
A Review of State R&D Investment Funds: Ten Case Studies

FINAL REPORT

**Prepared for
The Pew Center on the States &
The National Governors Association**

by Heike Mayer, Ph.D.

Assistant Professor
Urban Affairs and Planning Program
Virginia Tech – Alexandria Center

1021 Prince Street, Suite 200
Alexandria, VA 22314
Phone: (703) 706 8122
Fax: (703) 518 8009
E-mail: heikem@vt.edu

March 1, 2007

Executive Summary

This report examines the R&D investment efforts of 10 states: Connecticut, Idaho, Kansas, Kentucky, Maryland, Massachusetts, Missouri, Tennessee, Virginia, and West Virginia. The study is part of a larger research project undertaken by the Pew Center on the States and the National Governors Association, which seeks to understand the state's role in supporting research and development. This report complements the efforts of four other researchers and should be seen as a partial assessment of state R&D investment funds in the United States. A final report, tentatively titled *A Governor's Guide on State Investment Funds to Support Innovation-Based Economic Development*, will be published later in 2007.

This analysis finds that an interesting evolution regarding state R&D investments took place since the 1980s. During the 1980s, several states initiated programs aimed at strengthening their research capacities. These programs financed endowed faculty positions and established research centers. Funding was broadly targeted at higher education institutions. During the 1990s, there seemed to have been a pause in state efforts. Beginning in 2000, states became pro-active again. This time, funding programs began to target certain academic disciplines, primarily in the areas of bio-, info- and nanotechnology. In addition, states realized that they could be more strategic with their investments. We now see programs that encourage university-industry partnerships, institutional collaborations, and support research normally not funded by federal agencies such as the National Science Foundation (NSF) or the National Institutes of Health (NIH). Some states seemed to have moved from merely building supply side capacities (i.e. university research) to funding research and development efforts that complement the new corporate model of open innovation.

The following provides a short overview of the R&D investment efforts in the 10 states examined in this report. The research was conducted from December 2006 to March 2007. Information on each state was gathered and developed through a variety of sources such as websites, reports and news sources. About 40 phone interviews with key experts in the ten states provided contextual information.

Connecticut: The state has invested \$20 million in stem cell research and expects to invest another \$80 million over the next ten years. The Stem Cell Research Program funded research at Yale University, University of Connecticut, and Wesleyan University. The program is distinct from others because it is implemented and administered by the

Department of Public Health and by a public-private technology organization (Connecticut Innovations).

Idaho: Idaho does not have a dedicated state R&D investment funds. Business leaders and higher education officials have made various attempts to improve science and technology in the state. However rural interests and those from traditional industries are strong and have traditionally not been very supportive of significant investments in science and technology.

Kansas: In 2004, Kansas passed the Economic Growth Act which established the Kansas Bioscience Initiative and the Kansas Bioscience Authority. The program uses a unique funding mechanism – tax increment financing – to raise \$500 million in the next 10 to 12 years. So far, the Kansas Bioscience Authority received about \$30 million over two years and used the funding to invest in R&D vouchers, infrastructure, and the attraction of R&D institutions.

Kentucky: Kentucky's Bucks for Brains Program is well known. Since the program's start in 1998, the state has invested about \$350 million in attracting promising researchers to Kentucky universities. State leaders, however, realize that the program has limitations because it has traditionally not funded infrastructure investments. Thus, local leaders are considering revisions that would modify the program to not only fund "brains" but also "bricks."

Maryland: In 2006, Maryland passed the Stem Cell Research Act and appropriated \$15 million. The fund is used in unique ways to support translational research and research that involves new hypotheses, approaches, mechanisms or models that may differ from current thinking in the stem cell field. Maryland is also a pioneer in providing support for funds aimed at investing in university-industry partnerships.

Massachusetts: Massachusetts Research Center Matching Fund provides \$30 million in matching funds to researchers interested in applying to federal programs that require university-industry partnerships. The fund has been very successful in leveraging large federal awards and engaging industry. The fund is managed by the John Adams Innovation Institute. The institute's business plan is an outstanding example for a strategically focused document that guides state investments.

Missouri: Missouri's efforts to establish R&D funds and finance higher education facilities have been stymied by the state's fiscal problems and by political quarrels over the legality and appropriateness of stem cell research. The state provides for an interesting case study in how R&D funds can be politicized.

Tennessee: Tennessee engaged in a wide-ranging education reform in the mid 1980s. This reform established programs aimed at strengthening the research capacity at the Board of Regents and the University of Tennessee institutions. In 2004, the focus shifted to strategic investments in specific science and technology fields such as biology, advanced materials, and computational sciences. Current investments also focus on strengthening the partnerships between the University of Tennessee and Oak Ridge National Laboratories.

Virginia: Virginia established the Commonwealth Technology Research Fund in 2000 and funded it with \$13 million from the state's General Fund. In 2002, however, funding was discontinued and never restored. In the meantime, individual universities benefited from the \$204 million higher education research initiative former Governor Warner put together. Lately, Governor Kaine proposed to renew the CTRF fund with \$2 million, \$3 million short of his predecessor's proposal. The remaining \$3 million were used to recruit a California-based research institute.

West Virginia: The mountain state is experiencing a "research renaissance." Since 2001, West Virginia has restructured the EPSCoR program and successfully attracted \$18 million in NSF funding. In addition, the state instituted the Research Challenge Trust Fund. Unique about the fund is its funding mechanisms: 0.5 percent of the state's racetrack lottery dollars support the fund on an annual basis. So far, the state received about \$4 million annually from this funding source.

The report concludes the following:

- State R&D investments have evolved and some complement the open innovation model.
- State R&D investment funds should complement federal programs.
- State R&D investments are vulnerable to political vagaries and budget cuts.
- Some states – such as Kansas and West Virginia – developed steady funding streams for their investment funds.
- State R&D investment funds need to have political champions: Governors and state legislators need to stand behind R&D.
- State R&D investment funds need to incorporate strategic elements such as industry engagement, cost share, competitiveness and peer review.
- States need to be aware about the geographic impact of their R&D investments and state leaders need to reach out to all constituencies.
- R&D investment funds cannot exist in a vacuum. States have to have other programs industry and entrepreneurs can benefit from.

Table of Contents

Executive Summary	2
Table of Contents	5
1. Evolution of State R&D Investments	6
1980s: Building Research Capacity	6
2000s: Constructing Competitive Advantage	7
2. Case Studies	9
Connecticut	9
Endowed Chair Investment Fund	10
Yankee Ingenuity Technology Program	10
Connecticut Stem Cell Research Funding Program	11
Idaho	18
S&T Advisory Council Proposals	18
Kansas	22
Kansas Economic Growth Act (KEGA)	22
KTEC's Centers of Excellence	25
Kentucky	28
Bucks for Brains Program	28
Kentucky Innovation Act	30
Maryland	33
Maryland Industrial Partnerships (MIPS)	34
University Technology Development Fund (UTDF)	35
Maryland's Stem Cell Research Program	35
Massachusetts	39
Research Center Matching Fund	40
Missouri	46
Missouri State-Endowed Chair and Professor Program	46
Life Science Research Trust Fund	47
Lewis & Clark Discovery Initiative (MOHELA Sale)	47
Tennessee	50
Chairs of Excellence Program	50
Governor's Chair & Joint Institutes Programs	51
Memphis BioWorks Foundation	53
Innovation Tennessee	53
Virginia	55
Commonwealth Technology Research Fund	57
West Virginia	60
Research Challenge Trust Fund	62
Vision 2015: The West Virginia Science and Technology Strategic Plan	63
3. Closed versus Open Innovation: What is the Role of the State?	65
4. Conclusion	69
Appendix	71

1. Evolution of State R&D Investments

The ten states analyzed in this report went through a distinct evolution in their efforts to invest in research and development. During the 1980s many states invested in building capacity at their research universities. Only a few programs focused on university-industry partnerships. During the 1990s, there seemed to have been a pause in initiatives (only Missouri and Kentucky saw major investments). Beginning in 2000, however, states became more active. They strategically targeted their investments on certain technology areas (i.e. engineering, computer sciences, biosciences, stem cells etc.). In addition, state leaders became more creative regarding university-industry and/or university-university partnerships. This evolution may indicate that states have become more sophisticated regarding their R&D investments and that their investments help universities play a critical role in the open innovation model.

1980s: Building Research Capacity

As Table 1 outlines, most state efforts to invest in R&D that started in the 1980s were aimed at building research capacity through funding endowed chair or professorship positions. States also invested in the establishment of university-based centers of excellence. The primary goal of these programs was to strengthen the research capacity and to create areas of strengths. Generally, programs were not targeted towards certain technologies or research fields. In Tennessee, for example, centers of excellence created during this time focus on a wide range of fields such as popular music, Egyptology, and neurosciences. Sometimes programs were created through wide-ranging education reforms that not only touched the institutions of higher education but also the K-12 and community college systems (i.e. Tennessee and Kentucky). In some states, funds for endowed faculty positions have dried up (i.e. Kentucky, Missouri). Other states have successfully transitioned into a new phase of investments (i.e. Tennessee).

Among the states examined here, only two programs existed that were aimed at building university-industry partnerships during the 1980s: Maryland's Industrial Partnerships Program (MIPS) and Connecticut's Yankee Ingenuity Technology Program are examples of pioneering initiatives focused on connecting university and industry. Maryland's program has been very successful in supporting research that yielded significant economic benefit (i.e. funding was made available for research involving MedImmune's best-selling drug Synagis).

2000s: Constructing Competitive Advantage

Beginning in 2000, states began to strategically focus their R&D investments. The major goal was to construct competitive advantage¹ by focusing on certain technology areas, leveraging federal funding and connecting universities with industry. The efforts coincided with a decrease in federal funding and a heightened awareness among states about the competitive nature of federal investments in R&D.

Massachusetts stands out for its efforts to leverage federal and industry funding. The state's Research Center Matching Fund program supports university efforts aimed at attracting federal funding for university-industry centers. Virginia's Commonwealth Technology Fund supported collaborative research between universities and industry partners. This fund, however, has been plagued by budgetary problems and by a strong university lobby to appropriate money directly to their institutions. Tennessee is banking on the partnership between the University of Tennessee and Oak Ridge National Laboratory.

Popular among states is to focus investments on life sciences research. Kansas, for example, has made major investments in the biosciences. States with stem cell research funds represent a special case: In response President Bush's 2001 veto on stem cell research funding, states like Connecticut and Maryland created funds to support stem cell research. Their funding ranges between \$15 million and \$100 million. Maryland developed a Stem Cell Research Program that explicitly focuses on translational research and funds research that would otherwise not be funded by federal agencies such as NIH would the veto not exist. The issue of stem cell research, however, is not everywhere blissful: In Missouri, opposition to stem cell research – in addition to budgetary problems – has stymied the state's efforts to invest in higher education.

In smaller states – such as West Virginia and Idaho – proposals to support higher education are currently on the table. States where urban-rural differences are pronounced face more difficulties in gaining support for their investments (i.e. Idaho). Key to successful proposals seems to be a balanced geographic approach and extensive outreach efforts.

In many states, R&D investments funds are managed by public-private agencies or by universities. Agencies such as Connecticut Innovations, the Massachusetts Technology Collaborative, or Virginia's Center for Innovative Technology benefit from their experience with other types of

¹ Asheim et al. (2006) argue that universities play an important role in “constructing regional advantage.” See: Asheim, B., Coenen, L., Moodysson, J., & Vang, J. (2006). *Constructing knowledge-based regional advantage: Implications for regional innovation policy*. Paper presented at the Innovation Pressure, International ProACT Conference. from http://www.proact2006.fi/chapter_images/298_Ref_A94_BjOrn_Asheim.pdf.

funds and their ties to industry. It is important to note that state R&D investment funds do not exist in a vacuum. Most states offer a portfolio of funds focused on research and development, commercialization, technology transfer, and business development.

Table 1: Evolution of State R&D Funds

Time	Program Type	States
1980s	Chairs & Centers of Excellence Programs	KS: Centers of Excellence (1980s) VA: Technology Development Centers (1980s) TN: Chairs of Excellence & Centers of Excellence (1984) CT: Endowed Chair Investment Fund (1985) MO: Food for the 21 st Century (1985) MD: Biotechnology Institute (1985)
	University-Industry Partnership Programs	CT: Yankee Ingenuity Technology Program (1985) MD: Maryland Industrial Partnerships Program (1987)
1990s	Chair Programs	MO: State-Endowed Chair & Professorship Program (1995) KY: Bucks for Brains (1997)
2000s	University-Industry and/or University-University Partnerships	VA: Commonwealth Technology Research Fund (2000) MA: Research Center Matching Funds (2003) TN: Governor’s Chair & Joint Institutes (2004)
	Leveraging federal funding	KY: KSEF R&D Excellence Program (2000) WV: Research Challenge Trust Fund (2003)
	Life Sciences / Biotech	KS: University Research and Development Act (2001) MO: Life Sciences Research Trust Fund (2003) KS: Kansas Bioscience Initiative (2004) KS: Kansas Cancer Center (2006)
	Stem Cell Funds	CT: Stem Cell Research Fund (2005) MD: Stem Cell Research Program (2006)
	Major HEI investments	VA: Warner’s Higher Education Research Initiative (2005)
	Proposals	WV: Vision 2015 (2006) ID: S&T Council Proposal & Governor’s Proposal (2006) MO: MOHELA sale (2006/2007)

Note: Table excludes some programs discussed in this report (i.e. Maryland’s University Technology Development Fund). Also excluded from the analysis are state venture capital and commercialization funds.

2. Case Studies

Connecticut

Connecticut has long been a leader in supporting industry clusters. In 1997, the state launched the Connecticut Industry Cluster Initiative under the Department of Economic and Community Development (DECD). Throughout 1998, the Governor's Competitiveness Council examined a variety of topics important to industry cluster growth. The council's findings were published in the report *Partnership for Growth: Connecticut's Economic Competitiveness Strategy*. The report serves as a blueprint for the state's economic future.

The bioscience industry is one of the most active and supported clusters in Connecticut. The BioScience Cluster initiative was launched in 1998 and is overseen by Connecticut United for Research Excellence (CURE), a business support group that was established with \$300,000 in state seed money and \$700,000 from private industry. The state has supported CURE since its founding. CURE is active in business networking, government lobbying, education and workforce development, and as an information resource. Connecticut Innovations (CI), created by the state in 1989, functions as the state's investor in high-technology companies. Feldman et al note that CI is the nation's "first state-sponsored agency charged with the responsibility for supporting new ventures' product development activities with various financing mechanisms, such as equity investments."² CI manages a variety of funds that provide support to bioscience start-up companies, bioscience facilities, early-stage technology companies, and university/business research collaborations. It also manages the state's Clean Energy Fund.

In 2004, a group of patient advocates called the *Stem Cell Coalition of Connecticut* proposed a bill that would permit and fund stem cell research. The bill did not pass in the first session, but was adopted with overwhelming support a year later in 2005. Public Act No. 05-149 funds stem cell research with an initial investment of \$20 million and an additional commitment of \$10 million per year for 10 years. The bill established the Stem Cell Research Fund as a separate, nonlapsing account within the General Fund from which disbursements of the Tobacco Settlement Fund money will be made. Requests for applications were made available in 2006. 70 proposals were reviewed by November 2006. A total of \$19.75 million was allocated and 21 awards were made

² Feldman, M. P., Kelley, M., Schaff, J., & Farkas, G. (2000). Reinforcing interactions between the Advanced Technology Program and the States. Volume 2: Case studies of technology pioneering start-up companies and their use of state and federal programs. Retrieved February 20, 2007, from <http://www.atp.nist.gov/eao/ir-6523.pdf>, p. 31.

to researchers from the University of Connecticut, Yale University, and Wesleyan University.

