give others... I find out what the world needs, then I proceed to invent."

-- Thomas Alva Edison

In 1987, the state legislature appropriated funds for applied research to diversify the state's economy through the Texas Advanced Technology Program (ATP). These funds targeted projects to educate the state's scientists and engineers, create new products and production processes, and contribute to the application of science and technology to state businesses. One component of the ATP – the Technology Development and Transfer (TDT) program begun in 1995 – funded technology development and the transfer of that technology to the private sector in Texas.

A total of 1,854 ATP/TDT projects were funded in the eight biennial cycles from 1987 to 2001, for a total investment of approximately $320 million. The Bureau of Business Research reviewed these projects in order to determine the long-term economic repercussions of ATP/TDT funds invested in Texas educational and industrial enterprises. A final report was delivered March 1, 2005, based on this 14-month assessment.[1]

Data Collection

The BBR team developed a data-intensive research design to determine the identifiable returns generated by the ATP. The research team collected data from an extensive range of primary and secondary information sources in three phases. *Phase One* implemented an online survey of the principal investigators (PIs) for more than 680 funded projects; and personal interviews were conducted with over 100 TDT PIs and over 100 ATP PIs for more in-depth data collection. *Phase Two* developed 30 case studies of particularly noteworthy projects, and also included interviews with commercialization stakeholders such as university officials, venture capitalists, corporate research staffs, CEOs, and industrial partners. *Phase Three* focused on three benchmarking analyses drawing comparisons with other states' science and technology workforces, research and development expenditures, and comparable programs in other states and nationally.

This assessment was not an audit conforming to auditing methodologies such as first-hand examinations of documents and financial records. Instead, the research team conducted private interviews and aggregated the results. Throughout the data collection process, we relied primarily on self-reporting with vigorous double-checking in every instance of any data that was a significant outlier to the majority of other respondents.

In all cases, the research team applied the most restrictive view of all data toward its conclusions; therefore, any errors in findings are likely to understate the ATP program impacts, and the results presented here should be viewed as conservative estimates.

Major Quantifiable Economic Impacts

Follow-on research funding: The ATP/TDT awards, according to PIs, enhanced their credibility with other sponsors and

Approximately 80 new companies formed around ATP/TDT technologies, and about two-thirds of these companies remain operational; sixteen companies have been acquired or merged into other entities.

enabled them to more easily secure follow-on (and often substantial) research funding. Dozens of PIs reported their ATP/TDT awards led to subsequent research awards exceeding one million dollars, and one PI noted that he and a colleague received a $30 million foundation grant directly as a result of their ATP awards. Based on survey results, total follow-on funding for all ATP/TDT projects was estimated at $867.6 million. The large majority of this total was secured from federal departments and agencies and therefore represents new research money attracted to the State of Texas.

Licensing royalty revenues: The ATP/TDT projects returned licensing royalty revenues to Texas universities of more than $38 million. Like the national pattern, a small number of licenses provided a high proportion of these revenues; approximately 300 licenses were issued as a result of ATP/TDT projects, with slightly more than 125 returning royalty payments.

New businesses: Approximately 80 new companies formed around ATP/TDT technologies, and about two-thirds of these companies remain operational; sixteen companies have been acquired or merged into other entities. While some potentially large transactions could not be specifically evaluated due to incomplete historical data or overall complexity, seven of the acquired companies (for which market-based acquisition prices are public knowledge) had a combined price that totaled $184.1 million.

In 2004, current full-time employment for active ATP/TDT start-up companies was conservatively estimated at 156-169, with a combined minimum annual salary from $10.1 to $12.7 million. However, this annual salary estimate does not include amounts from some acquired companies, companies that are now inactive, or companies that are out-of-state but partially attributable to Texas ATP/TDT funding.[2] A review of start-up company histories for all active companies shows that a reasonable five-year estimate of salaries falls between $101 and $127 million.

Start-up companies raised a minimum of $100.4 million from private investors and obtained an additional $6.7 million from government contracts (not including monies from start-up companies that were later acquired and whose parent companies have subsequently raised funds).

