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Growing Quality Jobs in Tennessee:

A White Paper on Leveraging Tennessee's Research and Development Base for Innovation and Technology Commercialization

Prepared by:
Battelle Technology Partnership Practice

Prepared for:
Tennessee Technology Development Corporation

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Key Findings

Tennessee's ability to generate and attract high-quality jobs is a fundamental measure of the state's competitiveness in a global, knowledge-based economy. Governor Haslam has set the bar high for Tennessee—to become the #1 state in the Southeast for high-quality jobs.

To be successful in generating and attracting high-quality jobs, Tennessee must put in place the capacity to advance innovation and technology development. This depends not only on the size of a state's R&D base, but on its ability to translate that research base into fostering industry clusters, advancing new product development, and generating new company formation that matters.

This White Paper takes a critical assessment of Tennessee's position in leveraging its R&D base for economic development, with an eye towards identifying gaps found in Tennessee and possible strategic directions for the Tennessee Technology Development Corporation (TTDC) to address these gaps. It is informed by analysis of recent technology and economic trends, input from research performing institutions, and private industry leaders.

Five Key Challenges for Tennessee

- A need to upgrade the technology transfer and commercialization infrastructure and streamline processes across Tennessee's research performing institutions.
- A low and falling level of industry research and development expenditures over the last decade
- A lack of connection between industry and research performing institutions in Tennessee
- Mixed record of entrepreneurial activity
- Continued concerns about the availability of funding at early stages of technology development.

Specific Strategic Directions to Move Tennessee

- Consider developing a streamlined standard licensing agreement for Tennessee research performing institutions.
- Continue to advance TTDC's technology maturation funding with more comprehensive services to advance promising research discoveries through new firm start-ups.
- Advance regional technology industry clusters, in partnership with TTDC's regional innovation partners, through project-specific, competitive-based grants that address a key opportunity or gap identified within a specific region or across regions to support the growth and job generation of technology-based industry clusters.
- Establish a Tennessee industry-university applied research partnerships initiative to promote more effective collaborations in new product development and commercialization across existing Tennessee businesses, emerging companies and research performing institutions.

- Build out the capacity for a statewide commercialization and mentor network to ensure high-quality entrepreneurial services across the state, including entrepreneurial education, technical assistance and mentoring of aspiring high-growth Tennessee entrepreneurs with business advisors based on relevant technology and business development experience.
- Provide planning funds to develop the design and implementation plans for how Tennessee can best implement proven approaches to advance high potential, strategic research areas leading to technology commercialization, new business formation and high-quality job generation in the state, including multi-institutional research consortiums and the recruitment of eminent scholars in strategic research areas.
- Develop an entrepreneurial assistance component to the other venture capital programs to improve the quality of deal flow among Tennessee's start-up and emerging technology businesses in high technology, science and engineering seeking venture capital funding through business advisory services, including business plan evaluation and expanding the access to professional service resources and mentoring assistance each entrepreneur needs to be successful.

This White Paper seeks to continue the hard work of moving Tennessee forward in innovation and technology development as the foundation for growing and sustaining high-quality jobs. It takes a critical assessment of Tennessee's position in leveraging its R&D base for economic development, with an eye towards identifying gaps found in Tennessee and possible strategic directions for TTDC to address these gaps. It is informed by analysis of recent technology and economic trends, input from research performing institutions and private industry leaders.

To assist with this assessment, TTDC retained the services of the Battelle Technology Partnership Practice (TPP), the technology-based economic development consulting arm of Battelle. Battelle TPP has a demonstrated record of translating technology strengths into development strategies and designing key initiatives from research parks to incubators to research centers. Battelle established the Technology Partnership Practice (TPP) in 1990 to focus Battelle's broad experience and capabilities to better serve state and local organizations, universities, non-profit technology organizations, and others in the design, implementation, and assessment of technology programs, and in helping firms access and use federal, university, and industry developed technology. This practice includes leading analysts and practitioners in technology-based economic development including efforts in technology transfer, commercialization and industry partnering.

Tennessee's "High-Quality Job" Goal Requires Advancing the State's Environment for Innovation and Technology Development

Governor Haslam has established the goal for Tennessee to be the #1 state in the Southeast for high-quality jobs. To do this, Governor Haslam explained in his inaugural address that: "We are honing an edge that will allow Tennessee to stand out in a highly competitive world where everyone is looking for the smallest advantage to succeed."

Indeed, the ability of Tennessee to attract, retain and generate high-quality jobs is the "fundamental measure of competitiveness," according to a committee of leading experts from industry, academia and government brought together by the National Academies of Science, Engineering and Institute of Medicine, which issued the widely acclaimed report on *Rising Above The Gathering Storm* and its recent update.[1]

In today's global, knowledge-based economy, it is only through innovation and technology development that high-quality jobs can be created. As the World Economic Forum in its highly touted Global Competitiveness Report explains:

> "In the long run, standards of living can be expanded only with innovation…This requires an environment that is conducive to innovative activity, supported by both the public and the private sectors. In particular, this means sufficient investment in research and development (R&D) especially by the private sector, the presence of high-quality scientific research institutions, extensive collaboration in research between universities and industry, and the protection of intellectual property."[2]

What stands out in today's global economy is the pace at which this economic competition around increasing know-how and a rising level of skills of the workforce is conducted. The U.S. Council on Competitiveness in its report, *Innovate America*, put the issue succinctly: "We believe that the bar for innovation is rising. And, simply running in place will not be enough to sustain America's leadership in the 21st century…Today the forces of global economic integration and advances in technology are creating a different and more complex challenge."[3]

The private sector is clearly the driver for bringing innovation and technology development into the marketplace and creating high-quality jobs in Tennessee. But the ability to support innovation and technology development by the private sector involves fostering a business environment in Tennessee that draws upon the presence of universities and research institutions that are able to not only advance technology capabilities, but to generate and attract high-quality talent to a state either as students or faculty. The evidence is overwhelming in demonstrating the critical importance of having R&D drivers to support technology-based economic development:

- The Milken Institute found that 65% of the difference in economic success for regions from 1975 to 1998 is accounted for by the presence and growth of high-technology

[1] Rising Above the Gathering Storm, Revisited, page 17–18.
[2] Economic Forum, The Global Competitiveness Report 2010–2011, page 8.
[3] Council on Competitiveness, Innovate America, page 38.

industries and that research centers and institutes are "indisputably the most important factors in incubating high-tech industries."[4]

- According to a study prepared for the U.S. Small Business Administration, "Research universities and investment in research universities are major factors contributing to economic growth in the labor market areas in which the universities are situated."[5]
- Studies by the Office of Technology Policy and others have found that all areas of technology-based economic development in the United States have strong concentrations of both university and private research.[6]

> *World-class research is a passport to success in the global economy. Industry can no longer compete by selling standard products made with standard processes and that could be produced anywhere in the world at lower cost. Businesses must constantly innovate to raise the quality of production, introduce new product lines or services, and add greater value to their outputs. For this reason, states must create an environment that supports continuous innovation. This requires investment in cutting-edge research, facilities, and equipment.*
>
> National Governors Association, "A Governor's Guide to Building State Science and Technology Capacity," 2002, page 15.

The economic value of being successful in innovation and technology development goes well beyond the direct high-quality jobs being created. As the National Academies stated in *Rising Above The Gathering Storm* the generation of quality jobs through innovation and technology development has large economic multiplier impacts that support many other sheltered and locally-based industries—from retail to real estate to government services.

Creating Economic Development Value From R&D Activities

The economic development value of research and development cannot be measured solely by the "size" of a state's R&D budget. Increasingly, states are recognizing that it is the "translation" of that research base into fostering industry clusters, advancing new product development, and generating new company formation that matters.