Endowed Chair Investment Fund

Connecticut started to create higher education and R&D investment funds in the mid 1980s. In 1985 legislation authorized the Board of Governors to establish and administer the *Endowed Chair Investment Fund*. For this fund, the state provides a one-to-one match of private donations for the establishment of chair positions. In 2000, a new bill (An Act Concerning Education Aid, Public Act No. 00-187) increased the maximum state matching grant for the University of Connecticut and Connecticut State University endowed chairs from \$750,000 to \$1 million. The universities must raise a non-state contribution equal to the state's contribution. In addition, the chair positions are established in centers of excellence at the universities. By 2006, the fund supported a total of seven endowed chairs in the state.

Yankee Ingenuity Technology Program

The 2000 legislation also combined Connecticut's Critical Technology Program (CTP) with the Yankee Ingenuity Initiative Program (which was originally created in 1985) to create the *Yankee Ingenuity Technology Program*. The purpose of the program is to accelerate innovation in the state by connecting industry with university researchers. The program offers awards up to \$300,000 to Connecticut universities that collaborate with Connecticut businesses on applied research. Two types of peer reviews are conducted: Technical experts review the scientific merit and a review panel of entrepreneurs and academics review the proposal as well as the oral presentations by the principal investigators. The goal of the program is to "encourage Connecticut businesses, particularly emerging enterprises, to collaborate with Connecticut colleges and universities to develop and commercialize products or processes with high potential to contribute to long-term, sustainable economic growth in Connecticut."³

The original CTP program invested about \$15 million in UConn based university/industry partnerships since 1993. Before 2000, the program was funded through state bonds. In 1998, CTP restructured to operate as a project-specific competition. In 2000, CTP and Yankee Ingenuity Initiative Program were merged and funding for the new program now comes from Connecticut Innovations. Smith and Krisst note that "since 1998, one of the conditions of CTP funding is a required match from partnering companies, thereby increasing the value of this source of funding. For example, for the 1998 competition, which was funded at the level of \$2.8 million, Connecticut businesses provided a match of \$1.8

³ See current application instructions:

<http://www.ctinnovations.com/docs/YankeeApplication%20and%20cover%20for%20web.doc>

million, attesting to the importance of these collaborations to businesses and raising the investment in the program to nearly \$5 million per year!”⁴

The current round of investments from the Yankee Ingenuity Technology Program comes from the Connecticut Clean Energy Fund (DDEF) and focuses on “supporting the development of clean energy technologies and processes.” The application instructions are very explicit about the nature of university/business collaborations. Principal investigators need to have a contract with their industry partner in place by the time funding is awarded. Such a contractual agreement formalizes the industry-university partnership. In addition, investigators have to explain in their application how the research objectives “compare to the state of the art and current industry practice.” Applicants also have to submit evidence of commitment from all the partners involved.

Connecticut’s Yankee Ingenuity Technology Program is very similar to Maryland’s MIPS program (discussed later in this report). A 2000 case study of a Connecticut-based company receiving state investments from this program (CuraGen, Inc.) remarked on the success of the program and noted that Connecticut “already benefited materially from its investments, receiving a return on its initial capital investment that has far exceeded expectations.”⁵

Connecticut Stem Cell Research Funding Program

The Stem Cell Research Program is the newest state-funded R&D investment program in Connecticut. According to leaders in the state, the goal of the fund is to:

- enhance the R&D capacity of the state,
- recruit and retain researchers,
- contribute to the state’s economic development, and
- advance public health in the state.

Governor Rell summed up the dual purpose of the bill in a statement she made in 2005: “The state of Connecticut should be leading the effort to discover new cures for life-threatening illnesses and promoting jobs in the

⁴ Smith, R., & Krisst, I. (2007). Yankee Ingenuity Technology Program - A Critical Investment and Important Opportunity. Retrieved February 20, 2007, from <http://www.research.uconn.edu/whatsnew/april00/feature1.pdf>

⁵ Feldman, M. P., Kelley, M., Schaff, J., & Farkas, G. (2000). Reinforcing interactions between the Advanced Technology Program and the States. Volume 2: Case studies of technology pioneering start-up companies and their use of state and federal programs. Retrieved February 20, 2007, from <http://www.atp.nist.gov/eao/ir-6523.pdf>, p. 36. The company’s website is: <http://www.curagen.com/>.

bioscience industry at the same time.”⁶

In addition to these goals, the state is filling a void left by the federal government after the President’s veto regarding the funding of stem cell research. Unlike Maryland, however, Connecticut’s bill does not specifically address the economic development goals; it merely outlines the ways in which the fund is to be governed.

Legislative History

In 2004, a group of patient advocates called the *Stem Cell Coalition of Connecticut* proposed a bill that would permit and fund stem cell research. The bill did not pass when it was first introduced in 2004, but was adopted with overwhelming support a year later. Unlike other states, Connecticut’s bill does not restrict the type of cells used.

Early in the legislative process, the patient advocate group invited the biotechnology industry community (represented by CURE) to be part of the effort. Milton Wallack, one of the key proponents of the bill, remarked on this collaboration in a newspaper interview: “Together with CURE , we put together a fantastic group of people and presented our first proposed bill to the legislature in 2004, nine months after our first working meeting.”⁷ During the legislative process, the bill received strong support from the Chair of the Public Health committee and now Congressman Chris Murphy and from Governor Rell.

Key supporters in the state attribute the bill’s success as well as the widespread acceptance of the state’s role in funding stem cell research to the extensive grassroots efforts and outreach that accompanied the proposal from the beginning.

Funding

Connecticut’s policymakers recognized the long-term nature of stem cell research. Public Act No. 05-149 funds stem cell research with an initial investment of \$20 million and an additional commitment of \$10 million per year for 10 years. The bill established the Stem Cell Research Fund as a separate, nonlapsing account within the General Fund from which disbursements of the Tobacco Settlement Fund money will be made.

Eligible institutions include higher education institutions, hospitals, and “any entity that conducts biomedical research or embryonic or human

⁶ See press release for May 26, 2005 (<http://www.ct.gov/governorrell/cwp/view.asp?A=1761&Q=293208>).

⁷ Mindell, C. (2006). Conversation with...Dr. Milton Wallack. Retrieved February 21, 2007, from <http://www.jewishledger.com/articles/2006/03/16/news/news05.prt>

adult stem cell research.” This can include companies interested in conducting stem cell research.

Administration

The program is administered by the state’s Department of Public Health and by Connecticut Innovations. The fund is governed by the Stem Cell Research Advisory Committee and grant applications are reviewed by the Stem Cell Research Peer Review Committee.

The Advisory Committee consists of eight members (appointed by Governor, by the President of the Senate, the Speaker of the House of Representatives, by the majority leaders of the Senate and the House, and by the minority leader of the House) and is chaired by the Commissioner of Public Health. The members represent academia, hospitals, law, ethics, or patient advocate communities. However, only one member represents industry interests (in this case the venture capital industry). The Peer Review Committee consists of five members, all of whom are from outside the state. Warren Wollschlager, Chief of Staff at DPH, noted that it was “challenging to create the peer review committee because of the small size of the international stem cell research community.”

While programmatic development rests with the state’s Department of Public Health (DPH), Connecticut Innovation provides staff support for grant administration. According to the Commissioner of Public Health, Robert Galvin, in 2007, DPH receives about \$200,000 to defray the costs of the program. This amount does not cover the true costs for administering the program, which he estimates to be about \$450,000.

Grant Applications

Neither the bill nor the requests for applications make a distinction between the types of research, such as basic or applied, that are funded.

Researchers can apply for five types of awards. Those are:

- Seed Grant Award
 - These awards are intended to support early stages of projects that are not yet ready for larger scale funding, whether from federal or nonfederal sources.
 - Priority is given to junior faculty members.
 - Awards may be up to \$200,000 for 2 years (yearly budget not to exceed \$100,000).

- Established Investigator Award
 - Are intended for investigators with a track record of independent research including prior grant support and regular publications.
 - Awards may be up to \$1 million for 4 years.

- Group Project Award
 - Group Project Awards are intended to support “coordinated approaches to ambitious strategic goals that are beyond the scope of a typical single laboratory.”
 - Priority is given to projects involving collaboration across disciplines and / or institutions.
 - These may be up to \$4 million for up to 4 years.

- Core Facilities Award
 - Facilities grants provide support for facilities for stem cell researchers.
 - The Advisory Committee recognized the need to provide the physical capacity for the research at the universities receiving grants.
 - Awards may be up to \$5 million for 4 years.

- Hybrid Awards
 - This is a hybrid type of award, which combines group project and core facilities award type.
 - Awards may be up to \$5 million for 4 years.
 - Can include startup costs for new hires.

Connecticut has finished its first round of awards. Requests for applications were made available in May 2006. 70 proposals were reviewed by November 2006. A total of \$19.75 million were allocated. 21 awards were made to researchers from the University of Connecticut, Yale University, and Wesleyan University. Two awards fund research facilities and 10 grants fund early stage projects. Established researcher awards range from \$526,000 to \$3.8 million.

Returns on investments such as income generated from intellectual property of the research will be captured at a rate of 5 percent and will be reallocated to the fund.

Accountability

Accountability is ensured through regular reporting at six month and annual intervals.

Contributions

So far Connecticut's Stem Cell Research Program made the following contributions:

- The Stem Cell Advisory Committee made 21 awards totaling \$19.75 million. Awardees include researchers from the University of Connecticut, Yale University, and Wesleyan University.
- Since the program was initiated, scholars from the three major universities – Yale University, University of Connecticut, and Wesleyan University – have met on a regular basis to exchange ideas and to talk about research projects. Interviewees highlighted these meetings and collaborations among the universities as a major contribution.
- The Stem Cell Research Program in Connecticut contributed to the attraction of two star scientists. Yale hired Dr. Haifan Lin, a leading stem cell researcher, to direct the Yale Stem Cell Center. One Massachusetts-based researcher noted that the passage of the bill and the available funds were noticed in the stem cell research community. “We want to create an atmosphere here where we are showing that this is welcome in Connecticut. We are operating under the belief that if we build it, they will come“, said Robert Galvin, Commissioner of Public Health in a New York Times article.⁸
- Connecticut's program has received national and international attention. In September 2006, a delegation from the Parliament of the United Kingdom visited the state to learn more about the stem cell program. A press release quoted the Vice Consul for Science & Technology for the British Consulate-General in Boston with “We are aware of the stem cell research initiatives in the United States, and see Connecticut as a model state in this process.” In addition, DPH staff will travel to Australia to present the program. Connecticut will also host an international symposium in March 2007 where not only stem cell researcher exchange ideas but also state leaders who work with state-funded stem cell research program.

⁸ Medina, J. (2006). Connecticut Takes a Lead In Stem-Cell Research Aid. February 21, 2007, from <http://www.nytimes.com/2006/12/10/nyregion/10stem.html?ex=1172206800&en=fffb31ba9e5f41a&ei=5070>

- Through the program, new partnerships among state agencies and public-private organizations formed. Connecticut's Department of Public Health is working with CURE and with Connecticut Innovations. These partnerships were highlighted because they combine public health and economic development goals.
- Connecticut sees itself in a "first mover" position: Interviewees noted that their state will be in a good position once federal law changes and the veto on stem cell funding is lifted. Many believe that Connecticut will be ideally positioned to benefit from future federal funding and research on stem cell because it is currently building the capacity.

Challenges

Interviewees noted two types of challenges. The first had to do with convincing policymakers about the merit of funding stem cell research. Those involved in the legislative process remarked on the extensive education effort necessary to convince lawmakers.

The second challenge is related to Connecticut's pioneering status in the realm of supporting stem cell research. Robert Galvin, Commissioner of Public Health, noted that his department had to develop the details of the program without any model or benchmark to go by. Additional challenges include regulatory issues about cross-state collaboration in research and the standardization of stem cell lines.

Lessons / Observations

- Situating the program with the Department of Public Health may be unusual, but the organizational structure may have also ensured public trust and limited opposition
- Extensive grassroots efforts seemed to have guaranteed wide-spread support.
- Strong support by the Governor and other political leaders was crucial.
- Neither the bill nor the application requirements distinguish what type of stem cell research – basic, applied, translational, etc. – is funded. Unlike Maryland, Connecticut's efforts focus on funding stem cell research in general.

Resources for Connecticut

- Organizations:
 - Connecticut Innovations: <http://www.ctinnovations.com/>
 - Yankee Ingenuity Technology Program:
<http://www.ctinnovations.com/funding/ccef/Yanke%20Ingenuity%20Fact%20Sheet-DEC06.pdf>
 - CURE: <http://www.curenet.org/>
 - Department of Public Health: <http://www.dph.state.ct.us/>
- Documents
 - Governor's Council on Economic Competitiveness (2004). *Partnership for Growth: Connecticut's Economic Competitiveness Strategy*. State of Connecticut. Retrieved January 30, 2007, from the World Wide Web:
http://www.youbelonginct.com/pupload/PforGreport_web.pdf
- Bills
 - Act Concerning Education Aid (Public Act 00-0187):
<http://www.cga.ct.gov/2000/act/pa/2000PA-00187-R00HB-05737-PA.htm>
- Stem Cell Research Program (DPH website):
<http://www.dph.state.ct.us/StemCell/index.htm>
 - Link to bills:
http://www.dph.state.ct.us/StemCell/Laws_Regulations.htm

Idaho

Idaho's economy has traditionally been dependent on natural resources. However, the state is undergoing significant economic transformation. For example, Idaho's largest metropolitan area – Boise – is an important high-technology center and is home to firms like Micron Technology and Hewlett-Packard. These large high-technology firms have pushed local higher education institutions such as Boise State University to upgrade their offerings and have supported them financially. Traditionally the state has not invested much in R&D and major proposals were repeatedly rejected by the legislature. Beginning in the late 1990s, however, state leaders – primarily business and higher education representatives – started to pay attention to the needs of a technology-based economy. Several planning efforts were undertaken since then, but most legislative proposals failed so far because of rural opposition. The current Governor, however, has proposed several research programs.

S&T Advisory Council Proposals

In 1999, Governor Kempthorne announced the formation of the Idaho Science and Technology Advisory Council. The Council developed Idaho's first strategic plan for science and technology development which was released in early 2001. The strategy recommended investments in S&T education, R&D and university-industry collaborations (including a Research Excellence Initiative), commercialization and technology transfer, entrepreneurship, technology infrastructure, and marketing of Idaho as a technology center. Among the recommendations was also the creation of a science and technology corporation. The recommendations were incorporated in Governor Kempthorne's 2001 budget, but in the end most were not funded.

As a result of the Advisory Council first round of deliberations, the Office of Science and Technology (OST) within the Idaho Commerce and Labor Department was created in 2004 to provide a “focal point for the state's efforts to build a science and technology research and industry base.”

In 2004, the Advisory Council was reconstituted to assess the state's progress in science and technology and to provide an update to the strategic plan. The action plan priorities the Council prepared this time were similar to the 2000 strategy. In addition to the update, the Council prepared an assessment of Idaho's core competencies and developed a commercialization concept for the state. The Council's work provided the basis for Governor Kempthorne's 2007 budget request. His request, however, was rejected by the legislature in 2006 when lawmakers considered how to disburse a \$214 million surplus. The only budget request legislatures funded at the time were rural initiatives such as a \$5

million investment in rural broadband services. The rejected initiative included \$1 million for State Board of Higher Education to create two programs, a research matching grant program and a statewide patenting and technology transfer office.

During 2006, the Council made a third attempt and proposed a \$48.8 million economic stimulus package. The recommendations included \$10 million in tax credits and \$38.8 million for investments in education, research and development, marketing, incubators, and infrastructure. Part of the recommendations was a \$1.4 million Research Matching Grant Program which would meet the 1:2 match requirement of the 2008 EPSCoR Research Infrastructure Improvement grant.

The Council's third round of deliberations took place during a time when Idaho changed Governors. The new Governor (Otter) did not take up the Council's recommendation in his budget request. Instead, he included \$38 million for needs-based scholarship endowment fund, \$5 million for community colleges, a "one-time increase of \$15 million for the Higher Education Research Council for research projects that facilitate economic development. That includes research being conducted by our three universities at the Center for Advanced Energy Studies, a joint venture between the universities and the Idaho National Laboratory," and \$10.9 million for a dairy and animal research and education facility.⁹ The budget is currently debated in the state legislature.