Industrial partner benefits: While many economic benefits to industrial partners cannot be calculated precisely, and many PIs could not divulge data because of the proprietary information involved, benefits enjoyed by industrial partners from ATP/TDT projects were conservatively estimated at $127.5 million.[3]

Student post-project employment: Using survey data and reasonable assumptions for salary levels and employment tenure, the post-project salary total was calculated to be at least $112.6 million for students who worked on projects and then graduated; based on higher national employment tenure figures for post-graduation employment, the salary total was estimated to be $516 million. Under either set of assumptions, post-employment salary impacts have been significant; the lower figure was used in this assessment.

Overall: The total identifiable economic returns were conservatively estimated as follows:

Follow-on funding	$ 867.6 million
License and royalty revenue	38.6 million
Acquisition of start-ups	184.1 million
Start-up salaries (5 years)	101.0 million
Start-up capital raised	107.1 million
Partner economic benefits	127.5 million
Post-project student employment salaries	112.6 million
Total:	$1,538.5 million

This total represented nearly a 5:1 return on the $320 million state investment in the ATP/TDT projects since their inception; and if a number of higher estimates had been applied, such as the higher student employment salary total, the return would have exceeded 6:1.

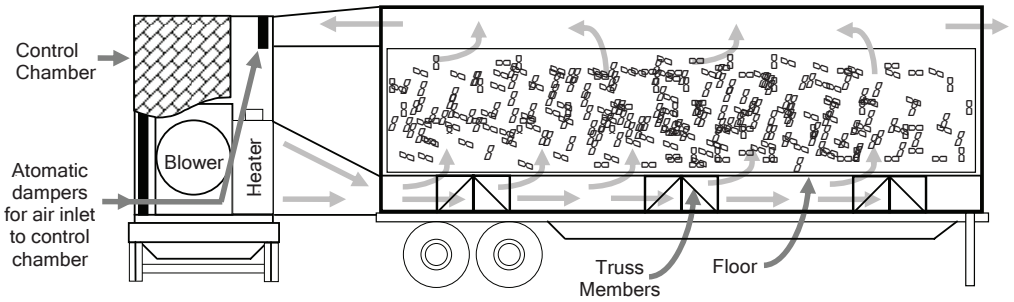
Student and Educational Outcomes

The research team examined educational outcomes from ATP/TDT grants, under five specific topics:

- Recruitment of talented students (undergraduate and graduate) to Texas universities
- Recruitment of talented faculty to Texas universities
- Student acquisition of new, marketable skills that make a positive contribution to the science and engineering workforce in Texas

Strong evidence exists that the Texas economy has realized hundreds of millions of dollars as a result of ATP/TDT technology commercialization.

Semi-Trailer Dryer
(Can be used for peanut transportation and storage)



One project with significant economic impact in Texas developed an automated process to dry peanuts that is more efficient, requires less energy, and is quieter (funded by a 1995 ATP grant and a 1997 TDT grant). This new method processes about 24 tons of peanuts at a time, while previous methods were limited to about 6 tons. In addition, 150 new jobs were created in new processing plants built with the technology.

- Retention of talented graduates within Texas (undergraduate and graduate degrees), including the development of research positions in PI-generated startups
- Faculty-student interaction with on-campus programs to promote entrepreneurial activities and strengthen the educational process

Data collected unequivocally indicate that ATP/TDT programs create significant positive impacts in all five categories. Sixty-three percent of PIs who responded reported that the programs were "very important" in attracting outstanding graduate students to their institutions, and 86 percent believed the programs were at least "moderately important." Forty-eight percent of PIs who responded reported that the programs were "very important" in attracting outstanding faculty, and 78 percent felt the programs were at least "moderately important." Principal investigators cited an extensive list of marketable, technical skills and competencies acquired by students who worked on their projects. Data also illustrated that the ATP/TDT program helped to retain talented students within the state after graduation.