Economic development is not easy to achieve in general, while technology-based economic development is an even greater challenge. For technology-based economic development to occur, an entire interconnected sequence of positive factors or what we term a "commercialization chain" has to be in place that connects and strengthens the drivers of innovation and industry development, namely technology, talent and capital. If links in the commercialization chain either inadequately address economic needs or are missing altogether, a sustainable innovation and technology development business environment able to generate quality jobs is unlikely to develop. Among the key requirements for innovation and technology-based economic development are:

- Active networking to create a sense of place and overcome issues of critical mass
- Entrepreneurial assistance

[4] Milken Institute, *America's High-Tech Economy*, 1999.
[5] Bruce Kirchhoff, "The Influence of R&D Expenditures on New Firm Formation and Economic Growth," Maplewood, N.J.: BJK Associates, 2002.
[6] U.S. Department of Commerce, Office of Technology Policy, *The Dynamics of Technology-based Economic Development: State Science and Technology Indicators*, Washington, D.C., 2000.

- Access to a continuum of business financing tools to serve stages in proof-of-concept, venture start-up, product development, product launch and business expansion
- Capability to educate, retain and recruit a qualified workforce with technical and management skills
- A supportive environment for ongoing research and development activities.

The states and regions in the U.S. that have achieved success in technology-based economic development have well-developed commercialization chains in place. These commercialization chains may form naturally over time, as occurred in Silicon Valley and Route 128 in Boston. More typical is that they are the result from dedicated activities of states, regions and key stakeholders to connect and build links in the commercialization chain to assure technology-based economic development and quality job creation happen. This is the case for North Carolina, Maryland, and Virginia, among other states that have successfully generated rising incomes from the presence of high-quality jobs.

As Krisztina Holly, vice provost for innovation at the University of Southern California and the founding executive director of MIT's Deshpande Center for Technological Innovation, explains: "Some parts of the country have developed a culture in which the free market works especially well—where innovators doing groundbreaking research have efficient access to capital, so they can transform their ideas into new ventures and jobs. Sometimes, whole industries get created. Silicon Valley and the university-rich Boston area are two of the world's best examples of zones where concepts and capital connect efficiently, to the benefit of those immediate regions and the world. However, it's a fallacy to say that these innovation ecosystems erupted purely spontaneously. As Josh Lerner outlines in his book, *Boulevard of Broken Dreams*, research contracts from the Department of Defense and government intervention in the venture capital industry played critical roles in establishing the seeds of these powerful ecosystems in the mid 1900s. Once critical mass is established, new venture creation flourishes…Although these ecosystems have taken decades to establish, it doesn't mean we can't deliberately accelerate the process elsewhere."[7]

The Tennessee Opportunity

Tennessee is well-positioned to tap research and development as a driver for creating high-quality jobs. Universities and research institutions in Tennessee, including the Oak Ridge National Laboratory and St. Jude's Research Hospital, undertake approximately $2.5 billion in research and development activities annually. This places Tennessee among the top states in the nation in research and development activity of research performing institutions encompassing public and private universities, national laboratories, research hospitals and other non-profit research organizations.

But Tennessee does not have a mature commercialization chain to advance innovation, entrepreneurship and technology deployment that translates its R&D base into broader private sector economic activity and high-quality job generation.

A recent profile of Tennessee Competitiveness prepared by Michael Porter, the internationally acclaimed expert on economic competitiveness and strategy from the Harvard Business School,

[7] Krisztina Holly, "Why Funding University Innovation Matters," June 29, 2010, Op-Ed Article.

on behalf of the National Governor's Association and presented to Governor Haslam at the February 2011 NGA Winter Meeting, makes it clear that Tennessee is not performing well in terms of innovation and technology development. Just consider:

- Productivity, a measure of how well technology is deployed, is 11.5% lower in Tennessee than the nation as measured by gross state product per worker and grew more slowly than the nation from 1998 to 2008.
- Innovation output in Tennessee as measured by patents per worker in Tennessee were nearly a third less than the nation in 2009 and total patents from 1998 to 2009 declined in the state.
- And, not surprisingly given this lower productivity and innovation output, high-quality jobs in Tennessee are lagging with private sector wages in Tennessee standing 14% lower than the U.S. average and growing more slowly from 1998 to 2008 than the national average.

Reversing these trends in innovation and technology development must be a key focus for Tennessee in the years ahead. As Governor Haslam explained in his inaugural address, "As Tennesseans we often aim too low when it comes to our education, our health and our economy. It is time to raise our sights."

Building On Efforts Underway

In recent years, Tennessee has been hard at work in putting the building blocks in place to advance its innovation and technology development infrastructure to leverage its R&D base.

One critical infrastructure building step was the formation of TTDC in 1997. TTDC is a legislatively created, non-profit organization whose mission is to increase the formation and expansion of science and technology businesses in Tennessee. Working in partnership with the Tennessee Department of Economic and Community Development and funded under an agreement with the state of Tennessee, TTDC is dedicated to aligning public and private research institutions with business development organizations and the investment community to increase the number of high-skill, high-wage jobs in Tennessee. Succinctly stated, TTDC is advancing Tennessee's commercialization chain.

The primary focus of TTDC is on three critical resources to technology-based economic development:

- Strategic Research and Innovation, with an emphasis on advancing applied research, the development of new technology and business creation and job growth in Tennessee from across the base of research organizations found in Tennessee across universities, federal laboratories and hospitals and non-profit research organizations.
- Capital, with a focus on serving as a facilitator to increase access to early-stage capital within and flowing into Tennessee to help finance entrepreneurial and expansion-stage companies.
- Entrepreneurship, with an emphasis on creating statewide approaches that effectively and efficiently identify, nurture and support high-growth, small- and medium-sized enterprises and the entrepreneurial talent needed to move promising technology into the marketplace.

- An emerging fourth cross-cutting focus of TTDC that links strategic research, capital and entrepreneurship into an effective economic development approach that ensures vibrant technology-based industry clusters, both at the statewide and regional levels across Tennessee.

Among TTDC's notable accomplishment are:

- Creating statewide collaborations and partnerships across leaders in industry, university and economic development stakeholders in technology-based economic development. This includes the active efforts of three statewide leadership boards for strategic research, enterprise development and capital formation, along with a growing partnership focused on capacity-building and service delivery with regional technology development organizations and technology transfer offices at research organizations across Tennessee.
- Implementing Tennessee's technology maturation fund, which in its three years of operation has provided nearly $1,000,000 in grant funding for eighteen (18) projects across the state to further the commercialization of promising technologies from the lab to the proof-of-concept or prototype stage in order to attract additional investor support or secure third-party licensing deals.
- Assisting Tennessee's emerging and small technology business access to the over $2 billion federal Small Business Innovation Research (SBIR) program through technical assistance and proposal development support. To date, TTDC has funded the assistance of twelve (12) Phase I and six (6) Phase II SBIR/STTR applicants in the state that has lead to multiple proposals with indications for funding of potentially $3 million resulting in a 17:1 leverage of this funding.
- Hosting the state's innovation conference, an annual statewide meeting providing a forum for showcasing the latest technological innovations and improving connectivity among investors, emerging growth-oriented technology businesses and the research community. Over the last four years of this event (2008-2011), 40% of presenting entrepreneurs have gone on to raise capital from private sector sources. At the 2011 event, over 500 entrepreneurs, intellectual property experts, researchers, venture capitalists, investors and technology transfer professionals attended.
- Providing $80,000 in funding awards to four entrepreneurs who were selected to be part of the inaugural Rural Seed Fund program.
- Providing leadership on a successfully funded proposal through the National Science Foundation resulting in a $20 million award to the state of Tennessee in which TTDC invested $137,000 focused on technology commercialization.