The Council's proposal also included a technology investment tax credit program (\$10 million). It included a 45 percent tax credit for investments in bioscience companies and a 35 percent tax credit for investments in technology companies. Governor Otter did not include this program in his budget and proponents are currently considering taking the proposal directly to the legislature.

Otter's proposal to invest \$15 million in Idaho's Higher Education Research Council topped the Council's recommendation of making a \$1.4 million investment in this program. According to the Higher Education Research Council's policies and procedures, the money can be allocated to infrastructure and research. Idaho's Higher Education Research Council seems to have experience with research incentive grants. The Council operates the so-called Technology Incentive Grant Program which was developed by the State board of Education to "promote the creation and use of innovative methods of instruction." According to the program's website, the goals are to focus on integrating technology into the curriculum; to enhance the rate and quality of student learning; to

⁹ For the full state-of-the-state speech, see http://gov.idaho.gov/mediacenter/speeches/sp_2007/sp_stateaddress.html

enhance faculty productivity; and to increase access to educational programs.¹⁰

The new Governor seems to be skeptical of state investments in research and development. Quoted in the Idaho Business Review, Governor Otter said that “some states making investments aren’t getting a return on investments.”¹¹ Council members seem to be disappointed. Jason Crawford, the founder of a Boise-based software company, said “if you don’t have support of the governor, it is challenging to initiate recommendations. The only way to measure our effectiveness is to give us the ability to try something.”¹² Karl Tueller, director of Idaho’s Office of Science and Technology, noted that Idaho’s Legislature and governor are more supportive of agriculture and rural interest, but he is also hopeful that the state is on the way to recognize the importance of technology-based economic development. Tueller suggested that research areas related to agriculture, bioscience and energy (such as alternative fuels) may provide a common platform for urban and rural interests.

Lessons / Observations

- Idaho is a state with a strong urban-rural divide. The state also experiences a shift from a resource-based to a knowledge-based economy.
- Large firms like Micron Technology and Hewlett-Packard have successfully shaped public policy (i.e. higher education, tax breaks etc.), but smaller firms like high-tech startup companies are interested in stronger state support for R&D.
- Idaho’s legislature and Governor have traditionally been more supportive of rural interests and traditional industries.

¹⁰ See <http://www.boardofed.idaho.gov/technology/tig/index.asp>

¹¹ Kovsky, E. (2007, January 22). Otter recommendations disappoint tech council. *Idaho Business Review*.

¹² Quoted in: Kovsky, E. (2007, January 22). Otter recommendations disappoint tech council. *Idaho Business Review*.

Resources for Idaho

Organizations

- Idaho EPSCoR program: <http://www.webs.uidaho.edu/epscor/>
 - 2002 Batelle evaluation of program:
<http://www.boardofed.idaho.gov/academics/documents/epscor.pdf>
- Higher Education Research Council:
<http://www.boardofed.idaho.gov/herc/index.asp>
 - Idaho Technology Incentive Grants:
<http://www.boardofed.idaho.gov/technology/tig/index.asp>
- Office of Science and Technology: <http://technology.idaho.gov/>
- Governor's Science and Technology Advisory Council:
<http://technology.idaho.gov/Overview/AdvisoryCouncil/tabid/586/Default.aspx>

Kansas

Kansas is aggressively trying to build its life science and biotechnology industry. In 2001, the legislature passed the University Research and Development Act, which authorized about \$130 million in bonds to finance various bioscience facilities at its universities. In 2004, Governor Sebelius signed into law the Kansas Economic Growth Act (KEGA). KEGA consists of the Kansas Entrepreneurship Initiative (\$3.5 million for 10 years) and the Kansas Bioscience Initiative (\$500 million for 10-12 years). The act also created the Kansas Bioscience Authority, which will oversee the implementation of the bioscience initiative. The financing of the bioscience initiative is unique: Kansas uses tax increments gained from the additional revenues generated from the growth of the employee base in bioscience companies and research institutions (Emerging Industry Investment Fund). So far, the fund has created about \$30 million in 2 years. In 2006, the legislature also appropriated \$5 million for the Kansas Cancer Center which will be housed at the University of Kansas Medical School (KUMC) in Kansas City.

Kansas Economic Growth Act (KEGA)

In April 2004, Governor Sebelius signed into law the Kansas Economic Growth Act. The Act includes two initiatives: The Kansas Entrepreneurship Initiative (\$3.5 million for 10 years) and the Kansas Bioscience Initiative (\$500 million for 10 to 12 years). The impetus for the Act was the establishment of the Stowers Institute for Medical Research in Kansas City in the late 1990s. With its endowment of about \$2 billion, the establishment of the institute galvanized the business, higher education and political communities in Kansas. In Kansas City, for example, the Kansas City Area Life Sciences Institute (KCLSI) formed as a stakeholder organization aimed at transforming Kansas City into a life sciences center. KCLSI's primary goal is to increase research expenditures at Kansas City research organizations. One of its tools is a research grant program and according to the institute's website, the organization "has issued over \$550,000 in grants since the inception of this program. The return on investment is 7:1. KCLSI expects to issue \$600,000 in research development grants in 2006 subject to the availability of funds."¹³

Statewide, business and political leaders realized that they also had to contribute to the growth of the state's bioscience community. The Kansas Economic Growth Act was championed by two legislators (Republican Senators Kenny Wilk and Nick Jordan). A pivotal role was played by the Kansas Technology Enterprise Corporation (KTEC), the state's technology-based economic development organization. In getting the legislation passed, it was argued that "to ensure Kansas creates

¹³ See: <http://www.kclifesciences.org/Default.aspx?tabid=403>

bioscience jobs, the state must do more than invest in bioscience research at our state universities, but must also set up a commercialization infrastructure to ensure important and potentially life-saving discoveries drive better food, health, well-being, and quality of life.”¹⁴

KEGA established the Kansas Bioscience Authority. The legislation required the authority to be headquartered in the county with the highest number of bioscience employees. Currently the Authority is located in Olathe, Kansas, which is part of Johnson County. The authority is governed by an eleven-member board, of which one member is an agricultural expert.

Funding for the Kansas Bioscience Authority comes from the Emerging Industry Investment Act. The act authorizes the use of tax increment revenues generated from the growth of the employee base in bioscience companies and research institutions. The base year is 2004 and estimates were based on a compound annual growth rate of about 8.45 percent. Lawmakers estimate the cumulative incremental revenue by 2015 to be \$593.1 million. According to Tom Thornton, President and CEO of the Kansas Bioscience Authority, tax increment revenues for 2005 and 2006 amounted to about \$30 million (this exceeded the initial projections which called for \$21.2 million during the same time period).

The Kansas Bioscience Authority uses the funding for the following programs:

- *Kansas Bioscience Research Matching Funds Program:* This program provides matching funds for research programs that attract federal, private or other sources of support. The program allows up to 50 percent match. According to the Director of the Authority, the program has not allocated any funds through this program.
- *Kansas Bioscience Research and Development Voucher Program:* This program provides incentives for bioscience companies or entrepreneurs to do business in Kansas by providing them with vouchers to undertake bioscience research and development activities with bioscience research institutions. It encourages collaboration between industry and academia. The program is very popular, well received and regarded. Companies receiving funds from this program have engaged in research activities with local universities.

¹⁴ See p. 4 in Kansas. (2004). *The Kansas Economic Growth Act: Economic Growth through Discovery, Innovation & Entrepreneurship*.

- *Bioscience Tax Investment Incentive Program*: According to the Authority's director, this program has not been used yet because the rules and regulations are still being prepared. The program allows direct payment to a bioscience company in the amount of 50% of its Kansas net operating loss, up to \$1 million annually. The authority has received inquiries from interested companies.
- *Bioscience Development Financing Program*: According to the Authority's website, this program "allows the Bioscience Authority to certify qualifications for and approve a local community's designation of an area of real estate as a Bioscience Development District which can then use future property tax proceeds to repay indebtedness that is incurred for the development. It encourages bioscience companies to expand and locate facilities in Kansas." The program is very popular and about \$14 million were spent on the development of facilities in Manhattan, Kansas City, Lawrence and Olathe.
- *Kansas Bioscience Scholar Program*: Legislation authorizes the Kansas Bioscience Authority to partner with universities to recruit an estimated 25 eminent scholars and 35 rising star scholars. The goal is to advance the state's research expertise in the biosciences. The program has not been implemented yet, but discussions are underway. Initial thoughts are to structure the program similar to Ohio's Wright Centers of Innovation. The intention is to focus on specific research areas such as animal health (Kansas State University), bio composites (Wichita), and human health (University of Kansas).
- *Bioscience Research Facilities Program*: This program is moderately used. It allows funding for the construction and maintenance of bioscience research facilities, which can be developed in collaboration with communities and universities. Currently, the Authority plans to connect this program with the Kansas Bioscience Scholar Program.

In addition to these programs, the Authority currently plays an important role in the recruitment of research institutions. In January 2007, Governor Sebelius formed a task force to lead the state's efforts in attracting the National Bio- and Agro-Defense Facility, a \$450 million, state-of-the-art national laboratory being commissioned by the Department of Homeland Security. Two sites in Kansas made the first cut (among 13 others) and the so-called Heartland BioAgro Consortium is hoping to attract this new facility.¹⁵ The Kansas Bioscience Authority

¹⁵ For more information about the facility, see http://www.dhs.gov/xres/labs/editorial_0762.shtm.

will spend \$250,000 on this recruitment effort. State leaders see this effort as key in the state's quest to gain more federal research funding. These efforts build on the newly created thrust to expand the state's animal health industry.

KTEC's Centers of Excellence

The Kansas Economic Growth Act is the landmark legislation in Kansas. However, it is not the only program aimed at supporting R&D investments. Since about the mid 1980s, KTEC supports Centers of Excellence at universities. According to KTEC, these university-based research centers "conduct innovative research and provide technical assistance with the overlapping aims of creating new companies, strengthening existing companies, and serving as expert resources to other KTEC programs."¹⁶

There are currently five centers, which are:

- **Advanced Manufacturing Institute:** The institute is affiliated with Kansas State University and helps companies in Kansas with their product and process development. It provides services such as product design and engineering, manufacturing process development, and technology development and commercialization.
- **Higuchi Biosciences Center:** This center was established in 1989 at the University of Kansas. The center aims to bridge basic research and commercial development. The center provides proof of concept grants.
- **Information and Telecommunication Technology Center:** This center is affiliated with the University of Kansas. The center's activities focus on computing, communications and sensors. The center is active in collaborative research with industry and technology transfer.
- **Kansas Polymer Research Center:** This center is located at Pittsburg State University and focuses on polymers and plastics. Its lab offers applied R&D services to interested companies and researchers.
- **National Institute for Aviation Research:** This center is located at Wichita State University. It provides applied research services to the aerospace industry, which has traditionally been strong in the area.

¹⁶ See: http://www.ktec.com/sec_research/section/centers.htm

KTEC also administers the state's EPSCoR program and the Strategic Technology and Research (STAR) Fund. The latter provides funding to researchers at Kansas Board of Regents' universities. The program's goal is to connect university researchers with industry and/or to leverage federal research funding. According to KTEC's 2004 annual report "KTEC invested \$2.2 million in Kansas EPSCoR and STAR Fund projects. Additionally, federal agencies provided \$12.4 million, a leverage of 5.6:1" in 2004. The program seems to work as one example shows: \$1 million in STAR funds went to the Center for Environmentally Beneficial Catalysis (CEBC), which then received a \$17 million award from the National Science Foundation Engineering Research Centers Program. The level of funding for these programs seems to be stable. In FY 2003, KTEC invested \$2.9 million in Kansas EPSCoR and STAR Fund projects (generating an additional \$16.0 million, a leverage of \$5.5:1).

Lessons / Observations:

- Kansas exhibits the classic evolution of state R&D investments. During the 1980s, the state invested in the creation of centers of excellence. In recent years, the focus has shifted towards a strategy to support biosciences.
- Kansas created a unique funding mechanism to finance R&D investments in biosciences. The state uses tax increment financing. However, some noted that the revenue projections might be too optimistic.
- While the Kansas Bioscience Authority is engaged in innovative projects such as the R&D Voucher Program, other programs that would support an open innovation model have yet to be developed.
- Recent efforts at the Kansas Bioscience Authority are more similar to traditional smokestack chasing. The Authority is helping the state to attract a major federal research laboratory.

Resources for Kansas:

Organizations

- Kansas Bioscience Authority: <http://www.kansasbioauthority.org/>
 - Kansas Bioscience Initiative Overview: http://www.ktec.com/sec_bioscience/section/KEGA/overview.htm
- Kansas Technology Corporation: http://www.ktec.com/index_Flash.htm
 - Centers of Excellence: http://www.ktec.com/sec_research/section/centers.htm
 - STAR Fund: http://www.ktec.com/sec_research/section/star.htm
- Kansas City Area Life Sciences Institute: <http://www.kclifesciences.org/>
- The Stowers Institute for Medical Research: <http://www.stowers-institute.org/>

Legislation

- Kansas Economic Growth Act (bill): <http://www.ktec.com/pdf/roadmap/KEGA.pdf>
- Emerging Industry Investment Act: [http://165.201.62.139/Pilots/Ntrntpil/IPILv1x0.NSF/0/62c796c8eef097df8625704d00492620/\\$FILE/2003r.pdf](http://165.201.62.139/Pilots/Ntrntpil/IPILv1x0.NSF/0/62c796c8eef097df8625704d00492620/$FILE/2003r.pdf)

Kentucky

Kentucky began to invest in higher education in 1997 when it passed the Postsecondary Education Improvement Act. This act established the *Research Challenge Trust Fund*. The fund is commonly known as “Bucks for Brains” program and provided the University of Kentucky and the University of Louisville matching funds for faculty positions. The program has been very successful in helping the universities attract researchers. State leaders, however, realize the program’s limitations and are currently considering proposing a new program that would provide state funding for the development of facilities. In 2000, the legislature passed the Kentucky Innovation Act (KIA). The act established several innovation and commercialization funds and several high-tech investments funds. The Act also established the Kentucky Science and Technology Foundation which manages the R&D Excellence Program, which is funded with about \$2 million a year.

Bucks for Brains Program

In 1997, the Kentucky legislature passed the Kentucky Postsecondary Education Improvement Act aimed at reforming the state’s higher education institutions. The legislation was driven by Governor Patton who recognized the importance of research and education to the state’s economic future. The major intentions of the Act were to elevate the research at Kentucky’s two major research universities, to reform the workforce development system (primarily the community colleges), and to set new goals for the state’s comprehensive universities.

The legislation also introduced the notion of a “public agenda” into the ways in which higher education is funded and policies are developed. Since then, the state’s Council on Postsecondary Education (CPE) holds higher education institutions accountable regarding their role in addressing the state’s pressing social and economic issues. The state’s performance is continuously reviewed using outcome measures focused on specific goals. In comparison to other states, Kentucky provides an outstanding example for transparency and accountability as the Council on Postsecondary Education regularly publishes a series of reports documenting the impacts of the reform. However, Council representatives acknowledge the difficulty of tracking the influence of the reform in general and the funds in particular.

The Postsecondary Education Improvement Act created the following six trust funds:

- Research Challenge Trust Fund (“Bucks for Brains”)
- Regional University Excellence Trust Fund
- Technology Initiative Trust Fund
- Physical Facilities Trust Fund

- Postsecondary Education Workforce Development Trust Fund
- Student Financial Aid and Advancement Trust Fund

Within the Research Challenge and Regional University Excellence Trust Funds resides the Endowment Match Program, which is commonly known as the “Bucks for Brains” Program. The program is administered by the Council on Postsecondary Education. It matches state dollars with private donations to fund faculty positions at the University of Kentucky (UK) and at the University of Louisville (UofL). 70 percent of the program funds must be used in five so-called new economy areas: human health and development, biosciences, materials science and advanced manufacturing, information technologies and communications, and environmental and energy technologies. These areas were determined by Kentucky’s Office of the New Economy, now Department of Commercialization and Innovation (DCI).