Start-Up Commercial Activity

Strong evidence exists that the Texas economy has realized hundreds of millions of dollars as a result of ATP/TDT technology commercialization. The 80 start-up companies to emerge from the program over the past fifteen years include the following:

ISOA, Inc. grew out of Dr. Kathleen Hennessey's and Dr. YouLing Lin's research at Texas Tech University, which was funded by ATP in 1987, as well as by two subsequent ATP awards and two TDT awards. Formed in 1994, ISOA's core technologies are knowledge-based algorithms used to detect and classify macro defects in semiconductor wafers. Employees no longer need to perform chip inspection via microscope but can use a personal computer and imaging system, which reduces inspection costs and improves a semiconductor chip manufacturer's process yields.

In 1996, ISOA had revenues of about $370,000 and 17 employees. By 1998, revenues had grown to $2.8 million; by 1999, they were $4 million. In 2002, revenues for the first two quarters' revenues exceeded $5.4 million, supporting annual salaries for 41 employees, consultants, and contractors at a cost of $3.8 million. Ten of the 41 employees were former students who participated in one of the research projects. (In total, these five ATP/TDT project awards provided career-building experiences for more than 100 students at Texas Tech and The University of Texas at Dallas.) One-third of the employees held advanced degrees. Self-funded and debt-free, ISOA was profitable each year, and in 2000 the company built a $3 million, 20,000-square-foot headquarters in

Dallas. ISOA was acquired in July 2002 by Rudolph Technologies for $27.5 million. Currently 28 employees work at the Dallas site, ten of whom are former students.

Chrysalis BioTechnology began as a 1989 ATP project by Dr. Darrell Carney of The University of Texas Medical Branch at Galveston (UTMB). Chrysalis had an exclusive worldwide license from UTMB for several technologies and paid the university approximately $1 million in royalties, in addition to providing a significant amount of subcontracted research back to UTMB. In 2004 OrthoLogic Corporation purchased Chrysalis for $34.5 million in stock and cash. OrthoLogic is funding the development of the peptide Chrysalin for a variety of medical applications, including a current Phase III trial evaluating the efficacy of Chrysalin in accelerating bone fracture healing. UTMB, as an equity holder in Chrysalis, benefited financially from this acquisition (an estimated $1.5 million in equity value with the potential for future returns based on product sales).

OrthoLogic is funding the development of the peptide Chrysalin for a variety of medical applications, including a current Phase III trial evaluating the efficacy of Chrysalin in accelerating bone fracture healing. UTMB, as an equity holder in Chrysalis, benefited financially from this acquisition (an estimated $1.5 million in equity value with the potential for future returns based on product sales).

The 1989 project produced other significant economic impacts. Six faculty members, two staff researchers, eight graduate students, and two undergraduate students participated in the research. The project also led to follow-on research funding of $4 million for basic research from NIH and other government entities, $3 million in SBIR grants, and $6 million in equity funding from private investors. Chrysalis also received licensing income of approximately $15 million. At the time of the acquisition, Chrysalis had 20 high-paying jobs in the Galveston region. The success of the Chrysalis start-up also enhanced the entrepreneurial experience of both the principals of Chrysalis as well as the University, hopefully fostering the development of future startups.

Carbon Nanotechnologies, Inc. (CNI) received three ATP grants in 1995, 1997, and 1999. Professor Richard Smalley of Rice University formed Carbon Nanotechnologies, Inc., in Houston in early 2000 to provide a commercial source for carbon nanotubes (buckytubes). (See illustration, p. 6.) CNI has licensed from Rice all rights to the intellectual property that Professor Smalley and his group had developed at Rice. Under the licensing arrangement, Rice has equity in CNI and receives royalties on products sold by the company. As of early 2005, CNI had 30 employees, 10 contractors, and 10 consultants. CNI has received $15 million in angel investor funding to produce significant quantities of buckytubes and has expanded its facilities in Houston to include approximately 7,500 square feet: 1,500 for operations and 6,000 for manufacturing. The National Institute of Standards and Technology granted a joint award of $3.6 million to CNI, Motorola, Inc., and Johnson Matthew Fuel Cells, Inc. in September 2004. According to Professor Smalley, "The Texas ATP grants to us here at Rice were absolutely crucial to the spawning of this company and its early success."