Complementing the activities of TTDC is the recent passage of the Tennessee Small Business Investment Company Credit Act, commonly referred to as the "TNInvestco Program," which is focused on establishing an infrastructure of venture capital in Tennessee to increase the flow of capital to innovative new companies in Tennessee in the early stages of development. The TNInvestco program has allocated $200 million dollars to provide matching funds to ten venture capital funds working in Tennessee, through a competitive review process.

When coupled with success stories that follow from the state's major research institutions, the opportunity for growing Tennessee's innovation economy through greater coordination and alignment is clear. In the following sections we present proven strategies for leveraging

technology innovation for economic growth and provide initial recommendations for consideration by Tennessee's public and private leadership.

Tennessee Success Stories

Insight Genetics was formed in 2007 to develop and commercialize a proprietary technique for improving the accuracy and affordability of molecular diagnostics. With support from the TTDC maturation fund, Insight has collaborated extensively with Dr. Stephan Morris of St. Jude Children's Research Hospital to develop better tests for identifying genetic mutations of the anaplastic lymphoma kinase (ALK) gene, which have an established pathogenic role in over 2 million new cancer diagnoses worldwide each year. In 2010, Insight and Dr. Morris were awarded a contract from the NCI/NIH to support development of a companion diagnostic for ALK-targeted cancer therapies, and their work was selected for presentation at the 2011 meetings of the American Association of Cancer Research (AACR) and the American Society of Clinical Oncology (ASCO). Insight has in-licensed from St. Jude several pieces of intellectual property related to ALK for broad commercialization. Insight currently offers molecular tests for ALK and other biomarkers as a service to pharmaceutical customers, and it will be globally launching an in-vitro diagnostic (IVD) test kit as a product through its commercial partners in 2012. Through July 2011 Insight has received $444,000 in federal government funding and $2.4 million in private equity. Insight is based in Nashville and currently employs 6 people.

Pathfinder Therapeutics, Inc. (PTI), founded by Vanderbilt University researchers in 2004 and located in Nashville, is a pioneering company based on image-guided surgery technology invented by the founders. Vanderbilt University licensed the technology and patent rights to PTI, and made an initial investment in the company. PTI raised $5 million in a series A financing round led by Hatteras Venture Partners. In 2010, PTI raised another $4m in a Series B financing round co-led by Limestone Fund, LLC and Tri-Star Technology Fund, LLC and participated in by existing investors including Hatteras Venture Partners, Florida Gulfshore Capital and Clayton Associates. PTI has 18 employees as of November 2011.

The University of Tennessee has licensed its Atmosphere Uniform Glow Discharge Plasmas (OAUGDP) technology to Advanced Plasma Products, a subsidiary of Applied Science Products Inc., and has initially been adapted into a portable air purification system, the Triclean Pro. The technology creates plasma at low temperatures in normal atmospheric conditions, making it very cost effective and efficient in contrast with other methods of producing plasma that use extreme heat, vacuums or specialty gasses. Advanced Plasma Products is currently developing a product that will periodically disinfect medical waste loading chambers in hospitals that use pneumatic waste movement systems, and has its sights on a bench-top medical instrument sterilization device. Advanced Plasma Products employs 11 people.

Informatics Corporation of America (ICA): Several years ago physicians at the Vanderbilt University Medical Center (VUMC) set out to determine how to improve paperwork and communication processes. The goal was to find a system and method to organize and integrate all of the hospital's patient records and, ultimately, to improve the delivery of patient care. The health care information technology (IT) that was developed from this undertaking allowed VUMC to revamp information processes while still utilizing existing technology investments. Vanderbilt licensed the health care IT technology to ICA, a startup company located in Nashville, in which Vanderbilt University was an early investor. ICA, which was formed in 2005, today has 63

employees. It was also recently named one of the 50 fastest growing companies in Tennessee by the Nashville Post.

Automated Medical Diagnostics (AMDx), a startup company based in Memphis, envisions its product helping preserve the sight of millions of people, especially the indigent and those in areas that are medically underserved, at risk of vision loss from diabetic retinopathy. Using Telemedical Retinal Image Analysis and Diagnosis (TRIAD), a technology recently licensed by AMDx from the Department of Energy's Oak Ridge National Laboratory and the University of Tennessee Health Science Center, patients can quickly be screened for the disease in their primary care doctor's office and other remote sites, permitting early detection and referral for diabetic retinopathy and other retinal diseases.

Oak Ridge National Laboratory (ORNL) has entered into an exclusive patent license with LED North America, which intends to use graphite foam to cool components in LEDs used in street lamps and similar applications, enabling the company to offer longer warranty periods than its competitors. One of the founders of LED North American decided to locate the company in Tech2020, a business incubator in Oak Ridge. That decision brought with it several advantages. One is that the company is able to take advantage of the numerous resources offered by Tech2020 to its client companies, such as assistance in obtaining funding and access to experienced executives who can offer valuable advice. Another is that by being in proximity to ORNL, the company is able to work closely with the inventor, James Klett of ORNL's Materials Science and Technology Division, to further refine the integration of the graphite foam material into the LED lamps.

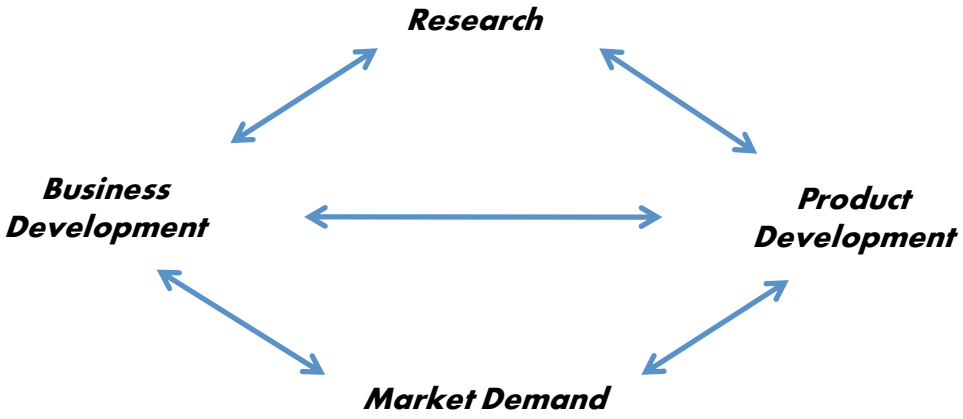
A Strategic Approach for Leveraging Tennessee's R&D Drivers for Technology-Based Economic Development and Sustaining High-Quality Job Creation

As Tennessee turns to advancing innovation and technology development by leveraging its substantial and growing R&D base, it is essential to bring a strategic approach that recognizes the process in which innovation and technology development and commercialization take place, as well as the nature of research and technology transfer.

Innovation and Technology Development Involves a Complex, Interactive and Market-Driven Process

It is important to recognize that moving innovation from research into the marketplace is not a simple linear "pipeline" approach that seamlessly moves from research to proof-of-concept to product development to business development. Instead, it is a highly complex, interactive, and market-driven process that calls for close attention to the quality and depth of linkages among the key drivers of technology development, including research performing institutions, technology-based business, and financial capital firms, among others.

Figure 1: Market-Driven Process of Innovation and Technology Development



Another important distinction around technology transfer, which is shared across the private return and societal perspectives, is the difference between technology transfer and technology commercialization.

A simple way to explain technology transfer is that at a minimum, it involves the passive management of intellectual property for a research organization. Technology transfer involves disclosure of research discoveries, the determination of whether to file for patent protection from both a technical and market perspective, and the licensing of the intellectual property to either a third party organization or the creation of a new business to pursue the creation of the product, process or other intervention based on the discovery and its associated license.