Participating universities must raise new gifts and pledges. They then submit a match request to the Council on Postsecondary Education. The minimum allowable request amount is \$50,000. Pledges must be paid within five years.

The legislature appropriated a total of \$350 million for the years between 1998 and 2004 of which \$300 million went to UK and UofL for the Bucks for Brains Program and \$50 million was allocated for the state’s six public comprehensive institutions. As of June 2006, about \$302.5 million were allocated to the universities. An additional \$282.2 million were received as cash gifts and \$28.5 million are outstanding in pledges (a total of about \$310.7 million). As a result the number of endowed chairs and professorships at the universities increased. From 1997 to 2006, the number of Chairs increased from 55 to 212. In the same time period, the number of professorships increased from 53 to 312. State leaders credit the program for the increase in federal R&D expenditures (190 percent from 1997 to 2005) and in extramural R&D expenditures (250 percent) at the state’s research universities. In addition, the endowment’s market value increased from \$453.5 million in 1997 to more than \$1.1 billion in 2005.

The first round of funding for the Bucks for Brains program was financed through appropriations from the General Fund. The final round of funding in the 2002-2004 biennium was financed through bonds. In 2003, the Council agreed to ask for less money (\$60 million) due to the state’s budget shortfall. In the end, Governor Fletcher did not allocate any money to the program. Even though the media noted that the state was not supportive of the program anymore, interviewees said that at the time the fund still contained unclaimed matching funds and that’s why funding renewal was not so important.

The state's higher education leaders think that the program has been "an enormous success," but they also recognize its limits. State dollars were invested almost exclusively to attract academic talent. A larger faculty at both universities however requires additional facilities. The program has traditionally not funded infrastructure investments and local leaders are considering revisions that would modify the program to not only fund "brains" but also "bricks."

The other funds have had similar good track records. The Regional University Excellence Trust Fund supported the development of so-called programs of distinctions. The program generated \$49.9 million in external funding in 2003. The Workforce Development Trust Funds supports the Kentucky Workforce Investment System, which provides education and services to Kentucky industries. Representatives from the Council on Postsecondary Education note that the workforce development aspects of the education reform were among the most successful changes.

Kentucky Innovation Act

The Kentucky education reform was followed by the Kentucky Innovation Act (KIA) in 2000.¹⁷ The act is the result of the Science and Technology Strategy designed by the Kentucky Science and Technology Corporation (KSTC) in 1999. The Act calls for Kentucky to make a \$53 million investment in technology-based economic development. It is important to note that Kentucky is the only state that offers Phase 0, 00, as well as Phase I and II SBIR/STTR awards.

Through a contract with CPE, KSTC manages the Kentucky Enterprise Fund, which consists of a series of pre-see and seed stage capital funds that focus on commercialization. The funds include the ICC Concept Pool Fund, the Rural Innovation Fund, R&D Voucher Fund, and Gap fund. Kentucky is also home to a series of so-called Innovation and Commercialization Centers (ICCs). These centers support the growth of knowledge-driven companies in all parts of the state. They are administered by KSTC under a contract with DCI.

KIA also established the *R&D Excellence Program* which is managed by the Kentucky Science and Engineering Foundation. The foundation is managed by KSTC. Its goal of the R&D Excellence Program is to "invest in research and development activity to promote innovation and build a pipeline of new ideas and technologies that could add value to the scientific and economic growth in the Commonwealth."

¹⁷ See: <http://www.lrc.ky.gov/research/00rs/HB572/bill.doc>

The R&D Excellence Program makes investments in research that either involves emerging ideas or emerging technologies. Emerging ideas projects represent untested, highly risky research. Emerging technology awards fund research that is close to developing products. University faculty and emerging technology companies can apply to the program. Grants can last up to two years. Applicants, however, can only apply once to the fund. It is expected that after they received funding once, they would be in a better position to leverage federal funding for research or funding for commercialization from programs such as SBIR or STTR.

The program is funded at about \$2 million a year. Emerging ideas applications can range from \$15,000 to \$50,000 a year for up to two years. Emerging technology applications are similarly funded and awards range from \$20,000 to \$50,000.

The program was developed in 2001 and the first awards were made in 2002. During the five year period from 2002 to 2006, the program invested about \$9.5 million. According to the program's manager, the return on investment is about \$8 for each \$1 invested in state funds. Overall, awards have leveraged about \$770 million.

The program tracks the economic impact of its funding and collects data on measures such as the number of inventions and disclosures, publications, presentations, collaborations inside and outside the university, patent activities, etc.

Since the program started in 2002, it has created about five new businesses. Two startups are currently under consideration. Awardees have engaged in more than 80 intellectual property activities. The program manager noted that the most promising areas and successful awards originated from areas of strength and expertise at Kentucky universities (including plant biology, coal-related technologies, human health).

The program is very popular among Kentucky's researchers. In December 2006 it received more than 140 applications, which represents twice as many compared to the start of the program. Applications are sent out for peer review. After they are peer reviewed, proposals are scored on their scientific merit and economic development potential. The Foundation's Advisory Board will then make the final decision.

The program strictly avoids funding for basic research, equipment, and facilities. Research focus areas were established by the state and investments are made in the fields of biosciences, environmental and energy technologies, human health and development, materials science and advanced manufacturing.

Lessons / Observations:

- Kentucky's Bucks for Brains program shows the limitations of a supply side, human resource strategy: The state has successfully attracted faculty, but is now facing a shortage of facilities.
- The Kentucky Innovation Act established a host of programs in support of technology transfer, commercialization, business development, etc. The act created the R&D Excellence Program which supports innovative research efforts. While the program seems to be successful in supporting research at local universities, it does not strategically focus on creating university-industry partnerships.

Resources for Kentucky

- Council on Postsecondary Education: <http://cpe.ky.gov/>
 - Council's accountability reports:
<http://cpe.ky.gov/planning/statusreports/>
- Kentucky Science and Engineering Foundation:
<http://ksef.kstc.com/index.cfm>
- Kentucky Science and Technology Corporation:
<http://ksef.kstc.com/index.cfm>
- Kentucky Enterprise Fund: <http://www.startupkentucky.com/?33>

Legislation

- Kentucky Postsecondary Education Act (1997, HB 1)
<http://www.lrc.ky.gov/recarch/97ss/HB1/bill.doc>
- Kentucky Innovation Act (2000):
<http://www.lrc.ky.gov/recarch/00rs/HB572/bill.doc>

Maryland

Maryland is well known for its significant biotechnology research and industry presence. The state hosts a number of federal agencies such as the National Institutes of Health (NIH), Food and Drug Administration (FDA). The region's largest bioscience companies cluster along Interstate 270 in the Washington D.C. region and include well known names such as MedImmune, Advancis Pharmaceutical, and Celera Genomics. The state's premier research institution, the Johns Hopkins University, consistently ranks among the largest NIH recipients.

Maryland serves as an example of a state that has a well defined and diverse technology-based economic development portfolio. Programs range from the support of basic and translational research in life sciences to technology transfer and commercialization. Unique about the state is the mix of programs provided by various levels of government and institutions, including the state, universities, and counties. The state's public-private technology support organization is called the Maryland Technology Development Corporation (TEDCO). TEDCO serves as a good example of an agency that makes investments in technology firms, R&D projects, technology transfer and commercialization. The organization was funded with about \$4.8 million in 2006.

Since the early 1980s, state and local governments have supported the growth of the biotechnology industry. In 1982, Governor Harry Hughes (who is now a strong supporter of the state's stem cell research program) established an ad hoc committee on high-technology. As a response to the Governor's committee, the University of Maryland Task Force Report on High Technology/Biotechnology recommended the establishment of the University of Maryland Biotechnology Institute which was officially established in 1985 by the Maryland General Assembly. Today, the institute consists of five centers and operates on a \$15 million budget. The institutes function as a state-wide system of technology-specific R&D centers that work on collaborative commercial oriented projects. In addition, since 1987, the University of Maryland operates an innovative program aimed at connecting industry and university. This program is called the *Maryland Industrial Partnerships* (MIPS), which is funded by the state with about \$1.35 million annually. Since 2001, TEDCO operates a program – the so-called University Technology Development Fund (UTDF) – that aims at closing the gap between basic research and commercial application.

Recently, Maryland joined the ranks of states supporting stem cell research. The state's Stem Cell Research Act passed in 2006 after a failed attempt the year earlier. The bill specified a one-time appropriation of \$15 million. Maryland stands out for its strategic focus on

translational research in this area. The program is organized and managed by TEDCO, which in January 2007 received 85 applications with a total request for more than \$80 million. There seems to be continued commitment to stem cell research funding: The new Governor of Maryland, O'Malley, proposed an additional \$25 million in his FY 2008 budget.

Maryland Industrial Partnerships (MIPS)

In 1987, the Maryland Technology Enterprise Institute at the University of Maryland began to offer the *Maryland Industrial Partnerships (MIPS) Program*. The program promotes product and process development and commercialization through university/industry partnerships. MIPS provides matching grants to companies interested in working with university researchers. Large firms and small firms can receive up to \$100,000 per year and startups can receive \$70,000 a year. The minimum is \$5,000 per year. Unique about the program is that projects are initiated by companies. Research projects must be in areas such as engineering, computer science, physical sciences and life sciences, but awards can also be made for industrial training programs.

In 2006, Maryland's legislature recognized the benefits of the program and increased MIPS funding by \$1 million. The increase almost doubled the program's \$1.35 million operating budget. According to the program, "MIPS supports an average of 32 projects yearly; the increase will enable up to 22 additional projects a year."¹⁸

MIPS has been instrumental in supporting research at high-tech and life science companies that yields commercially successful products. MIPS helped fund several research projects at MedImmune, including some related to the company's drug Synagis which accounted for \$6.1 billion in sales since 1998. On its website, the program notes: MIPS "helped in [the] structural testing of Synagis lots," said MedImmune scientist Dr. John Hope in a post-project report. "The process for which the MIPS grant assisted in development of is still being used at MedImmune for testing Synagis and related glycoproteins."¹⁹

MIPS funding boasts a high leverage. From 1987 to 2006, MIPS invested \$27,802,672 and leveraged more than \$1.1 billion in company funds. According to the program, this represents a 5.2:1 match. Its economic impact in terms of sales and revenues for the top four companies / products MIPS-related research has contributed to accounts for \$12.1 billion.

¹⁸ See: <http://www.mtech.umd.edu/news/reports/impact/2006/index.html>

¹⁹ For MIPS success stories, see: http://www.mips.umd.edu/success_stories.html.

MIPS seems to be a popular program among industry representatives in Maryland. In a 2006 newspaper report, the CEO of a small company said that “MIPS is a tremendous opportunity for startups. It is not so much the money, but you get to work with the best and brightest.”²⁰

University Technology Development Fund (UTDF)

In contrast to MIPS, TEDCO’s University Technology Development Fund is a new program aimed at supporting pre-commercial research of university intellectual property. It was started in 2001 to fill the gap between basic research and commercially viable concepts. If a researcher is interested in commercializing his or her research, the program will provide up to \$50,000 in support. Funds can also be used to defray patent expenses (up to \$5,000). Researchers have to apply for funding in cooperation with their respective university technology license office. Since its start, the program has funded 60 projects from which 15 have licensed their work to private firms.

The program incorporates a unique revenue sharing mechanism. Universities receiving UTDF funds have to share 25 percent of the revenues created from the intellectual property until it has repaid twice the amount of the funding awarded (up to \$100,000).

Maryland’s Stem Cell Research Program

Maryland’s Stem Cell Research Program differs in important ways from Connecticut’s program. In contrast to Connecticut, Maryland’s program emphasizes the importance of translational research. In doing so, Maryland provides funding to researchers who may come from different disciplines or who are emerging as scholars. Linda Powers, Chair of Maryland’s Stem Cell Commission, noted that the goal of the Commission was not to replicate federal programs such as those at NIH, but to encourage discoveries and innovations that may lie outside of a specific field and that may not stand a chance of obtaining federal funding.

Legislation in Maryland is also more explicit than its counterpart in Connecticut about the program’s economic development goals. In particular, the program seeks to:

- retain and attract scientists in the field,
- built upon existing research strengths,
- develop and accelerate new development for patient health, and
- capture economic development benefits from the nascent industry development around stem cell research.

²⁰ Berberich, S. (2006). University, companies tackle new products. Retrieved February 22, 2007, from http://www.gazette.net/stories/082506/businew180655_31976.shtml

Like Connecticut, proponents of stem cell research became active after the landmark decision in California. Linda Powers, chair of Maryland's Stem Cell Commission, said that "California's proposition was a galvanizing event." In addition, proponents recognized Maryland's existing research strengths in stem cell research at Johns Hopkins University and the National Institutes of Health and wanted to build on and support these strengths.

Legislative history

Like in Connecticut, the legislation passed in the second attempt in 2006. The bill was driven by patient advocates that were organized in a group called Maryland Families of Stem Cell Research. Neither the Governor nor the biotechnology industry community was involved in the beginning. They joined the effort during the second attempt to pass the bill. In 2006, the bill passed with overwhelming support after legislatures compromised on the level of funding of \$15 million.

Funding

Maryland's Stem Cell Research Program is funded with \$15 million. Governor O'Malley followed through with his election promise and budgeted another \$25 million in his FY 2008 budget. According to interviewees, the Stem Cell Research Commission engaged in a contentious discussion whether the awards they would make would total \$15 million or whether they would make financial promises in excess of the \$15 million in the hope that additional funding in subsequent years would become available. In the end, the Commission voted on limiting the total amount that would be given out to \$15 million. Important to this decision was the thought that researchers depended on a reliable source of funding.

Administration

The Stem Cell Research Commission is assigned to govern the fund and exists within TEDCO. It is a 15-member commission with representatives from academia, hospitals, patient advocacy groups, and industry. Linda Powers, co-founder and Managing Director at Toucan Capital, chairs the Commission. The Commission establishes an independent peer review committee to review the grant applications. TEDCO provides staff and grant administration support.

Grant Applications

In November 2006, two requests for applications were issued. One RFA was issued for established investigators and the other for exploratory research. In particular, the two categories were:

- Investigator-Initiated Research Grants for Basic and Translational Stem Cell Research in Support of Medical Therapies
 - o Designed for investigators with preliminary data
 - o Goal: broaden and advance basic knowledge that will be relevant for eventual development of clinical applications
 - o \$500,000 per year for up to three years
 - o Application must include explanation of translation potential (relevance of work to clinical applications); also applications must focus on impact on the biotechnology industry in Maryland

- Exploratory Research Grants for Basic and Translational Stem Cell Research in Support of Medical Therapies
 - o Designed for investigators who are new to the field (either researchers who are young or from outside stem cell research) and for new hypotheses, approaches, mechanisms or models that may differ from current thinking in the stem cell field, and without any preliminary data
 - o Goal: broaden and advance basic knowledge that will be relevant for eventual development of clinical applications, and to enable, support and accelerate clinical applications, attract and support researchers who are new to the field and proposal that lack preliminary data or are outside of prevailing views
 - o \$100,000 per year for up to two years

TEDCO received 91 letters of intent after it issued the request for applications. In January 2007, it received 85 applications seeking a total of \$80 million. 44 of the 85 applications applied for the Exploratory Research Grants, an “indication that we succeeded with our intention to focus on innovative approaches and filling a niche in funding,” said Linda Powers.

The review of the applications is currently under way. Those reviews will not only focus on the applications’ scientific merit, but will pay special attention the potential for translational research. Reviewers will focus on the potential impact of the research on the advancement of biotechnology in Maryland, on the extent to which collaborations are evident between basic and preclinical components and plans are in place

for the transfer of potential findings from basic research to preclinical studies.