In addition to start-up activity, dozens of ATP/TDT projects are on the verge of being commercialized. Some of these are described in the 30 case studies that highlighted economic achievements, entrepreneurial successes, and technical and scientific innovation. Partners' economic benefits, both quantifiable and unquantifiable, are also noteworthy and are described in the complete impact assessment.

Benchmarking

Benchmarking data on R&D expenditures were compiled for Texas against a group of other states at a particular point in time as well as across time. Texas generally compared unfavorably to other states. With the point-in-time comparisons, Texas ranked lower than most peer states on five R&D measures, as well as ranking below the national average on five measures. The pattern was mixed in the six across-time comparisons. One bright spot in R&D benchmarking were comparisons for the Texas health institutions, which showed a very positive result. The proportion of federal R&D captured by major Texas health institutions has increased over the past 20

years at a rate approximately ten times faster than one would anticipate due to population growth solely.

Of greater importance were the results from comparing ATP/TDT outcomes to a number of other programs and institutions, including Association of University Technology Managers (AUTM) data, nine U.S. federal laboratories, the Georgia Research Alliance, the Federal Advanced Technology Program, and the Oklahoma Applied Research Program (OARS). While inferences between ATP/TDT and these other programs must be drawn very cautiously due to differences in program objectives, award size and structure, and limited available data, the findings were instructive nevertheless. The expectation was that outcome metrics for research grant programs that fund applied research, such as Texas ATP/TDT, should be higher than for U.S. universities and Canadian institutions in general and also should be higher than U.S. hospitals and research institutes and federal laboratories.[4] Actual findings generally confirmed expectations, although in some cases Texas ATP/TDT metrics were found to be far superior.

Outcome metrics for other programs, such as OARS and the federal ATP, were expected to be higher than the Texas ATP/TDT because both programs provide funding to private companies, with limited university involvement. (R&D funding provided to companies is normally further downstream, more product-oriented, less risky, and more likely to result in commercialization outcomes than university research and development.) In fact, the actual findings are somewhat mixed—sometimes Texas ATP/TDT had lower metrics as expected, and sometimes its metrics exceeded those of the other programs.

Summary of Program Outcomes

Texas ATP/TDT programs target applied research and development, workforce development, and commercialization. The results of 1,854 ATP/TDT projects indicate that on average:

- One in three yields a patent application
- One in three leads to commercialization
- One in five leads to an issued patent
- One in six leads to a license
- One in 25 results in new company formation
- Excluding in-kind matching, each project receives follow-on research funds of nearly three times the ATP grant
- Each project provides paid positions to five graduate and two undergraduate students and each project will lead to two new employees for Texas businesses

In the complete report, suggestions are outlined that might further increase the ATP's effectiveness. Nevertheless, the Advanced Technology Program has accomplished the original legislative goals and has been a solid investment in the state's economy.

Notes

1. The 79th Texas Legislature did not fund the ATP but provided approximately $8.5 million in funding for the Advanced Research Program, which focuses on basic research projects. Legislative leaders also directed $43 million to the Research Development Fund, which helps build research capacity on the "front end" at a number of higher education institutions and $200 million to the Emerging Technology Fund, which encourages commercialization of science and engineering discoveries.
2. These limitations could be substantial as two acquired companies had at least 40 employees each for a minimum of three years.
3. This amount reflects only a token of actual capital expenditures and does not attempt to calculate operating efficiencies for partners who built new plants.
4. The rationale is explained in the full report.