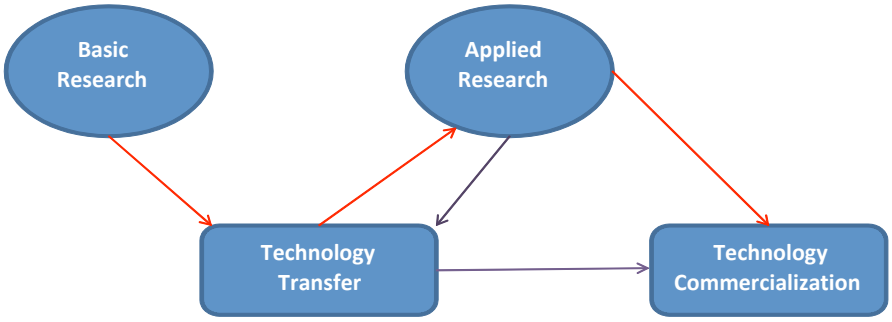
Complementing, but distinct from technology transfer, are more pro-active efforts to commercialize technologies, focused on enhancing technology solutions to meet the need(s) of customers in the marketplace. Technology commercialization is principally involved in product development, and involves proof-of-concept, prototyping and ensuring the ability to scale-up production. From a venture start-up perspective, technology transfer is not sufficient to form a venture, but is at a pre-start-up stage, while technology commercialization is involved in the early stage start-up activities that ensure the commercial potential of a new venture.

Basic and Applied Research both involve Technology Transfer but at Different Stages of Development

It is also important to recognize that not all research activities are the same, and their differences have implications for technology development. As shown in Figure 1, the two main types of research leading to technology development are:

- Basic research involving the general search for improved knowledge and understanding. Intellectual property (IP) from basic research is based on key discoveries that have the potential to advance new technology innovations.
- Applied research involving research to address development of specific applications and solutions using cutting edge technologies. Often applied research involves integration and convergence of leading technologies to solve a problem or develop an application.

Figure 2: Technology Transfer and its Connection to Basic and Applied Research



Both basic research and applied research can generate intellectual property and require further technology commercialization to enter the marketplace. But the starting points are different, and what is needed to move forward in terms of technology transfer activities can vary. In particular, a basic research discovery that has IP potential often needs additional applied research efforts to advance the discovery. For instance, a new research discovery of a key drug target still needs to go through drug development before it can be advanced as a new drug candidate for clinical testing. Similarly, a basic nanotechnology discovery of a new material or structure needs further applied research to develop more specific uses, which then needs to go through prototyping and scale up.

For applied research, the starting point is focused on advancing an application or solution in response to a market need and often involves convergence of multiple technologies. As such,

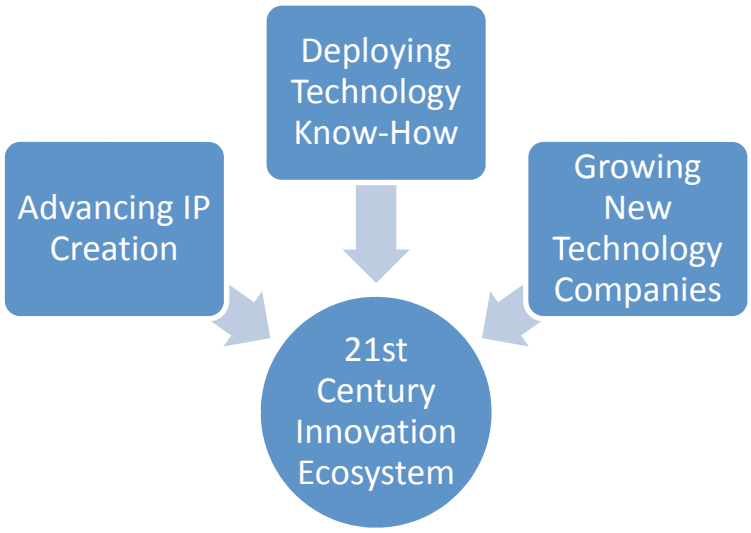
once the applied research is completed it becomes intellectual property that from a technology transfer perspective can then be disclosed, technically evaluated, assessed from a market potential, protected through patents or copyrights, licensed and information on it exchanged. If promising, it can then move into technology commercialization activities with an exclusive partner or number of non-exclusive partners for prototyping and other product line development activities.

Organizing for Success

To be successful Tennessee will need to create a 21st century innovation ecosystem that addresses three strategic priorities:

- **Advancing IP Creation** – It is not simply a matter of passively protecting intellectual property, but tackling the more pro-active steps needed to commercialize technologies in terms of assessing the market potential and commercial viability of innovations from research discoveries. Advancing IP creation can also be bi-directional with ideas of applied research for addressing market needs identified by companies also leading to IP creation, as well as the more traditional approach of basic research discoveries leading to IP creation.

Figure 3: Organizing Tennessee for Success



- **Deploying Technology Know-How** – The value of a state's R&D base is far more than simply a reflection of the output of research discoveries. An R&D base represents a set of core competencies or technology know-how that can be brought to address market needs of companies, and is closely linked to generating high skilled talent among graduates of higher education with specific knowledge that can propel industry innovation forward. What stands out is that specific areas with critical mass in technology know-how that can propel broader industry clusters forward. As Michael Porter from Harvard Business School explains:
"Clusters are a striking feature of virtually every national, regional, state and even metropolitan economy…Clusters are not unique; however, they are highly typical—and herein lies a paradox: the enduring competitive advantages in a global economy lie increasingly in local things—knowledge, relationships, motivation—that distant rivals cannot match."[8]

- **Growing New Technology Companies** – Simply having good ideas is not enough to succeed in the marketplace. It is essential to have in place the skilled entrepreneurs and

[8] Michael Porter, Harvard Business School Professor, "Clusters and the New Economics of Competition," Harvard Business Review, November-December 1998.

management teams as well as support resources and services that can turn innovative ideas into viable businesses. With a few notable exceptions such as Silicon Valley in California or Route 128 in Massachusetts, the entrepreneurial climate necessary to spawn high-growth enterprises has not developed fully and sustainably through market forces alone. The ability to build a critical mass of entrepreneurial management talent in a locality is first dependent on providing the resources that must be amassed to successfully build a company. Those resources may include technology, capital, professional expertise, and a host of other services such as assistance in determining economic feasibility and identifying markets and distribution channels.

Advancing IP Creation

Overview

Clearly, the greater the size of the research and development base, the more likely for there to be opportunities to advance IP creation, but the size of R&D budgets is not sufficient by itself to drive IP creation.

The starting point for advancing IP creation is largely the domain of each research performing institution to identify new research discoveries, legally protect the intellectual property generated by those research discoveries and then negotiate licenses and other forms of agreement to transfer those research discoveries to commercial entities primarily on an institution by institution basis.

The ability of research performing institutions to undertake technology transfer activities depends on the availability of qualified staff, particularly those who bring business expertise to help identify and negotiate with appropriate commercial entities, and funding to pay for legal expenses involved in filing patents. But what most significantly underpins the work of the technology transfer office is the receptivity of researchers to get involved in commercializing their research discoveries. Whether researchers are inclined to be receptive to technology commercialization is a personal decision, but one that is strongly influenced by the orientation of an institution towards technology commercialization as demonstrated by its leadership and research peers. It also relates to the specific rules set out by the research institution or federal policy, including how the researcher's tenure and other career advancement prospects within the research institution will be affected by spending time involved with advancing IP creation and technology commercialization, what limits are placed on the researcher's relationships with commercial entities and how the researcher is compensated from any economic returns from technology transfer and commercialization.