Contributions

It is too early to tell what the contributions of the program are.

Challenges

Like Connecticut, Maryland faces the challenge of developing a program from scratch. In addition, TEDCO faces a short time frame for issuing the request for applications, conducting the peer reviews and selecting proposals. The Stem Cell Commission strives to make awards before the legislative session is over which will be on April 9, 2007.

Lessons / Observations

- Maryland's Stem Cell Research Program focuses on translational research and there is a greater awareness about the unique role state government can play in funding research and development. It was recognized that the state needs to be a complementary role rather than duplicate federal efforts.
- Unlike in Connecticut, Maryland's bill is more explicitly focused on the economic development benefits of the stem cell research program. According to interviewees, the Stem Cell Commission paid attention to the bill's economic development intent when they request for applications was developed.
- Maryland's MIPS program allows industry to apply and initiate R&D partnerships with universities.

Resources

- Maryland Families for Stem Cell Research:
<http://www.marylandcures.org/default.asp>
- TEDCO: <http://www.marylandtedco.org/index.cfm>
- University Technology Development Fund:
<http://www.marylandtedco.org/tedcoprograms/utdf.cfm>
- MIPS: <http://www.mips.umd.edu/>
- Stem Cell Research Program:
<http://www.marylandtedco.org/MSCRFPage.cfm>
- Maryland Stem Cell Research Act of 2006:
<http://mlis.state.md.us/2006rs/bills/sb/sb0144t.pdf>

Massachusetts

Massachusetts stands out for its excellent research infrastructure. The state is home to a variety of public and private research universities that have successfully attracted federal research and development funding. For the first time, however, in 2003, the state began to offer matching funds for federally funded research. The change in attitude is a result of an increased awareness of the importance of federal research support and the threat of losing out to other states.

In the early 1990s, state leaders recognized the importance of a proactive strategy to increase the state's competitiveness and innovation potential and to leverage existing research strengths. These considerations took place at a time of federal budget constraints. A 1996 report entitled *Planning for Change, Preparing for Growth* highlighted the implications fewer federal dollars would have for the state's economy. As a result of this report and others the Massachusetts Technology Collaborative published, business and higher education leaders in the state recognized the need for strategic investments in the university infrastructure.²¹

In December 2003, the legislature passed the Economic Stimulus Bill designed to make strategic investments in the state's innovation economy. A total of \$82.4 million were appropriated to a diverse range of economic development projects. Of the total, \$35 million were approved for the so-called *Regional Fund* and for the *Research Center Matching Fund*. Both funds are administered by MTC's newly created John Adams Innovation Institute whose goal is to support academic research centers and the growth of technology and industry clusters. The Regional Fund supports technology-based economic development projects across the state. Grants include funding for cluster-based economic development initiatives and infrastructure projects. The more interesting fund for this research, however, is the Research Center Matching Fund. This fund "supports efforts to enable university-based research centers to develop and transfer technology to industry in the Commonwealth."

The Research Center Matching Fund is an example of a state R&D investment effort aimed at leveraging federal funding and connecting research with industry. The Economic Stimulus Bill noted the importance of industry involvement. It also recognized the uneven

²¹ The Massachusetts Technology Collaborative is the state's technology-based economic development agency. Its predecessor, the Massachusetts Technology Park Corporation, was established during the severe economic recession of the early 1980s. The Corporation began as a public private partnership that initially supported the microelectronics industry, but later evolved into the state's economic development agency for the innovation economy.

distribution of economic assets in the state and stipulated the location of one of the first funded centers in parts of the state that are less successful economically.²²

In addition investing in research and development, the state is playing the match making role for industry and academia. In early 2006, Massachusetts' economic development department launched the *Massachusetts Business Connect Program*. The program engages in needs assessments and resource identification at companies regarding their R&D needs and connects firms with academic institutions. The program originated during talks with Procter & Gamble when the firm expanded in the state. In the case of Procter & Gamble the efforts resulted in partnerships with other Massachusetts-based companies and research institutions. In addition to these efforts, MTC is planning to organize a joint academic research council that will provide a platform for discussions among the key vice presidents of research at the various research institutions in Massachusetts.

Research Center Matching Fund

The goal of the Research Center Matching Fund is to increase the competitive position of applications for federal funding and to induce industry investments. The request for proposals guidelines are very specific as to what kind of proposals are funded. Specifically, the funds are available to university researchers interested in applying to NSF programs that support collaborative research between academic institutions and industry partners. Eligible federal funds include programs at NSF such as Partnerships for Innovation Program, Industry-University Research Center Program, Engineering Research Center Program, Nanoscale Science and Engineering Center Program, Science and Technology Center Program and other similar programs at the NIH. Pat Larkin, Director of the John Adams Innovation Institute, noted that even though these programs do not contain the lion's share of available federal funding, matching funds from the state will make a bigger difference for the competitiveness of the proposals.

Massachusetts has been very strategic with the establishment of the fund. Shortly after, the legislation passed, leaders at the John Adams Innovation Institute developed a business plan. Among the states examined in this report, the institute's business plan stands out for its strategic intention. The plan spells out the competitive environment for federal R&D funding. It is noted that "federal agencies such as the National Science Foundation are increasingly awarding funds to research centers rather than directly to principal investigators. These large, multi-year grants

²² MassINC and the Brookings Institution just published a report on 10 cities in Massachusetts that have not shared in the state's economic success. See: <http://www.brookings.edu/metro/pubs/massgateways.pdf>

often have a cost-sharing requirement that obligates grant recipients to contribute 10 to 20 percent of the total cost of the operations of the center. Cost sharing is an issue of eligibility, rather than an evaluation criterion used in selecting particular research centers for awards. Therefore, efforts to increase the competitiveness of research centers in Massachusetts hinges on an ability to strengthen the capabilities of centers in ways that address the objectives of funding agencies, including the commercialization of research. It is not simply a matter of providing more money.”²³

Funding

A total of \$20 million was appropriated under the 2003 Economic Stimulus Package for the Research Center Matching Fund. An additional \$10 million was guaranteed under the 2006 Economic Stimulus Bill. As of December 2006, the program approved grants for 17 projects, 10 of which obtained required federal funds and the amount of funds matched or leveraged is \$12.4 million. According to interviewees, the expected leverage is \$35 million in federal and industry funding. Total expenditures from the fund so far amount to more than \$18.2 million in approved grants.²⁴

The legislation was very specific about the geographic location and some of the operating guidelines of the Centers. For example, it noted that Centers receiving funds must demonstrate collaborations with other higher education institutions and with one or more industries and nonprofit partners. It also noted that “one of the first 2 Centers shall be located in southwestern Massachusetts, and the other shall be located in northeastern Massachusetts.”²⁵ In addition, the legislation stipulates that Centers have to match state funding in the first year with at least \$1 from federal or private funding sources. The match requirement increases in subsequent years to at least \$2.

Type of Grants

Funding is available for three types of applications:

- Centers for Excellence Grants
- Research Center Matching Grants
- Research Center Development Grants

²³ See: John Adams Innovation Institute. (2004). Supporting Growth in the Commonwealth's Innovation Economy. Business Plan of the John Adams Innovation Institute [Electronic Version]. Retrieved February 28 from http://www.masstech.org/institute/Business%20Plan%20ExecCom_9.23.04.pdf.

²⁴ For a current accounting of the Fund, see http://www.masseconomy.org/html/2_3_7p_research.html

²⁵ See p. 43 in John Adams Innovation Institute's business plan.

It is instructive to note here the guidelines established for each grant program in the Institute's business plan.

Centers of Excellence:

Massachusetts' legislation mandates the establishment of Centers of Excellence focusing on medical devices, biotechnology and nanotechnology. The Institute's business plan specifies the legislation's requirements as follows:

- Centers must demonstrate strong interest by Massachusetts-based companies. They must also address market opportunities and contribute to the state's economic development priorities.
- They must demonstrate excellence in scientific and/or engineering sciences.
- They must integrate research, technical assistance, and educational programs. These functions must meet industry needs.
- They must have a commercialization program.
- They must be led by universities and include collaborations with other higher education institutions.
- Partners must demonstrate commitment through financial and other institutional buy-in.
- They must have an industry-led advisory board.
- They must have a full-time staff.
- Their operating budget should exceed \$2 million a year indicating a critical mass of activity.
- They must meet the legislation's match requirement.

Research Center Matching Grants:

This program provides funding to universities interesting in establishing research centers that will secure funding from federal agencies. The Institute's business plans specifies the following guidelines:

- Recipients must demonstrate how they meet industry needs and how they transfer scientific knowledge and innovations to companies in Massachusetts.
- Matching funds will only be given to institutions that are competing for certain federal awards (center grants).
- Partners must commit through cost-sharing.
- Collaborations among multiple higher education institutions and non-profits is strongly encouraged because it strengthens the prospect of obtaining federal funding.
- Funding should go towards technology-related activities and will not be used for facilities, equipments and capital expenditures.

Research Center Development Grants are available to institutions who are interested in planning and establishing a new research center. Funds can be used to establish partnerships with industry and other institutions. There is a dollar-for-dollar cash match requirement.

Funded Projects

So far, the Research Center Matching Fund provided financial support to the following projects:

- Center for High-Rate Nanomanufacturing at UMass Lowell

This Center is the only institution in northeastern Massachusetts that meets the legislation's geographic criteria. This center received \$ 5 million from the Research Center Matching fund and leveraged the investment with \$12.4 million in federal funding from NSF for the establishment of a Nanotechnology Science and Engineering Center. The center also received a \$10,000 grant earlier for the development of a business plan. It is interesting to note that the effort is part of a industry consortium that crosses state boundaries because UMass is part of the consortium which also includes Northeastern University and the University of New Hampshire. The center encourages industry-university collaborations.

Center's website: <http://www.uml.edu/research/chn/index.htm>

- Center for Hierarchical Manufacturing at UMass Amherst

This center received a \$2 million award, which leveraged a \$16 million award from NSF for the establishment of the nation's sole Nanoscale Science and Engineering Center. Jack Wilson, President of the University of Massachusetts noted that "Of critical importance to the success of the proposal was \$2 million in state matching funds provided by the John Adams Innovation Institute." The center includes key industry partners such as Lucent Technologies, IBM, Seagate Technologies, Novellus Systems, and TIAX LLC, who will provide support regarding state-of-the-art facilities, collaborate on research, and provide technology and commercialization assessment. Industry and academic partners come from across the nation and from other countries, thereby creating a global network of innovation partners. The Center has adopted a novel approach to university-industry partnerships by providing a test bed for the innovative application of nanotechnology. According to Larkin, the Center is contributing to a cultural change at the university regarding the engagement of industry partners.

Center's website: <http://www.umass.edu/chm/>

- Massachusetts Center of Excellence in Apoptosis Research at the Pioneer Valley Life Sciences Institute

The third award was made to the Pioneer Valley Life Sciences Institute, which is a partnership between UMass Amherst and the Baystate Medical Center in Springfield. Since 2002, the institute is engaged in translational research in the field of apoptosis, the study of cell death, which is critical in understanding diseases such as cancer, cardiovascular diseases, etc.

For more information on the institute: <http://www.pvlsi.org/>

- Other recipients include:
 - o NSF Engineering Research Center for Sustainable Product Design at Northeastern University: \$663,000
 - o Natick Army Soldier Systems Center Procurement and Innovation Center of Excellence: \$40,000 development and assessment grant
 - o MIT Center for Biomedical Innovation: \$150,000 development grant
 - o Northeastern University Capture Center for Industrial Innovation: \$150,000 development grant
 - o NSF Partnership for Innovation at Tufts University: \$120,000 grant to develop process model for educating women and under-represented groups in science and technology entrepreneurship

Lessons / Observations

According to Pat Larkin Massachusetts is in the “exploitation phase” of leveraging research and development investments. The Research Center Matching Funds have made a difference in establishing research centers that focus on applied research and engage industry. In addition, the Institute plans to use funding to help reorient existing centers for the “life after NSF funding,” according to Larkin.

The Research Center Matching Fund program was developed out of a long history of experience with federal funding programs at MTC. The ideas were developed in collaboration with university-based center directors and MTC’s Board of Directors. Massachusetts’ efforts stand out for their strategic orientation. In particular, legislation and funding guidelines require universities to engage in partnerships with other institutions and with industry. As the guidelines note these partnerships have to be substantiated by financial and other institutional commitments. Also, state leaders strategically provide matching funds to meet federal cost sharing requirements.

Resources

Organizations

- Massachusetts Technology Collaborative:
<http://www.mtpc.org/>
- John Adams Innovation Institute:
<http://www.mtpc.org/institute/index.htm>
 - JAI's business plan:
http://www.masstech.org/institute/Business%20Plan%20ExecCom_9.23.04.pdf
- Massachusetts Business Connect:
<http://www.mass.gov/?pageID=eoedsubtopic&L=4&L0=Home&L1=Expanding+or+Locating+in+Massachusetts&L2=State+Agencies&L3=Massachusetts+Business+Connect&sid=Eoed>
- MassEconomy.org:
<http://www.masseconomy.org/>

Legislation

- Economic Stimulus Bills:
 - Bill of 2006:
http://www.masseconomy.org/pdfs/chapter_123_of_the_acts_of_2006.pdf
 - Bill of 2003:
http://www.masseconomy.org/pdfs/chapter_141_of_the_acts_of_2003.pdf

Missouri

The case study of Missouri is interesting because it provides an example of how state R&D investments funds suffer from budget cuts and from politics.

Missouri began to make strategic investments in higher education in the mid 1980s. In 1985, state leaders created the *Food for the 21st Century Program*. It was designed to attract scholars and to stimulate research in nutritional sciences at the University of Missouri. The success of the program led to the creation of the *Missouri State-Matched Endowed Chair and Professorship Program* in 1995. This program still exists, but there is no current funding available. In 2003, HB 688 created the Life Sciences Research Board and the *Missouri Life Science Research Trust Fund*. The fund was to allocate 25 percent of the Tobacco Settlement Money in the state. Funding, however, was diverted to finance a Medicaid program. In 2006, Governor Blunt announced the Lewis and Clark Discovery Initiative (LCDI) to invest in higher education facilities in the state. The initiative would be financed through the capitalization of a portion of the Missouri Higher Education Lending Authority's (MOHELA) assets. While budget constraints played a big role in diverting funding from the Life Science Trust Fund in 2003, political quarrels primarily related to the stem cell ballot initiative in 2006 are complicating the efforts in Missouri.

Missouri State-Endowed Chair and Professor Program

The Missouri State-Endowed Chair and Professor program was started in 1995 after its precursor program, Food for the 21st Century, turned out to be a great success. Food for the 21st Century was very effective in attracting eminent scholars such as University of Missouri researcher Dr. Michael Roberts, who later became a member of the National Academy of Sciences.

Initially universities had to provide a one-to-one match of about \$550,000 to obtain state funding from the state-endowed chair and professor program. Around 2003, the match was increased to \$1 million. The program created about 121 endowed chair and professorships in Missouri. According to John Gardner, University of Missouri Vice President for Research and Economic Development, the program was very successful in attracting entrepreneurial scientists. These scientists, according to Gardner, attracted research funding that was significantly above the average of other similarly ranked faculty.

The program was popular among universities in Missouri: When matching funds were available, state funds were quickly claimed. There is no current funding available.

Life Science Research Trust Fund

The Life Science Research Trust Fund was created in 2003 through HB 688, which was signed into law by Governor Holden. The legislation also created the Life Sciences Research Board. The goal of the bill was to use 25 percent of the state's yearly proceeds from tobacco settlement beginning in 2007 to:

- enhance research capacity in life sciences,
- promote Missouri as a center of life science research and development by building on the success of existing research institutions,
- create and attract research and development institutions, and
- to transform research into commercial life science technology.

The Life Science Research Board conducted peer reviews of about 17 proposals from universities across the state. Some noted that the process was highly collaborative. The fund was intended to build capacity at universities equally across the state so that researchers would be able to leverage federal awards.