The original assessment was undertaken for the Texas Higher Education Coordinating Board. The authors wish to express our appreciation to the members of the Advisory Committee on Research Programs for their support and to Coordinating Board staff for providing assistance during this project. The complete report, "Impact Assessment of the Advanced Technology Program," *is available online at www.mccombs.utexas.edu/research/bbr/ or by contacting James Jarrett at jj@icc.utexas.edu.*

The proportion of federal R&D captured by major Texas health institutions has increased over the past 20 years at a rate approximately ten times faster than one would anticipate due to population growth solely.

Texas Business Review is published six times a year (February, April, June, August, October, and December) by the Bureau of Business Research, IC² Institute, The University of Texas at Austin. Subscriptions are available free upon request. Views expressed in this newsletter are those of the authors and do not necessarily reflect the position of the Bureau of Business Research.

Research and service activities of the Bureau of Business Research focus on the ways Texas industries can become nationally and globally competitive. The Bureau is policy oriented and dedicated to public service. The Bureau is located on the sixth floor of the College of Business Administration building.

IC² Institute Director:
John Sibley Butler
John.butler@mccombs.utexas.edu

IC² Institute Deputy Director & Director of Research:
Robert A. Peterson
RAP@mail.utexas.edu

TBR Editor:
Bruce Kellison
Bruce@icc.utexas.edu

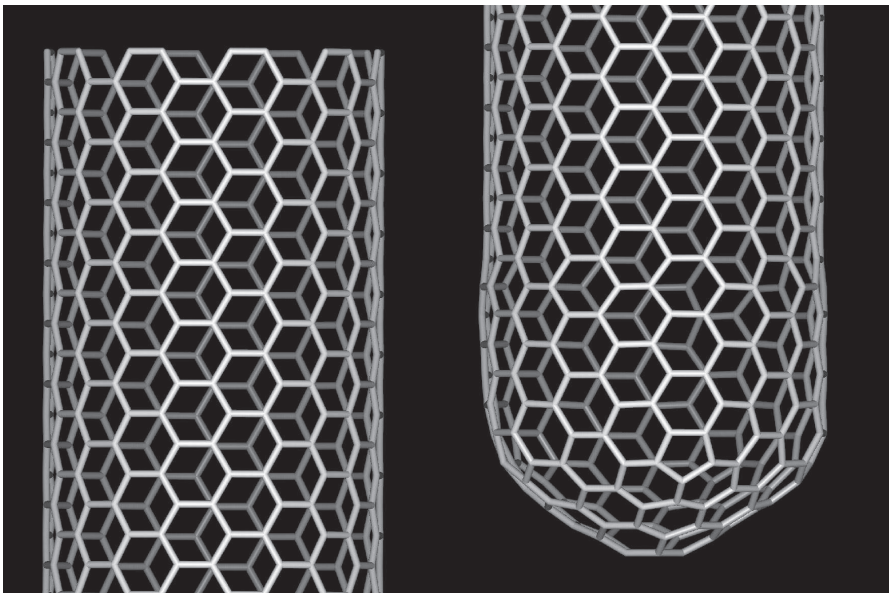
TBR Managing Editor:
Margaret Cotrofeld
Margaret@icc.utexas.edu

Sales Office:
(888) 212-4386
(512) 471-1063 fax
Rita@icc.utexas.edu

www.mccombs.utexas.edu/research/bbr/

The University of Texas at Austin
BUREAU OF BUSINESS RESEARCH
IC² Institute
1 University Station B8500
Austin, Texas 78712

Change Service Requested



Carbon Nanotechnologies, Inc. (CNI) received three ATP grants in 1995, 1997, and 1999. Professor Richard Smalley of Rice University formed Carbon Nanotechnologies, Inc., in Houston in early 2000 to provide a commercial source for carbon nanotubes (buckytubes). *Images courtesy of CNI.*

Announcement

For all current and back issues of **Texas Business Review**, visit and bookmark the website of the Bureau of Business Research (www.mccombs.utexas.edu/research/bbr/bbrpub/tbr). Featuring **TBR** issues and articles dating back to 1997, the site also contains an abundance of valuable information, articles, and data to help your business stay competitive. Much of the information is available free of charge as a service to the state. ◆