Once these IP management processes are in place, there still remains the key issues regarding how to bridge the gap between innovations and discoveries made in research institutions and commercial development of those research discoveries undertaken by businesses. This involves what we term "technology commercialization" versus "technology transfer." Technology transfer is the passive management of intellectual property (disclosures, patents, licenses), while technology commercialization takes basic scientific research and develops technology as a product/service to meet the needs of customers in the marketplace. Common tools used in technology commercialization include:

- **Translational Funding and Technology Commercialization Funding.** Providing access to proof-of-concept funding to assess the potential of technology, demonstrate proof of concept, or protect intellectual property.
- **Strategic Partnering.** Encouraging strategic partnerships between large companies and startups.
- **Market Assessments and Business Planning.** Intensive market assessments and business planning services to entrepreneurs with ideas to focus on market niches with cost effective products and markets.

- **Prototyping Facilities.** Offering prototype facilities and services to produce engineering prototypes or to produce test runs for marketing or evaluation purposes.
- **Scouting.** Supporting staff with business expertise to engage researchers to scout for discoveries that may have commercial potential.

Increasingly, the tools needed for technology commercialization are being made available through more statewide mechanisms that reach across research performing institutions.

Situational Assessment

Tennessee has a large and fast growing base of R&D across its research performing institutions. Tennessee has a diverse base of research performing institutions, including public and private research universities, national laboratories and research hospital centers. Altogether these research performing institutions reported R&D expenditures in FY 2010 of $2.5 billion, a substantial gain of $700 million from FY 2006.

On a percentage basis, the R&D expenditures at Tennessee's research performing institutions over the five year period, FY 2006 to FY 2010, increased a hefty 37%. This is despite the severe economic recession of 2007 to 2009.

To put this increase into perspective, from FY 2006 to FY 2009, the National Science Foundation reports that total university R&D expenditures in the nation rose a mere 15%. (Note: FY 2010 data on university R&D expenditures is not yet available).

Overall technology transfer and commercialization results across Tennessee's research performing institutions are not keeping pace with the growth in R&D expenditures. The strong growth in R&D expenditures for Tennessee's research performing institutions are not being reflected in gains in invention disclosures, patents filed, licenses or start-ups formed. The one bright spot is in patents issued, which rose 64% over the period.

Table 1: Gains in R&D Expenditures and Technology Transfer/Commercialization of Tennessee's Research Performing Institutions

Key Indicator	FY 2010 Level	Change from FY 2006 to FY 2010	% Change
Total Research Expenditures	$2.5 b	$700 m	37.3%
Invention Disclosures	496	28	6.0%
Patents Filed	319	30	10.4%
Patents Issued	128	50	64.1%
Licenses for IP	141	26	22.6%
In-State Start-ups Formed	8	2	33.3%

Source: Based on survey conducted by Battelle and TTDC.

Compared to the national average performance reported by the Association of University Technology Managers, Tennessee's research performing institutions are slightly off the mark in the level of technology transfer and commercialization results relative to their R&D budgets. Tennessee's research performing institutions in particular lag substantially in the number of start-ups formed, but also are behind in the level of invention disclosures, patents filed, and licenses compared to the national average of other research performing institutions.

Table 2: Comparison of FY 2010 Tennessee Research Performing Institution Technology Transfer and Commercialization Activities to 2009 National Averages

	Invention Disclosures per $10 million in R&D Expenditures	Patents Filed per $10 million in R&D Expenditures	Patents Issued per $10 million in R&D Expenditures	Licenses per $10 million in R&D Expenditures	Start-ups Formed per $10 million in R&D Expenditures
Tennessee Research Performing Institutions	2.0	1.2	0.5	0.6	0.03
National Average	3.8	2.2	0.6	0.9	0.11

Source: Tennessee results for FY 2010 based on survey conducted by Battelle and TTDC. National averages based on 2009 AUTM report that covers many of the nation's universities, national labs and research hospitals.

Perspectives of technology transfer managers from Tennessee's research performing institutions and leading technology industry executives in Tennessee suggest the need for improvements in technology transfer operations for advancing IP creation.

The Technology Transfer Managers of the nine (9) research performing institutions in Tennessee highlighted several key challenges and barriers that they are encountering in IP creation, including:

- Difficulties of advancing early stage discoveries.
- The institutional culture where researchers are primarily focused on publishing and operating their labs, while administrators want quick wins and selling IP off the shelf.
- Limitations in funding and staffing.
- Lack of entrepreneurial talent to drive new firm start-ups from IP creation.

More than half of the nineteen (19) technology industry executives surveyed viewed the technology transfer infrastructure found across Tennessee research performing institutions as a major barrier for advancing IP creation in Tennessee.

- Nine (9) out of the nineteen (19) technology industry executives rated the overall technology transfer infrastructure across Tennessee's research institutions as a major barrier and another seven saw it as a moderate barrier.
- The most significant issue for technology industry executives is the cumbersome nature of licensing technologies and the excess of procedures and processes in place at Tennessee's research performing institutions with nine (9) rating that as a major barrier and another three (3) as a moderate barrier.

Policy Implications

Consider developing a streamlined standard licensing agreement for Tennessee research performing institutions.

Build for success in advancing IP creation by focusing on high potential, strategic research areas leading to technology commercialization, new business formation and high-quality job generation, including multi-institutional research consortiums and the recruitment of eminent scholars in strategic research areas.

Continue to advance TTDC's technology maturation funding with more comprehensive services to advance promising research discoveries through new firm start-ups.

Best Practice Model

Proven Success: Georgia Research Alliance's VentureLab Program

- Focused on starting up new companies from university research through identifying promising technologies, conducting due diligence, supporting proof of concept and venture start-up.
- Provides for a rigorous and staged assessment of commercialization potential
- Three phase grant process:
  - Up to $50k grant → is it commercially feasible to support a new company
  - Up to $100k matching grant → prototype development – matching funds to validate in marketplace required
  - Up to $250k loan → Executed license + management team in place
- Supports "VentureLab" managers at each participating campus, who focus on recruiting and overseeing the efforts of serial entrepreneurs to move the VentureLab process forward.
- Requires outside review at Phase 3 by serial entrepreneurs and investors
- Results: 2002–2008
  - $17 million expended
  - 500+ university inventions or discoveries evaluated
  - 100+ active companies formed with 500+ employment
  - $350 million in equity investments raised

Innovative Idea to Watch: Carolina Express License

- New initiative to provide the option of a "standard" license agreement to ease the burden and time requirements on negotiations
- Focus is on increasing deal flow for equity rather than on maximizing immediate financial returns.
- Key provisions:
  - Reimbursement of patent expenses
  - 1.0% royalty on products requiring FDA approval

- 2% on all other products
- 0.75% payout of the companies fair market value upon a merger, sale, IPO, etc.
- No equity or milestone fees.

Deploying Technology Know-How

Overview

It is well understood that most job creation in state and regional economies is generated by existing businesses found in a state. At the same time, innovation is of particular importance for the competitiveness of all U.S. industries facing international competition, and especially technology-based industries. So, it is not surprising that one of the most effective approaches for technology-based economic development efforts to generate new high-quality jobs is by encouraging and fostering sustained relationships between existing companies in a state and the state's research performing institutions.