When the Board was ready to make awards, the state was in a fiscal crisis. A unique clause in the legislation allowed the General Assembly to divert the tobacco money from the fund to put it toward the state budget. Legislators took advantage of this option and diverted funding to the Missouri Medicaid Pharmacy Administration program.

While initially life sciences in the state were not funded because of budgetary problems, later on the discussions about the fund became politicized. When the General Assembly decided to divert the money because of the state's financial problems, the chairman of the House appropriations committee, Rep. Jim Lembke, recommended that the fund be eliminated because of concerns that it could be used to fund embryonic stem cell research. As a result, Governor Blunt moved the fund per executive order to the Department of Economic Development, whose budget does not go to Lembke's committee.

The Life Science Research Trust Fund still exists and about \$35.7 million would currently be available. In early 2007, Governor Blunt recommended to use the fund for supporting life science research in plant and animal sciences. This represents a de facto gentlemen's agreement to not use the funding for life sciences research, which may provoke opposition from stem cell opponents.

Lewis & Clark Discovery Initiative (MOHELA Sale)

In addition to the controversies around the Life Science Trust Fund, Missouri is currently facing a controversial debate about Governor Blunt's Lewis and Clark Discovery Initiative. In early 2006, Governor

Blunt announced plans to transform the Missouri Higher Education Loan Authority (MOHELA) from a state agency into a public-private partnership. The transformation would yield one-time cash proceeds from the capitalization of a portion of student loans and assets. It is expected that this sale would provide a one-time infusion of about \$350 million for capital improvement projects at the state's higher education institutions.

The sale is seen as necessary because only Kansas City and Columbia have seen significant capital improvement projects at their higher education institutions. The sale would finance about 24 projects such as the renovations of classrooms and labs, additions and expansions, and equipment replacement. The projects' total costs are \$593.5 million. The largest projects include \$150 million for a Health Sciences Research and Education Center and \$15 million for a Plant Science Research Center. Both projects are at the University of Missouri in Columbia.

In addition to capital improvement, the project will fund \$15 million to the Missouri Technology Investment Fund, which will be utilized by the Missouri Technology Corporation (MTC, formerly known as Research Alliance of Missouri). Robert Monsees, Director of MTC, expects to use the funds for technology commercialization (i.e. he envisions SBIR and STTR funds), the improvement of technology at universities, and assisting universities in identifying and patenting commercial technology.

The initial proposal also included funding for the Missouri Opportunity Scholarship Fund (\$100 million) and for the Missouri Endowed Professorship Initiative (\$20 million). However, these were dropped during the negotiations.

The sale is currently debated in the Senate and the bill has been altered substantially. The Republican-led Senate Education Committee removed six university buildings that would receive funding from the MOHELA sale (including a business incubator and the Health Sciences Center at MU). The committee also added language barring funding for other buildings if they are to be used for stem cell research. Later on, Sen. Gary Nodler, R-Joplin, presented the Senate with a revised version of the bill that included all projects. However, his proposal was packaged so that if any part of the bill is challenged, the whole bill would fail. In addition to the controversies surrounding the bill, one of the third-party consulting firms advising the Governor on the sale noted concerns about the financial viability of the sale. Following this announcement, one of the major proponents of the bill (Democrat Jeff Harris) withdrew his support.

Many Democratic Party representatives in the state are against the sale of MOHELA assets. They argue that they would rather see the money go towards lowering interest rates on student loans. SB 362, introduced by Democrats, would modify the use of MOHELA proceeds. The MOHELA sale is also facing strong opposition from Missouri Right to Life and the Missouri Catholic Conference. Both organizations fear that capital improvement projects at Missouri universities would enable researchers to conduct embryonic stem cell research.

Lessons / Observations:

- The case of Missouri illustrates how state investments in R&D are not only stifled by budget problems, but also by politics. In particular, opposition to stem cell research seems to paralyze all efforts in the state to invest in higher education.

Resources for Missouri:

- Food for the 21st Century Program:
<http://web.missouri.edu/~umchesnweb/f21c.htm>
- MOHELA: <https://www.mohela.org/Default.aspx>
- Lewis and Clark Discovery Initiative:
 - FAQ:
[http://www.umsystem.edu/ums/departments/gr/newsletter/060127/01-27-06FactSheet1-23-06\(3\).pdf](http://www.umsystem.edu/ums/departments/gr/newsletter/060127/01-27-06FactSheet1-23-06(3).pdf)
 - Economic Impact Analysis:
<http://www.umsystem.edu/ums/departments/gr/reports/LC/DI-state-jan06.pdf>
- Missouri Technology Corporation:
<http://www.missouritechnology.org/>
- Research Alliance of Missouri:
<http://www.missouritechnology.org/ram/>

Tennessee

In the mid 1980s, Tennessee began to reform its higher education system. The state created several programs designed to build the research strengths of universities in the Tennessee Board of Regents and the University of Tennessee systems. The *Chairs of Excellence* program was part of the reform and its goal was to bring eminent scholars to Tennessee's universities. The program focused on capacity building at individual universities. Twenty years later in 2004, the University of Tennessee system and Oak Ridge National Laboratory (ORNL) proposed a new program, the so-called *Governor's Chair (GC) Program*. This program combines state funds with those from ORNL to attract star scientists to Tennessee who will have joint appointments as tenured professors at UT and distinguished research staff at ORNL. The program builds on the earlier Chairs of Excellence Program, but extends it to include a collaborative effort between the state's strongest research institutions. In addition, Tennessee is investing in UT-ORNL partnerships through funding of several joint institutes. While these investments primarily benefit the eastern part of Tennessee, the state has also made significant investments in the west, primarily in Memphis. For example, the Memphis Bioworks Foundation, a public-private partnership that was formed in 2001 to establish the region as a biotechnology center, received \$15 million in state funding.

Chairs of Excellence Program

Tennessee started to invest in scholarly talent and research in the mid 1980s. In 1981, the state engaged in a comprehensive study of its education system. The Tennessee Comprehensive Education Study (TCES) led to the Comprehensive Education Reform Act (CERA) of 1984. This Act initiated a significant reform of the K-12 and postsecondary education systems. Part of the legislation was funding (\$10 million) for the so-called Centers of Excellence at universities. With this program, the state's goal was to increase the quality of teaching and research at Tennessee's universities. The state also created the Centers of Emphasis program, which supports educational initiatives at community colleges around the state.

Since the mid 1980s, the Chairs of Excellence Program has been funded with \$44 million. According to the Tennessee Higher Education Commission, the 1997-1998 value of the endowment was more than \$205 million. So far, the program created 97 chair positions (48 are at Tennessee Board of Regents universities and 49 are at the University of Tennessee campuses). The chair positions created through this program are in diverse academic fields including humanities, Judaic studies, public affairs, education, biosciences and engineering.

Tennessee's Higher Education Commission notes that "the program has brought new levels of scholarship to our campuses and has greatly increased the research output of all universities. This program coupled with the equally successful Centers of Excellence program, raised Tennessee's status, among national peers, to new heights."²⁶

The Centers of Excellence program created dedicated research centers at Tennessee universities. The centers are selected through a competitive process and are designed to build the research capacity of the state. According to the Commission, the centers "have been among the most productive section of the higher education enterprise in the state. They have brought in millions of dollars in research grants from federal and private foundations and have produced world class basic and applied research."²⁷ There are now 26 centers of excellence. Their focus ranges from popular music to neurosciences.

The Centers of Emphasis program is the third program administered by the Tennessee Higher Education Commission. Initially called the Campus Centers program, provides matching funds to community college or technical institutes to establish special training programs. Proposals have to be submitted to the Tennessee Board of Regents. Each program is re-authorized every two years and has to demonstrate its impact. The Centers primarily focus on environmental, computer, nursing, manufacturing, information, business, microelectronics and telecommunications training.

Governor's Chair & Joint Institutes Programs

The partnership between the University of Tennessee and Oak Ridge National Laboratory can be traced to the 1984 education reform. The reform created the so-called Science Alliance with the goal to strengthen the collaboration between these research institutions. The Alliance features various programs including the Distinguished Scientist Program, joint institutes and centers, and other collaborative efforts.

In 2004, UT and ORNL advanced a proposal to Governor Bredesen to fund joint appointments of eminent scholars. The appointments focus on specific areas of expertise such as biology, advanced materials and computational sciences. The governor recommended and the legislature approved the first \$2.5 million for 2005-2006. A total of \$10 million is expected, which will be matched by an additional \$10 million from ORNL.

²⁶ See:

http://www.state.tn.us/thec/2004web/division_pages/academic_pages/chairs/chairs.html

²⁷ See:

http://www.state.tn.us/thec/2004web/division_pages/academic_pages/centers/excellence.html

The Governor's Chair program replaces the Distinguished Scientist Program. The program's goal is to attract eminent scholars to Tennessee who would help position various Joint Institutes at the forefront of science. In contrast to the earlier Chairs of Excellence program, the Governor's Chair program is more focused. Chair positions are funded in the areas of biological science, computational science, advanced materials and neutron sciences.

The program is jointly funded by the state and by ORNL. In 2005, the state appropriated \$10 million, which ORNL matched with another \$10 million. The goal is to bring about 30 high profile academics to the state. It is hoped that appointees are National Academy-level scientists that would advance the state's research capacity.

According to the Alliance, "appointees hold a tenured, chaired professorship at the University of Tennessee and a chair-level scientific appointment at Oak Ridge National Laboratory, nominally half time at each institution. The appointments include an ongoing discretionary research fund equal to twelve month's salary."²⁸ In June 2006, the first appointment was made and biophysicist Jeremy Smith from the University of Heidelberg (Germany) was hired. According to David Milhorn, Vice President for Research at UT, currently three offers are extended to potential candidates and another search is underway.

Local leaders are optimistic about the program's success. Governor Bredesen said that "our goal, very simply, is to bring some of the best scientists in the world to Tennessee. The impact of their work can make a lasting difference for our state's future."²⁹

The Governor's Chair program is focused to strengthen the research capacity at the state's major research institutions. In his 2005, state-of-the-state address, Governor Bredesen noted that he wanted to "start focusing some extra attention on our flagship university, the University of Tennessee. I want UT to grow in stature as a first-rate teaching and research university." He recognized that "top of the line universities do so much for their states. They power the economy, they build reputation, they keep the best and the brightest students at home."³⁰ With the Chair program, the state is making focused investments that promote partnerships with institutions like Oak Ridge National Laboratory.

The Governor's Chair Program augments the state's efforts to support special institutes, which are jointly run by UT and ORNL. State funding

²⁸ See: <http://www.scialli.org/frameSetdistinguished.html>

²⁹ See: <http://www.tennessee.edu/news/article.php?id=3692>

³⁰ See: <http://www.ssti.org/Digest/Indices/indexstate.htm>

supports the construction of facilities. There are currently six joint institutes, of which four are receiving state funds.

The Joint Institute for Computational Sciences (JICS) received \$10 million from the state to build a facility on the ORNL campus. The Joint Institute of Biological Sciences will be completed in August 2007 and received \$11.6 million. The Joint Institute for Neutron Sciences will be located on the ORNL campus and will be built with a state investment of about \$11 to \$12 million. The fourth institute, the Joint Institute for Advanced Materials, will be located on a campus at UT in Knoxville. This institute will be jointly financed by the federal (about \$20 million) and state government (between \$10 and 15 million).

Memphis BioWorks Foundation

In addition to the efforts in the eastern part of Tennessee, the state is investing in the western part, particularly in Memphis. The Memphis BioWorks Foundation received \$15 million in state funding for its efforts to establish Memphis as a biosciences center. Founded in 2001, the Foundation works on the implementation of a 10-year, \$500 million plan to redevelop parts of downtown Memphis. Urban redevelopment takes up a large part of the project and the plan is to redevelop a new research park. The Foundation adopted the Smart Growth philosophy and is working on inner city issues such as vacant properties, community development, education and workforce development. The foundation also has plans to raise about \$1 million a year to invest in research and development. The foundation also operates a grant program aimed at commercializing biomedical research.³¹

Innovation Tennessee

Tennessee's Department of Economic and Community Development is in the midst of restructuring its technology-based economic development efforts. The Department has received \$5 million in state funds for Innovation Tennessee, a new entity designed to support commercialization and technology transfer. Innovation Tennessee has enlisted a consulting firm (New Economy Strategies) to conduct a strategic assessment of the state's innovation assets and planning is currently underway for a state-wide commercialization program

Lessons / Observations

- Tennessee's strategic focus on strengthening the partnerships between UT and ORNL fits with the open innovation model. However, industry involvement is not as strongly developed as in the case of Massachusetts.

³¹ See: http://www.memphisbioworks.org/download/app_mbf-grant.pdf

Resources for Tennessee

- Tennessee Higher Education Commission:
<http://www.state.tn.us/thec/>
 - Centers of Excellence:
http://www.state.tn.us/thec/2004web/division_pages/academic_pages/centers/excellence.html
 - Chairs of Excellence:
http://www.state.tn.us/thec/2004web/division_pages/academic_pages/chairs/chairs.html
 - Centers of Emphasis:
http://www.state.tn.us/thec/2004web/division_pages/academic_pages/centers/emphasis.html

- Governor's Chairs of Excellence Program:
<http://www.tennessee.edu/governorchairs/>

- UT-ORNL Joint Institutes:
<http://www.tennessee.edu/governorchairs/institutes.shtml>

- Science Alliance: <http://www.scialli.org/index.html>

- Tennessee EPSCoR:
https://my.tennessee.edu/portal/page?_pageid=37,1&_dad=portal&_schema=PORTAL

- Tennessee Department of Economic and Community Development's Technology Development Office:
<http://www.tnecd.gov/techdev.htm>

- Governor Bredesen "Next Steps" Job Creation Strategy:
<http://www.tennesseeanytime.org/governor/viewArticleContent.do?id=865&page=0>

- Memphis Bioworks Foundation:
<http://www.memphisbioworks.org/>

Virginia

In 2000, state leaders started the Commonwealth Technology Research Fund (CTRF) and infused it with \$13 million for investments in research and development at Virginia universities. Even though the fund required a one-to-one match from universities, it proved to be a successful program. In 2002, the General Assembly decided to discontinue funding for the Commonwealth Technology Research Fund. The decision was part of statewide budget reductions. Even though several advisory bodies recommended additional investments in the fund since then, CTRF never recovered. In his outgoing budget, Governor Warner recommended \$5 million for the fund. Governor Kaine amended this and proposed \$2 million for CTRF in his 2006-2008 budget. According to interviewees, the remaining \$3 million were used to attract SRI International, an independent non-profit research organization headquartered in California. Kaine also proposed \$500,000 for stem cell research funding in the so-called Christopher Reeve Stem Cell Research Fund.

History

The 1980s marked a good decade for investments in higher education and research in Virginia. In 1984, Virginia joined the ranks of other states (such as Massachusetts and Connecticut) when it created the Center for Innovative Technology. Since its founding, the Center evolved from its original mission to enhance research and technology transfer in the state to supporting research, commercialization, and infrastructure development. Even though funding has declined in relative terms, CIT still receives significant state support. Funding ranged between \$8.22 million in 2003 to \$6.2 million in 2006. In the 1980s, the State Council of Higher Education for Virginia invested in Centers of Excellence at universities and created research capacities that still exist today.

During the Wilder administration, however, funding for research dried up and the emphasis was placed on teaching and increasing student enrollment. At the same time, however, the state experienced tremendous growth in high-technology industries around the Washington metropolitan region. Business leaders and higher education officials realized the limitations of Virginia's research institutions and the need for strategic investments.

At the urge of higher education officials, Governor Gilmore proposed the establishment of the Commonwealth Technology Research Fund. The initial proposal called for \$20 million, but it was cut back by the legislature to \$13 million direct state investment with a one-to-one match requirement for participating universities. In 2002, however, the Legislature decided to discontinue the fund because of a budget shortfall.