Along with the importance of innovation for existing U.S. technology-based businesses to compete with the recent emergence of strong new global competitors in technology, another key change in the technology landscape is the movement towards "open innovation." Today, many of our large technology companies are more integrators of technology advances and are moving away from their historical reliance on internal, captive corporate laboratories as the primary sources for new technologies and innovations. This shift to open innovation models is due to several factors including the market reality that in the face of global competition it is hard for corporations to support the high cost of internal R&D to the technological challenges posed by the more multi-disciplinary scientific and engineering competencies needed for technology advances that are beyond the reach of most corporations. The Economist in a special report on Innovation explains: *"According to popular notion, innovation is something that men wearing white coats in laboratories do. And that's the way it used to be. Companies set up vertically integrated R&D organizations and governments fussed over innovation policies to help them succeed. This approach had successes and many companies still spend pots of money on corporate research. But firms are growing increasingly disenchanted because the process is slow and insular. A global study across industries by Booz Allen Hamilton, a consultancy, even concluded that "higher R&D spending doesn't ensure better performance in terms of growth, profitability or shareholder returns…Now the centrally planned approach is giving way to the more democratic, even joyously anarchic, new model of innovation. Clever ideas have always been everywhere, of course, but companies were often too closed to pick them up. The move to an open approach to innovation is far more promising."*[9]

Accompanying the shift towards open innovation is the recognition of the importance of industry cluster development for knowledge-intensive, technology-based industries. In simple terms, cluster development reflects the fact that the emergence and growth of businesses do not occur in isolation, but often within the context of broader regional resources and industry presence. An interesting paradox is that the more global and integrated our economy becomes the more local R&D know-how, entrepreneurial culture, workforce skills and manufacturing competencies matter for economic success. In the emerging 21st century global competition, economic growth of particular clusters depends on the proximity of local assets. Harvard professors Gary Pisano and Willy Shih explain the importance of geographic proximity to the

[9] "Innovation: Something New Under the Sun," The Economist, Oct 11th 2007.

competitiveness of industries in a 2009 Harvard Business Review article: "*What about the popular notion that distance and location no longer matter, or, as Thomas Friedman put it, "The world is flat"?…the evidence suggests that when it comes to knowledge, distance does matter…An engineer in Silicon Valley, for instance, is more likely to exchange ideas with other engineers in Silicon Valley than with engineers in Boston. When you think about it, this is not surprising, given that much technical knowledge, even in hard sciences, is highly tacit and therefore far more effectively transmitted face-to-face.*"[10]

Both the shift towards open innovation and the focus on industry cluster development points to the need for fostering relationships and communications across and between universities who generate new discoveries, emerging technology companies focused on new product development and larger original equipment manufacturer (OEM) companies seeking to meet the needs of existing and emerging markets. This suggests that sustained and systematic approaches to create a culture of industry-university partnerships matter considerably to economic competitiveness and high-quality job creation.

Situational Assessment

Tennessee has a low and falling level of industry research and development expenditures over the last decade. In sharp contrast to the hefty gains in R&D expenditures at Tennessee's research performing institutions, Tennessee industry's R&D stood at $1.64 billion in 2007, the latest year available, well below the level of $2.4 billion in industry R&D for Tennessee reached in 1998. During this 1998 to 2007 period when Tennessee's industry R&D fell by 33%, the national level of industry R&D grew by 33%!

What is particularly disconcerting for Tennessee is the pattern of a lack of connection between industry and universities in research and development activities:

- **Of the one hundred forty (141) licenses that Tennessee's research performing institutions have in place, only twenty-eight (29) are with Tennessee companies.**
- **Industry support for R&D at Tennessee's universities is also quite low.** Among Tennessee's research universities, only $21.2 million of its $833 million in research and development expenditures were supported by industry. This represents 2.5% of the R&D funding of universities in Tennessee for FY 2009, and is less than half the national average level of industry R&D support for university R&D, which stood at 5.8% in FY 2009.

Example of LOIS in TINA?

The vast majority of technology industry executives surveyed saw the lack of engagement of industry and processes to match technologies with companies as a major or moderate barrier—at the same time, none of the technology transfer managers at Tennessee's research universities raised the issue, pointing to the extent of the disconnect.

Interestingly, from industries perspective, lack of engagement was also a problem (per 2013 forum)

- Of the nineteen (19) technology industry executives surveyed, seven (7) rated the lack of engagement with industry by Tennessee's research performing institutions as a major barrier and eight (8) as a moderate barrier to successful technology transfer and commercialization in Tennessee.

[10] Gary P. Pisano and Willy C. Shih, "Restoring American Competitiveness," Harvard Business Review, July 2009, page 3 of reprint.

- Of particular note was the lack of formal processes to match technologies with companies.

Policy Implications

- Advance regional technology industry clusters, in partnership with TTDC's regional innovation partners, through project-specific, competitive-based grants that address a key opportunity or gap identified within a specific region or across regions to support the growth and job generation of technology-based industry clusters.
- Establish a Tennessee industry-university applied research partnerships initiative to promote more effective collaborations in new product development and commercialization across existing Tennessee businesses, emerging companies and research performing institutions.

Best Practice Model

As of 2008, twenty-eight (28) states have matching grant programs that provide an incentive for firms to support research projects at local colleges and universities. Most of these programs solicit applications on a competitive basis and make awards to projects that are both technically sound and likely to have a positive economic development impact. All of the programs require that the company shares the cost of the research project, which is conducted by faculty and students on behalf of the company. The level of cost share can vary. Some programs vary the matching requirement based on the size of the company.

Proven Success: Maryland Industrial Partnerships Program (MIPS)

- MIPS has a proven track record of working with industry to accelerate the commercialization of technology by funding collaborative university-industry product R&D projects.
- Originally started as an outreach effort by the University of Maryland College Park Engineering School, MIPS has grown to encompass all campuses of the University of Maryland System across all fields.
- MIPS projects are conducted by university faculty and graduate students in conjunction with company researchers.
- Results:
    - More than 400 companies have participated in project awards worth more than $160 million since 1987.
    - MIPS-supported products have generated more than $19.5 billion in sales, added jobs to Maryland, and exported state-of-the-art Maryland-originated technology into the global marketplace. MIPS, for example, jointly funded six different research projects with MedImmune, including three directly related to their drug Synagis, the first monoclonal antibody approved for the prevention of an infectious disease. Total sales of Synagis© since 1998 exceed $6.4 billion.

Innovative Idea to Watch: Connecticut's Small Business Innovation Office

- Focuses on advancing the use of the federal SBIR program in the context of open innovation.
- Supports partnering across large corporations, who can define market needs and bring technology solutions to the market, with emerging and smaller technology companies, who in turn forge partnerships with universities to identify innovative approaches, access shared use laboratories and conduct testing/evaluation/proof-of-concept.
- An example of a grant competition for small technology businesses around a key technology need identified by a large defense contractor involving nanotechnology, matching large and small companies and a graduate fellowship program around research projects to bring new sensor technologies forward in companies.
- The key enabling infrastructure to advancing these partnerships is having a robust outreach effort to large companies needing innovations, small technology businesses and research leaders interested in working with industry and capturing that intelligence in a customer relationship management (CRM) software tool that enables active means to identify and reach potential partners.

Growing New Technology Companies

Overview

Even with success in generating discoveries and then moving them through the technology transfer and commercialization process, the value of leveraging a state's R&D base falls short if there is not a robust entrepreneurial culture to generate fast growing companies. Most people realize that the discovery of new knowledge resulting in the development of new technologies requires significant expertise and is a very expensive process, often requiring millions of dollars. What many people do not realize is that the management skills and costs associated with developing and taking a technology product or service to market also are very substantial. This involves moving product development forward and scaling up manufacturing, developing and executing a marketing and sales plan and growing a business organization.

Situational Assessment

There is a low level of new start-ups being generated by Tennessee's research performing institutions. As already identified, with only eight (8) start-ups in FY 2010, Tennessee's research performing institutions are lagging well behind other research institutions.

In measures of entrepreneurial activity across the overall economy, Tennessee has a mixed record. The U.S. Census of Business Dynamics is a unique database of the U.S. economy at the level of establishments with paid employees, which allows for measuring job openings and closings, start-ups and job levels by firm age. Tennessee lags the U.S. in the share of establishments and jobs found in firms that are five years old or less in 2009. But Tennessee has a slightly higher level in the size of firms that have been created in the last five years.

Table 3: Share of Establishments and Jobs – Tennessee vs. U.S. (2009)

	2009 Share of Establishments for Firms 5 Years and Less	2009 Share of Jobs for Firms 5 Years and Less	2009 Size of Firms 5 Years or Less
United States	28.8%	12.5%	7.4 workers
Tennessee	25.5%	10.7%	7.9 workers

Source: U.S. Census of Business Dynamics, 2009

Lacking the availability of funding at critical early stages of technology development is still viewed as a considerable barrier in Tennessee, based on technology industry executives surveyed.

- Of the nineteen (19) technology industry executives surveyed, nine (9) rated availability of funding at critical early stages of technology development as a major barrier and another eight (8) as a moderate barrier.

- Proof-of-concept, prototyping and seed funding for company formation were all viewed as key barriers in Tennessee by the technology industry executives.

The lack of entrepreneurial talent in Tennessee was generally viewed as barrier by technology industry executives, but not as significant as the availability of capital.

- Of the nineteen (19) technology industry executives surveyed, six (6) rated the lack of entrepreneurial talent as a major barrier and another nine (9) as a moderate barrier.

Policy Implications

- Build out the capacity for a statewide commercialization and mentor network to ensure high-quality entrepreneurial services across the state, including entrepreneurial education, technical assistance and mentoring of aspiring high-growth Tennessee entrepreneurs with business advisors based on relevant technology and business development experience.
- Develop an entrepreneurial assistance component to the TNInvestco program to improve the quality of deal flow among Tennessee's start-up and emerging technology businesses seeking venture capital funding through business advisory services, including business plan evaluation, expanding the access to professional service resources each entrepreneur needs to be successful and mentoring assistance.

Best Practice Model

Proven Success: i2E, Inc., Oklahoma

I2E, Inc. (innovation to enterprise) is a non-profit corporation focused on growing technology-based companies in Oklahoma with support from the state's technology development agency (the Oklahoma Center for the Advancement of Science and Technology, OCAST).

- i2E offers a range of enterprise development services including:
  - Technology, Market & Competitive Assessment Research
  - Comprehensive Strategy & Business Plan Review
  - Emerging Enterprise Evaluation Workshop
  - Development & Critique of Investor Presentation
- i2E guides entrepreneurs and offers them access to the tools to conduct a full business risk assessment, analyze their market, develop a market-based valuation, and write a business plan, ultimately preparing them for capital sources. This includes angel investor networks that i2E cultivates as well as a proof-of-concept and seed funding they provide on behalf of the state's technology development agency.
- Results:
  - Each year i2E serves about 200 entrepreneurs.
  - Between 40–50% of i2E's clients raise equity capital.
  - Through i2E's enterprise development services and state supported venture financing of $26,553,345, the entrepreneurs they have assisted have attracted an additional $238,603,738 in private investment.

Performance Assessment of Technology Transfer and Commercialization at Tennessee's Research Institutions

Technology Transfer & Commercialization Performance in Tennessee

Battelle assisted Tennessee Technology Development Corporation in conducting an inaugural survey of technology transfer and commercialization activities at eight (8) major research institutions in Tennessee to help determine the impact of these types of activities on the lives of people living in the state and the state's economy over a five (5) year period from FY 2006–FY 2010. As shown in Table 4, combined these eight (8) institutions in FY 2010 reported $2.5B in research expenditures, a 37% increase from FY 2006. This increase in research expenditures over this five (5) year period shows that the Tennessee institutions are continuing to establish a pipeline of research that could potentially lead to commercialized technologies in the future.

It is evident that the increase in research expenditures has also led to growth in the intellectual property portfolio for these institutions in Tennessee. This is demonstrated through the increase in invention disclosures (6% increase), U.S. patent applications (10.4% increase) and U.S. patents issued (64.1% increase). The decrease in the foreign patent applications and the foreign patents issued over this period was probably due to the majority of the institutions reacting to the adverse global economic conditions and cutting back on paying the additional fees to pursue foreign patents.

From an economic impact standpoint, the Tennessee institutions overall are making a significant contribution to the state by supporting a growing number of in-state licensees (29 licensees, an increase of 38%) and start-ups (8 start-ups, an increase of 33%), and they have brought the $13 million in licensing income into the state. These institutions have also had an impact outside of the state as indicated by the 23% growth in licenses granted. The only area where the economic impact of the Tennessee institutions has decreased since FY 2006 is in licensing income at -16.9%. This decrease in licensing income is likely the result of fees from licenses at the institutions reaching the end of the licensing period. Tennessee has also seen an increase in technology transfer talent with the institutions increasing full-time equivalent staff by 58% from FY 2006–FY 2010. This increased talent should also help Tennessee continue to increase the number of licenses executed and start-ups to help create growth in the state as well as nationally.

Table 4: Tennessee Institution Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$1,809,432,107	$2,484,632,448	$675,200,341	37.3%
Invention Disclosures	468	496	28	6.0%
U.S. Patent Applications	289	319	30	10.4%
U.S. Patents Issued	78	128	50	64.1%
Foreign Patent Applications	168	143	-25	-14.9%
Foreign Patents Issued	115	85	-30	-26.1%
Licenses	115	141	26	22.6%
Licensing Income	$12,992,468	$10,800,315	-$2,192,153	-16.9%
In State Licensees	21	29	8	38.1%
In State Start-ups	6	8	2	33.3%
FTEs in Tech Transfer Office	32.1	50.55	18.5	57.5%

Overall Evaluation of Technology Transfer & Commercialization Performance in Tennessee

In Table 5, an overall evaluation of technology transfer and commercialization performance at each of the eight (8) Tennessee institutions is provided to show which institutions have experienced the greatest change in each of the respective activities during the five (5) year period. All of the research institutions that reported research expenditures from FY 2006–FY 2010 experienced positive growth with the most significant growth occurring at St. Jude Children's Research Hospital. This positive trend among the institutions is the reason why there was an overall increase in research expenditures from FY 2006–FY 2010.

The changes in invention disclosures, U.S. patent applications and U.S. patents issued since FY 2006 has been mixed across institutions. Among the bright spots were significant gains by the University of Memphis and Y-12 in disclosures, Tennessee Board of Regents in disclosures and patent applications, Vanderbilt in foreign patents, St. Jude Children's Research Hospital in licensing income, and Oak Ridge National Lab in patents issued, total licenses, in-state licenses, and start-ups.

Since FY 2006 the technology transfer full time equivalent (FTE) staffing has been pretty stable at the majority of the institutions with Y-12 having the greatest increase of talent during this timeframe to help foster the transfer of technology in the state.