At the same time, the State Council of Higher Education for Virginia published a key report on the status of research in Virginia. The report, *Conditions of Research at Virginia Colleges and Universities*, noted that Virginia universities lag other institutions in the nation in their ability to recruit star scientists. The report remarked that because of the traditional emphasis on teaching, the state does not pay enough attention to research. The report's authors went on to say that "the lack of state policies that support and foster academic research has hindered the ability of Virginia institutions to advance their research efforts." It further noted that "most successful R&D initiatives share key similar characteristics: 1) focused area(s) of research; 2) long-term and sustained investments in research activities; and 3) collaborative efforts among higher education, government, and business and industry."³² The report recommended increasing the state's commitment to research and development.

The findings were taken up by the so-called Steger Committee, which formed in 2002 and was chaired by Virginia Tech's president Charles Steger. The Committee made a variety of recommendations aimed at increasing Virginia's research capacity. Among those recommendations was the creation of a "Blue Ribbon Panel" made up of nationally recognized experts to evaluate research programs at Virginia universities and to compare them to others in the nation. The committee also recommended expanding the Commonwealth Technology Research Fund through steady funding of at least \$100 million per biennium. In addition, the committee suggested capitalizing on the proximity to federal agencies in the Washington D.C. region, building industry partnerships, initiating a state-wide graduate assistant stipend program, and examining regulatory barriers to research (i.e. overhead regulations, etc.).

In 2003, the Warner administration took up the idea of a Blue Ribbon Panel and invited a group of national experts. The panel invited universities to self-select programs for presentation and evaluated 26 universities' proposals. At the same time, representatives from Virginia's high-technology industries and higher education published two reports through the Virginia Research and Technology Advisory Commission. These reports supported previous recommendations. In particular, one of the reports recommended renewing investments in the Commonwealth Technology Research Fund by \$10 million annually.³³

³² See p. 4 and 5 in this report: State Council of Higher Education for Virginia. (2002). *Condition of research at Virginia colleges & universities*.

³³ See reports posted at: <http://www.cit.org/vrtac/documents.htm/>. In particular, see: Virginia Research & Technology Advisory Committee. (2003). *Report of the VRTAC Sub-committee on: The creation of new high-technology industries in Virginia*. See also: Virginia Research & Technology Advisory Committee. (2003). *Research & development strategies for the Commonwealth of Virginia: A report of the Virginia Research & Technology Advisory Commission*.

As a result of these efforts, Governor Warner incorporated most recommendation in his Higher Education Research Initiative. He recognized the need for investments in faculty, facilities, and equipment, which he saw as the three pillars of a well-functioning higher education system. His initiative yielded the following:

- \$123.5 million (\$39.1 from general fund) to build research capacity in biomedical sciences and biomaterials engineering.
- \$23 million (\$11.6 million from general fund) to build capacity in modeling and simulation research
- \$33.5 million for research equipment
- \$10 million for support to graduate students
- \$0.6 million for graduate education in nanotechnology
- \$5 million for a special technology commercialization fund
- \$4.4 million for a research institute in Southside Virginia
- \$204 million (\$63.2 million from general fund) for six new research facilities.

Warner's initial proposal included \$210.3 million investment from general funds. The legislative process cut the initiative to \$63.2 million in state funding with the rest matched by federal and private sources. Total investments in Virginia's higher education system for 2006-2008 amount to \$204 million.

Even though Warner's initiative funded individual university initiatives, the Commonwealth Technology Research Fund was not forgotten. In his outgoing budget, Warner proposed \$5 million for the Commonwealth Technology Research Fund. Kaine, however, amended the budget and proposed \$2 million to the fund with an additional \$0.5 million for stem cell research. The remaining \$3 million that were initially allocated to CTRF, was used to attract SRI International to Harrisonburg, Virginia.³⁴

Commonwealth Technology Research Fund

Even though the Commonwealth Technology Research Fund was short lived, it had some significant impacts. Researchers who benefited from the fund noted the following contributions:

- The fund seeded research competencies at universities.
- University researchers were able to leverage state funds and brought in a significant amount of federal and private investments.

³⁴ To make the SRI deal work, Kaine submitted a funding request for \$12 million to the General Assembly in 2007. The total amount in state incentives to SRI could amount to \$22 million (\$3 million diverted from CTRF, \$12 million of a total of \$19 million requested from the General Assembly). See: <http://www.sri.com/news/releases/121406.html>

- The fund encouraged industry collaboration and attracted a company from South Carolina who is now working with university researchers in Virginia.
- The fund encouraged collaborations among Virginia universities that still exist.

Academics, however, also noted the fund's shortcoming. They were primarily concerned about funding cuts that created uncertainties about the future of research and development support. They also noted that they are extremely unhappy about the decision to use some of the money that would have been available to the Fund for recruiting a rival research institution (SRI International).

According to the annual report from 2005-2006, CTRF leveraged more than \$167 million, representing a 6.7:1 return on investments. The fund also contributed to the relocation of a bioinformatics company to Virginia (INCOGEN). As a result of CTRF funding, one company was created (Adaptive Genomics Corp. in Blacksburg, Virginia). CTRF award recipients reported 45 disclosures, patent applications, patents received, and licenses. Through the fund, promising junior faculty and post-doctoral fellows were recruited. Many strategic partnerships between universities in Virginia were formed. The fund also allowed upgrading of facilities and capital investments. Awards ranged between \$100,000 and \$4.3 million and were made primarily in the areas of information security, bioinformatics, cancer genomics, imaging, aerospace, modeling and simulation, high performance manufacturing, cell and molecular biology, as well as infectious and autoimmune diseases.

In November 2006, CIT issued new guidelines for applications. They do not differ much from the original guidelines. The fund has four grant programs, which are:

1. Matching Funds Program: Intended to leverage federal and private research dollars. Awards from this program shall be contingent upon the approval of the applicant's grant proposal for federal or private funds;
2. Strategic Enhancement Program: to upgrade the research capacity of those academic departments that have demonstrated the ability to perform innovative research in technology fields that has strong potential to contribute to economic development in the Commonwealth;
3. Industry Inducement Program: to upgrade research capacity in key departments of the institutions in order to attract specific

companies to locate or expand in Virginia; and

4. Technology Commercialization Program to enhance the capability of the institutions of higher education to commercialize technologies developed through their research.

Applications can be made for research programs in the following technology fields. These fields were selected because of their promise to Virginia's economic development:

- Aerospace Biotechnology Energy
- Environmental and information technologies
- High performance manufacturing
- Telecommunications
- Transportation

Lessons / Observations:

- Virginia's efforts to invest in R&D – like those in Missouri – have been subject to politics. In Virginia, however, the politics of traditional economic development (i.e. incentives to attract a research institution) are dominant.

Resources for Virginia

- Center for Innovative Technology: <http://www.cit.org/index.html>
- Virginia Research and Technology Advisory Commission: <http://www.cit.org/vrtac/>
- Department of Education's Higher Education Research Initiative: <http://www.education.virginia.gov/Initiatives/HigherEducation/ResearchInitiative.cfm>
- Commonwealth Technology Research Fund:
 - 2006 Guidelines: http://www.cit.org/programs/r_and_d/2006-ctrf-guidelines.pdf
 - Annual report 2005-2006: <http://jcots.state.va.us/pdf/2006/2006%20CTRF%20Report.pdf>

West Virginia

West Virginia's investments in R&D have undergone significant changes. Borrowing from Governor Manchin, it could be said that the state has undergone a major "research renaissance" in recent years. Since 1979, West Virginia has been part of the federal EPSCoR program. Early NSF awards through this program were small and supported a limited range of activities. After a failed application in 2001, the state began to restructure the EPSCoR program. As a result, NSF has invested more than \$18 million. In addition, state leaders have realized that they needed to contribute to the state's renaissance. In 2003, the state enacted the *Research Challenge Fund* and the *Eminent Scholars Endowment Trust Fund*. Unfortunately, the Eminent Scholars Endowment Trust Fund never got off the ground because of a lack of resources. In contrast, the Research Challenge Trust Fund has evolved into a very successful tool to fund research and development projects. The fund operates as a special revenue fund and receives 0.5 percent of the state's racetrack lottery proceeds. This arrangement makes for a stable funding source and West Virginia was able to invest about \$4.1 million each year in 2005 and 2006. The goal of the fund is to increase research capacity, leverage federal funds, and commercialize R&D.

The program funded six projects so far and shows promising results. According to WV EPSCoR, the program's manager, five startup companies formed. Three of the five startups received venture capital and more than a dozen patent applications are pending. Currently, WV EPSCoR has a call issued for another round of funding through the Research Challenge Fund.

Other areas where the state has invested in the research and development infrastructure are:

- \$4 million for the West Virginia Jobs Investment Trust (JIT), the state's venture capital fund, in 1992
- Bond funding for the Blanchette Rockefeller Neuroscience Institute
- Funding for Marshall University's Forensic Science Center
- \$24.54 million for West Virginia University in 2003
- In 2004, Governor Wise signed two bills adding two tax credit programs: The High Growth Business Investment Tax Credit and the Strategic Research and Development Tax Credit.

In 2006, West Virginia's EPSCoR leaders took another bold step and developed a science and technology strategy for the state. *Vision 2015: The West Virginia Science and Technology Strategic Plan* sets out sixteen goals aimed at improving the S&T infrastructure, R&D funding,

education and outreach, and economic development. The strategy calls for state investments of up to \$250 million, which would also fund the recruitment of 89 new scientists. Governor Manchin endorsed the strategy and incorporated a down payment of \$7.5 million in his most recent higher education budget.

History

The history of R&D investments in West Virginia is interesting. The EPSCoR program in West Virginia started in 1979, but since then the program languished and never achieved any significant outcomes. According to interviewees, part of the problem was that the program was administered by one university and that it was not aligned with state-wide economic development goals. In 2000, an application to NSF to renew EPSCoR funding was denied. NSF recognized the limitations of the program, especially the lack of alignment with state goals. As a result, the state began to restructure the program. In 2001, a new director (Paul Hill) was hired and the program was incorporated into the Higher Education Policy Commission, which now serves as its fiscal agent. In addition, the WVEPSCoR State Advisory Council was established by a Governor's Executive Order. The eleven-member Council advises the Program Director on various management issues and assists in the direction, policies, and procedures for program implementation.

In 2001, the program resubmitted an application to NSF for additional EPSCoR funding. This time WVEPSCoR won the \$8.9 million RII award for its proposal *West Virginia Blueprint for Science and Technology*. By renewing the funding, NSF recognized the restructuring efforts that were underway. As a result of the restructuring, state leaders say that the program has become more strategic and accountable. The program seems to work: In 2006, it received an additional \$9 million grant from NSF. This time the award was for a new 3-year infrastructure grant from NSF. The so-called "Next Generation Biometrics" will build on the 2002 RII grant and will be invested in additional research faculty.

The EPSCoR restructuring ushered in a period of change for the ways in which West Virginia invests in research and development. In 2003, the Governor set aside \$2 million for the Research Challenge Trust Fund. A year later in 2004, legislation passed to dedicate a portion (0.5 %) of the state's racetrack lottery proceeds to the Fund. Since then, WVEPSCoR was able to invest an additional \$4.1 million per year in 2005 and 2006.

WVEPSCoR current research initiatives include identification technologies, nanoscale technologies, energy technologies, and biotechnology. Academic strengths exist in biometrics, high-performance computing, and molecular biology.

Research Challenge Trust Fund

The overarching goal of the Research Challenge Trust Fund is to leverage external funding from national institutions such as NSF or NIH. Awards are made to researchers at West Virginia universities on the basis of scientific merit and competitiveness. The grant programs are the Research Challenge Grants, the Research Group Initiation Grants and the Mini-Grants. The Fund is also supporting energy research by providing cost share required by the U.S. Department of Energy EPSCoR program.

West Virginia's Research Challenge Trust Fund is unique regarding the sources of funding. Rather than a line item in the annual budget (which is typically subject to annual approval), the state decided to fund the program through a percentage share of the racetrack lottery proceeds. State leaders like this type of funding because it ensures a steady stream of investments. A similar funding mechanism is currently discussed for financing the programs suggested in the Vision 2015 strategy.

Since 2003 the state has funded six research projects at West Virginia University and Marshall University. The projects received first-time funding in 2003 and additional investments were made in subsequent years.

Out of these projects five startup companies emerged (Vandalia Research, Protea Biosciences, Datacaster Inc., Vrgris Corporation, and Progenesis Technologies). Two of these firms focus on geographic information system technologies, while the other two work in the field of life sciences. Datacaster and Protea Biosciences partnered with investors for the commercialization of their technology. Other outcomes include more than a dozen patents, three commercial licenses, and "millions of complementary dollars in the form of federal grants and venture capital."³⁵

Projects are selected through a peer review process. The program is still developing the research areas of strengths. Program administrators note that they like to see good proposals "percolate up" and that they will await another round of grants before they determine additional areas. Currently, West Virginia's research strengths are in biometrics, forensic sciences, energy, and molecular biology. Those will also be the areas which will be focused on in the Vision 2015 strategy.

WVEPSCoR just issued a new program announcement and request for proposals for the Research Challenge Trust Fund. Proposals are due at the end of February 2007. Program administrators anticipate another four

³⁵ For a review of the outcomes see the WVEPSCoR's 2006 annual report: <http://www.wvepscor.org/downloads/2006AnnualReport.pdf>

to 6 awards. Awards can be up to \$500,000 in the first year with decreasing amounts thereafter. However, unlike other states, the application guidelines do not include any specific requirements about industry engagement.

Vision 2015: The West Virginia Science and Technology Strategic Plan

In 2005, the West Virginia EPSCoR Advisory Council began a strategic planning process for the state's science and technology future. NSF provided a planning grant of about \$200,000 to develop the strategy. Vision 2015 recognizes the need to build capacity by focusing on 16 goals. Among these goals are an increase of researchers in science, technology, engineering and mathematics (STEM) by 20 percent by 2008, the building of research facilities, the creation of nationally competitive research thrusts, technology commercialization, student retention, and technology-based economic development among others. Governor Manchin endorsed the strategy in 2006 and committed a down payment of \$7.5 million. The total costs of the vision were estimated to be \$250 million.

Outcomes

According to WVEPSCoR's 2006 annual report, West Virginia universities have seen a steady increase in federal grant support. Awards have almost doubled from \$28.3 million in 2000 to more than \$60 million in 2005.

Lessons / Observations

- It might be worthwhile to further investigate West Virginia and to examine the question why the state has been so successful in creating economic benefits from its R&D investments.
- Extensive outreach efforts were instrumental in convincing policymakers about the merit of higher education investments.

Resources for West Virginia

- Legislation
 - Research Challenge Trust Fund:
<http://www.legis.state.wv.us/WVCODE/18B/WVC%2018%20B-%20%201%20B-%20%2012%20%20.htm>
 - Eminent Scholars Endowment Trust Fund:
<http://www.legis.state.wv.us/WVCODE/18B/WVC%2018%20B-%2018%20%20-%20%20%205%20%20.htm>
- WV EPSCoR: <http://www.wvepscor.org/>
 - 2006 Annual Report:
<http://www.wvepscor.org/downloads/2006AnnualReport.pdf>
 - Research Challenge Trust Fund spin off companies:
 - Vandalia Research:
<http://www.vandaliaresearch.com/about.asp>
 - Protea Biosciences: <http://www.proteabio.com/>
 - Datacaster: <http://www.datacaster.com/>
 - Vrgis Corporation: <http://www.vrgis.com/#>

3. Closed versus Open Innovation: What is the Role of the State?

The evolution of state R&D investments has to be considered in the context of a changing corporate innovation model. During the 1980s, states built research capacity at their universities. Beginning in 2000, some states began to use their R&D investment funds to encourage collaborations with external parties such as industry partners and other universities. This change in approach coincided with the dramatic transformation in the way knowledge-based industries organize their innovation efforts.

Until a couple of decades ago, firms like Bell Laboratories, Xerox, and General Electrics organized innovation in a centralized fashion. These were companies known for having strong in-house R&D laboratories staffed by legions of innovative researchers. Their laboratories contributed to important inventions such as the light bulb, laser printer technologies, or the graphic user interface among others. This centralized approach is commonly referred to as the “Closed Innovation Model.”³⁶ Often these laboratories were too innovative and some of their technologies ended up unused on the shelf. In some cases, former employees commercialized the ideas by starting new firms or taking the ideas with them to their next job.

According to business scholar Henry Chesbrough, four trends undermined the closed innovation model in recent decades. One was the increased availability and mobility of skilled workers. Employees would leave centralized R&D organizations and commercialize their knowledge. Their endeavors were aided by the rise of the venture capital industry, which provided the necessary capital for startup companies. The expansion of the venture capital industry since the 1980s was a second trend that eroded the viability of the centralized R&D laboratory. The third factor was the emergence of external options to commercialize the knowledge created in the centralized R&D organization (i.e. startup companies, customers, suppliers, etc.). Fourth, external partners such as suppliers and customers became more capable of taking innovation to the marketplace. Because of these trends, the closed innovation model increasingly became unpopular and a new model – the Open Innovation Model – developed.

In the Open Innovation Model, it is assumed that innovative ideas emerge from a variety of sources and not just from internal R&D capacities.

³⁶ Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.

Chesbrough notes that in this new model “a company commercializes both its own ideas as well as innovations from other firms and seeks ways to bring its in-house ideas to market by deploying pathways outside its current businesses.”³⁷ In the open innovation model, knowledge can emerge from many different sources: a firms’ internal R&D capacity, its customers, the supply chain, startup companies, technology users, and universities. The centralized R&D laboratory has become a thing of the past. Firms like Intel, Nokia, Qualcomm or MedImmune engage in many partnerships with other firms (often small startup companies), their suppliers and customers, but also universities across the world. These firms are looking to absorb information and innovation from all these sources. As a result, university research and the university’s ability to partner with these firms are at a premium. Thus, state investments in R&D are critical. More specifically, the ways in which these funds are structured and organized is pivotal because they can encourage and reward university-industry partnerships.

In addition, the open innovation model benefits from so-called *innovation benefactors*.³⁸ Since many large companies have abandoned their centralized R&D laboratories, others have to step in and fund research and development. The federal government has provided funding through programs at the National Science Foundation, National Institutes of Health, and the Defense Advanced Research Projects Agency (DARPA). But federal government funding is changing. It is declining relative to industry funding and its orientation is changing. Increasingly – as Massachusetts’ John Adams Innovation Institute noted – federal funds are awarded to multi-institutional efforts aimed at connecting industry with universities. As this report shows, states are acting as *innovation benefactors*. State governments are taking up this role by providing resources to their universities for basic and applied research. Are states acting as smart innovation benefactors? In other words, are states using their limited resources in ways that have the greatest benefit for their economic development? Is state funding for R&D structured in a way that benefits the open innovation model?

Several states examined in this report are in a good position to take advantage of and add value to the open innovation model. Massachusetts’ Research Center Matching Fund for example provides state matching funds to universities interested in obtaining federal funding for university-industry centers. Centers that receive investment from this fund have to engage in partnerships with industry and with universities and they can do so even beyond the state’s borders.

³⁷ See p. 37 in Chesbrough, H. (2003). The era of open innovation. *MIT Sloan Management Review* (Spring), 35-41.

³⁸ Ibid.

However, states experience political vagaries especially regarding the steadiness of their funds. Virginia’s Commonwealth Technology Fund, for example, was discontinued due to budgetary problems. The fund fit the open innovation model because it encouraged partnerships between universities and industries. Missouri’s efforts to be an innovation benefactor are stymied by the controversy over stem cell research.

States are in a good position to play the role of the innovation benefactor. In recent years, federal funding for basic scientific research has declined. The monopoly of large companies on research does not exist anymore and the share of industrial R&D increased for smaller firms. In addition, universities have become more adept at working with industry and obtaining funding from the private sector. This created a milieu in which R&D investment funds can help construct a state’s competitive advantage. The following table outlines the characteristics of the open innovation model from the corporate perspective. States have to think about their role in matching this new corporate perspective. Table 3 provides examples for the ways in which state R&D investment funds fit the open and closed innovation models.

Table 2: The role of the state in the open innovation model

Open Innovation Model	State Government Role
Tap into knowledge outside of organization	Recognize that universities play an important role in industry R&D.
External R&D creates value	Encourage industry to work with universities.
It’s possible to profit from external R&D; but internal R&D is needed to claim value	Continue to look beyond your state’s horizon, get to know where innovation comes from in your major industries and figure out how to capture more in-state.
Importance of business model	Get to know your industries’ innovation models and the role R&D plays in advancing their businesses.
Make best use of internal and external ideas	Make sure that universities realize and value the involvement of industry.
Enable outbound flow of innovation	Open and connect the university with industry. Provide matchmaking venues where industry and university can get to know each other (i.e. centers, networking events)
Manage, share and expand intellectual property	Develop IP models that make sense not only to university; do not “fence off” university research.
Multi-disciplinary	Encourage cross-disciplinary, cross-institutional research, cross-border collaborations.
Self-organizing relationships	Don’t pick winners, let ideas percolate.
Role of intermediaries	Be proactive and broker university-industry relationships.
Use new metrics for assessing innovation capability and performance	Do not just count number of startups and patents, but also measure rate of utilization of patents, the time it takes to get ideas form the lab to the market, share of new ideas originating within company and within the industry you partner with, etc.

Source: Adapted from Chesbrough (2003)

Table 3: State R&D Investment Funds and Innovation Models

	Closed Innovation Model		Open Innovation Model	
	Linear Model Supply Side	Basic Research / Specific Science	Translational Research	Partnership- driven: University- Industry/ University- University
Goals	Boost research Leverage federal R&D Some kind of economic development effect hoped for, but often effect not known or hard to measure.	Become leader in one specific area of science (i.e. Stem Cell). Create favorable climate for scientists (attract, recruit and retain them).	Contribute to cross-disciplinary research. Translate basic research into applied work ("From bench to bed"). Be a smart innovation benefactor and fill void.	Figure out a specific niche and connect industry with universities.
Fit with Open Innovation Model	No fit at all University = closed system	No fit University = closed system	Realizes connections between different innovation actors	Realizes connections between different innovation actors
State Examples	Various Chairs of Excellence Programs (TN, CT)	Connecticut's Stem Cell Research Fund	Maryland's Stem Cell Research Program	Massachusetts' Research Center Matching Funds Virginia's CTRF Maryland's MIPS
Spillover Effects	Limited	Limited	Some	Plenty
Likelihood of keeping spillovers in state	Small	Small	Medium	High
Necessary Program Elements	May work for states needing to build capacity. States should move to the open innovation model to increase economic benefit of their investments.		Be complementary to other innovation benefactors such as (NSF/NIH); Don't overlap; Pay attention to how legislation and RFPs are written; involve industry in deliberations; Require partnerships with industry and have industry share risks and rewards; Encourage crossing boundaries; Develop smart IP sharing policies	

Note: Some programs cross the typology boundaries.

4. Conclusion

The following outlines some concluding remarks drawn from this report's analysis of ten states:

- **State R&D investments have evolved and some complement the open innovation model.**
State R&D investments have come a long way. During the 1980s, investments primarily focused on strengthening university research. In recent years, states have become sophisticated about focusing their funds on creating partnerships outside the ivory towers. To function as successful innovation benefactors, states need to pay attention to the way the legislation and request for proposals are written.
- **State R&D investment funds should complement federal programs.**
Successful R&D investment funds complement federal programs. One interview noted that states should not try to be “mini NIHS.” Rather, state funding should be used to either leverage larger federal grants or to fill voids left by the shortcomings of federal funding programs.
- **State R&D investments are vulnerable to political vagaries and budget cuts.**
The biggest threat to the state's role in the open innovation model is the vulnerabilities emerging from political struggles over funding. It is not uncommon that state legislatures stop funding R&D investments when they are faced with budget cuts and competing priorities.
- **However, some states developed steady funding streams for their R&D investment funds.**
Kansas and West Virginia have found ways to provide for steady funding. Tax increment funding is used in Kansas. West Virginia's Research Challenge Trust Fund receives a percentage share of the state's racetrack lottery proceeds.
- **State R&D investment funds need to have political champions. Governors and state legislators need to stand behind R&D investment proposals.** Industry by itself – as was shown in the case of Idaho – may have a hard time convincing politicians about the importance of the investments.

- **State R&D investments funds need to have some important strategic elements.**
Industry needs to share the risks and rewards of the research they are engaging with. Peer review shields from politicization.
- **States need to be aware about the geographic impact of their R&D investments; state leaders need to reach out to all constituencies.**
States that have successfully overcome the urban-rural divide communicated the benefits of state R&D investments to all their communities.
- **Finally, R&D investment funds cannot exist in a vacuum. States have to have a portfolio of funds entrepreneurs can take advantage of.**
Entrepreneurs and their startup companies do not only benefit from R&D investment funds, but they also benefit from programs that support commercialization, technology transfer, and business development.

Appendix

Table 4: List of Interviewees

State	Name	Position	Contact Info	Date
Connecticut				
	Warren Wollschlager	Director, Office of R&D, Department of Public Health	(860) 509 7107	December 27, 2006
	Marianne Horn	Legal expert at DPH		
	Milton Wallack	Stem Cell Coalition of Connecticut (patient advocate)	(203) 288 8221	January 4, 2007
	Willy Lensch	Instructor, Children's Hospital, Boston, Massachusetts, Member of Stem Cell Research Advisory Committee	(617) 919 2011	January 4, 2007
	Robert Galvin	Commissioner of Public Health, State of Connecticut	(860) 509 7101	January 17, 2007
	Paul Pescatello	President, CURE	(860) 508 6767	January 18, 2007
Idaho				
	Julie Howard	Department of Labor and Commerce, Office of Science and Technology	(208) 334-2650 ext. 2147	January 10, 2007
	Karl Tueller	Executive Director, Office of Science & Technology, Department of Labor	(208) 334-2650 ext. 2104	February 6, 2007
Kansas				
	Bill Duncan	President, Kansas City Area Life Sciences Institute (KCLSI)	(816) 753 7700	January 19, 2007
	Tom Thornton	President, Kansas Bioscience Authority	(913) 397 8300	January 19, 2007
	Steve Kelly	Deputy Secretary of the Kansas Department of Commerce	(785) 296 3481	January 31, 2007

Kentucky				
	Kris Kimel	Founder and president of the Kentucky Science and Technology Corporation (KSTC),	(859) 233 3502 ext. 223	January 11, 2007
	Jim Applegate	Vice President, Academic Affairs, Council on Postsecondary Education	(502) 573 1555 x 257	January 18, 2007
	Bill Payne	Senior Associate, Finance		
	Chuck Staben	Associate Vice President for Research, University of Kentucky	(859) 257 5294	January 19, 2007
	Tom Layzell	President, Kentucky Council on Postsecondary Education	(502) 573 1555	January 26, 2007
	Deborah Clayton	Commissioner, Department of Commercialization and Innovation	(502) 320 4846	January 31, 2007
	Mahendra Jain	Executive Director, Kentucky Science and Engineering Foundation	(859) 255-3613	February 1, 2007
Maryland				
	Renée Winsky	TEDCO, Executive Director	(410) 740 9442	January 9, 2007
	Brian Levine	Tech Council of Maryland, Director of Government Relations	(240) 453 6211	January 9, 2007
	Bob Eaton	MdBio, President	(301) 228 2445	January 18, 2007
	Linda Powers	Co-founder and Managing Director of Toucan Capital Corporation; Chair Maryland Stem Cell Commission	(240) 497-4060	January 20, 2007
Massachusetts				
	Pat Larkin	MTC Deputy Director Director of the John Adams Innovation Institute	(413) 496 9430	January 26, 2007

Missouri				
	Robert Monsees	Executive Director of the Missouri Technology Corporation (MTC)	(573) 526 0470	January 30, 2007
	Donn Rubin	Coalition for Plant & Life Sciences	(314) 206 3242	February 12, 2007
	John Gardner	Vice President for Research, University of Missouri	(573) 882 6726	February 21, 2007
Tennessee				
	David Kolzow	Executive Director, Tennessee Leadership Center	(615) 972 4801	December 27, 2006
	Eric Cromwell	Director of Technology, Department of Economic and Community Development	(615) 253 1946	January 30, 2007
	Steven Bares	President, Memphis Bioworks Foundation	(901) 448 2560	February 2, 2007
	David Milhorn	VP for Research, University of Tennessee	(865) 974 8913	February 5, 2007
Virginia				
	Nancy Vorona	VP Research Investments Center for Innovative Technology	(703) 689 3043	December 27, 2006 January 12, 2007
	Ralph Byers	Virginia Tech, Director of Government Relations	(540) 231 7111	January 5, 2007
	Dennis Manos	College of William and Mary, Vice Provost for Research and Graduate/Professional Studies	(757) 871 9581	January 5, 2007
	Jim Noftsinger	Associate Vice President of Academic Affairs for Research and Program Innovation, Executive Director of the Institute for Infrastructure and Information Assurance, and Assistant Professor of Integrated Science and Technology and Education at James Madison University	(540) 568 2700	January 11, 2007

	Peter Blake	Vice Chancellor for Workforce Development, Virginia Community College System (former Secretary of Education)	(804) 819 49 45	January 12, 2007
	Rob Lockridge	Executive Assistant to the President for State Governmental Relations, University of Virginia	(804) 371 0202	January 12, 2007
	John Bennett	Vice President for Finance, Virginia Commonwealth University (former VA Secretary of Finance)	(804) 828 6116	January 22, 2006
	Aneesh Chopra	Secretary of Technology, Commonwealth of Virginia	(804) 786-9579	January 24, 2007
	Bruno Sobral	Executive and Scientific Director, Virginia Bioinformatics Institute	(540) 231 2100	January 24, 2007
West Virginia				
	Paul Hill	State Executive Director for the West Virginia Experimental Program to Stimulate Competitive Research (EPSCoR)	(304) 558 4128	January 25, 2007
	Brian Noland	Chancellor, West Virginia Higher Education Policy Commission	(304) 558 0699	January 26, 2007
	Jay Cole	Governor's Higher Education Advisor	(304) 558 3152	January 30, 2007

Biographical Information

Dr. Heike (pronounced Hi-ka) Mayer is an assistant professor in the Urban Affairs and Planning program at Virginia Tech's Alexandria Center. She received her bachelor's degree from the University of Konstanz (Germany) and a master's degree and Ph.D. in Urban Studies from Portland State University.

Her dissertation research examined the evolution of Portland's high-technology industry – also known as Silicon Forest – in the absence of a major, world class research university such as MIT or Stanford. Her research interests are in regional economic development, high-technology regions, entrepreneurship and innovation. She is currently working on a variety of research projects: One examines the evolution of second-tier high-tech regions in the absence of world-class universities (this work will be published in a book with Edward Elgar Publishing). The second project focuses on women high-tech entrepreneurs in Silicon Valley, Boston, Portland, and Washington D.C. She is also working on a study of Slow Cities in Europe (with Paul Knox).

Heike's research has been funded by a variety of institutions such as the Smith Richardson Foundation, the Kauffman Foundation, The Brookings Institution, the Small Business Administration, Virginia Economic Development Partnership, and Arlington County. Her work has been published in the *Journal of the American Planning Association*, *Journal of Urban Affairs*, *Economic Development Quarterly*, *Economic Development Journal*, and by the Brookings Institution.

Heike is a native of Germany and she enjoys whitewater kayaking and hiking.

She can be contacted at (703) 706 8122 or heikem@vt.edu.

Website:

http://www.nvc.vt.edu/uap/faculty_main.asp?sectionid=50&pageid=284&pagename=Heike%20Mayer.