Table 5: Overall Evaluation of Technology Transfer and Commercialization Performance for Tennessee Institutions

All Institutions	Meharry Medical College	Vanderbilt University	University Tennessee Research Foundation (UTRF)	St. Jude Children's Research Hospital	University of Memphis	Y-12 National Security Complex	Oak Ridge National Laboratory (ORNL)	Tennessee Board of Regents (Excluding Univ. of Memphis)
RESEARCH EXPENDITURES								
★★		★★	★★	★★★	★★	★★	★★	n/a
INVENTION DISCLOSURES								
★		★	○	○	★★★	★★★	○	★★★
U.S. PATENT APPLICATIONS								
★		★	○○	★			★★	★★★
U.S. PATENTS ISSUED								
★★★		★★	★★	○○		★★★	★★★	○○○
FOREIGN PATENT APPLICATIONS								
○		★★	○○	○○○			★★	○○○
FOREIGN PATENTS ISSUED								
○○	n/a	★★★	★★★	○○○		○○	○	
LICENSES								
★★		★★	★	○○		○○○	★★★	
LICENSING INCOME								
○		○○	○○	★★★	n/a	★	○	n/a
IN STATE LICENSEES								
★★		★★	○○			★	★★★	
IN STATE START-UPS								
★★		○○○	★★				★★★	
FTES IN TECH TRANSFER OFFICE								
★★★		★	○			★★★	n/a	

Legend:

no symbol = 0%	n/a = data not available
★ = 1 to 20% change from FY 2006–2010	○ = -1 to -20% change from FY 2006–2010
★★ = 21 to 50% change from FY 2006–2010	○○ = -21 to -50% change from FY 2006–2010
★★★= greater than 50% change from FY 2006–2010	○○○= greater than -50% change from FY 2006–2010

In the following are a detailed assessment of the technology transfer and commercialization activities and a discussion of programs or approaches used to help facilitate these activities at each of the eight (8) Tennessee research institutions that participated in this survey.

Meharry Medical College

Table 6: Meharry Medical College Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$40,000,000	$40,000,000	$0	0.0%
Invention Disclosures	1	1	0	0.0%
U.S. Patent Applications	0	0	0	0.0%
U.S. Patents Issued	0	0	0	0.0%
Foreign Patent Applications	0	0	0	0.0%
Foreign Patents Issued	-	-	-	-
Licenses	0	0	0	0.0%
Licensing Income	$0	$0	$0	0.0%
In State Licensees	0	0	0	0.0%
In State Start-ups	0	0	0	0.0%
FTE in Tech Transfer Office	0	0	0	0.0%

Assessment of the Institution's Tech Transfer Performance

Meharry Medical College is a medical university that does not have a standalone technology transfer office with staff and has been limited in the amount of activity that it has performed in this area over the last five (5) years. The research pipeline at Meharry Medical College has been consistent with about $40 million spent in research expenditures each year since FY 2006. The research area that has the greatest technology transfer and commercialization potential at this institution is focused on health disparities such as HIV/AIDS and cancer. Meharry outsources the evaluation of invention disclosures to help them determine whether or not to pursue a patent and have had limited volume with only one (1) invention disclosure and no patents prosecuted since FY 2006. Without any patents in their portfolio and no staff focused technology transfer, Meharry did not have any licensees or start-ups formed to help create economic impact in the state or outside the area from FY 2006–2010.

Institutional Approaches or Programs to Facilitate Tech Transfer

Meharry has had some current efforts that could help institution make continued progress in the technology transfer area going forward.

- The institution has recently secured two (2) patents in the HIV/AIDS area that could be potentially licensed and generate some licensing income.
- There are also opportunities for the institution to develop programs in the future focused on educating faculty about technology transfer and commercialization, which could also lead to an increase in the amount of intellectual property created from university technology and potentially lead to commercialization via licensing or start-ups.

Vanderbilt University

Table 7: Vanderbilt University Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$387,857,107	$491,632,448	$103,775,341	26.8%
Invention Disclosures	132	133	1	0.8%
U.S. Patent Applications	99	110	11	11.1%
U.S. Patents Issued	15	19	4	26.7%
Foreign Patent Applications	32	47	15	46.9%
Foreign Patents Issued	41	11	-30	-73.2%
Licenses	47	65	18	38.3%
Licensing Income	$8,553,468	$4,809,815	-$3,743,653	-43.8%
In State Licensees	3	4	1	33.3%
In State Start-ups	2	0	-2	-100.0%
FTE in Tech Transfer Office	15	15.75	0.75	5.0%

Assessment of the Institution's Tech Transfer Performance

Vanderbilt University is an institution with an established technology transfer office that has had 15 FTEs since FY 2006 to help foster the transfer and commercialization of university technology. The research expenditures at Vanderbilt have continued to grow by 27% from $388 to $492 million over the last five (5) years to help create a growing source of potential ideas that can be disclosed. Some of the research areas that have the potential to foster technology transfer and commercialization are drug discovery and diagnostics, personalized medicine, medical devices, healthcare information technology and robotics. This institution has had upward growth in with most of the areas in its intellectual property portfolio over the last five (5) years with slight increases in invention disclosures (1% increase) and U.S. patent applications (11% increase) and more significant increases with U.S. patent issued (27% increase) and foreign patent applications (47% increase). The area with respect to Vanderbilt's intellectual property that experienced a decrease since FY 2006 was foreign patents issued. This could be the direct result of the global economic crisis or a change in strategy not to pursue these patents. About 90–95% of the licenses executed at this university are with existing firms. The increase in in-state licensees over the last five years shows that Vanderbilt has been consistently making a contribution to the economy in the state, but its economic impact from a licensing income has had less impact with a decrease of 44% (or 3.7 million) during this timeframe. This decrease in licensing income could be the result of licenses that previously generated significant income is reaching the end of the term.

Institutional Approaches or Programs to Facilitate Tech Transfer

Vanderbilt has started the following approaches to help facilitate technology transfer and commercialization:

- **Formation and support of Cumberland Emerging Technologies** – A joint effort between Vanderbilt University, Cumberland Pharmaceuticals and Tennessee

Technology Development Corporation to help foster the development of biomedical technology from the lab to the marketplace by early stage companies through the expertise and services from the three institutions.

- **Creation of an on-line store for ease of licensing software tools** – The online store helps to market the tools and makes it easier for potential licenses to conduct a licensing transaction with the university.
- **Tech Transfer Support Services** – These services include support of faculty members exploring company formation and seeking investors to commercialize Vanderbilt university technology.

University of Tennessee Research Foundation (UTRF)

Table 8: Univ. of Tennessee Research Foundation Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$240,000,000	$323,000,000	$83,000,000	34.6%
Invention Disclosures	92	91	-1	-1.1%
U.S. Patent Applications	78	60	-18	-23.1%
U.S. Patents Issued	15	22	7	46.7%
Foreign Patent Applications	101	58	-43	-42.6%
Foreign Patents Issued	19	33	14	73.7%
Licenses	14	16	2	14.3%
Licensing Income	$954,000	$629,000	-$325,000	-34.1%
In State Licensees	6	3	-3	-50.0%
In State Start-ups	2	3	1	50.0%
FTE in Tech Transfer Office	10.8	10.5	-0.3	-2.8%

Assessment of the Institution's Tech Transfer Performance

The University of Tennessee Research Foundation (UTRF) is an established organization with about 11 FTEs that have responsibility for the university's technology transfer, commercialization and economic development activities. At the University of Tennessee, the amount of research expenditures has increased by 35% during the last five (5) years, which is creating a larger pool of technology innovations from UTRF that could be potentially commercialized. An increase in the number of U.S. and foreign patents issued since FY 2006 indicates that UTRF has increased its intellectual property (IP) portfolio, but the decrease in U.S. and foreign patent applications as well as a slight decrease in invention disclosures may eventually lead to the size of their intellectual property portfolio decreasing in the future. Licensing activity has slightly increased by 14.3% from FY 2006–FY 2010, but this has not resulted in an increase in licensing income or in-state licenses, which experienced decreases of 34% and 50%. Overall, the UTRF has contributed to the economic growth of the state with a 50% increase in the number of start-ups from since FY 2006 and licensing income of $629,000 in FY 2010.

Institutional Approaches or Programs to Facilitate Tech Transfer

UTRF has started the following approaches to help facilitate technology transfer and commercialization

- **TNovation** – A new company created with Technology 2020 to allow students to submit SBIR/STTR proposals in conjunction with university researchers. Only one set of proposals has been submitted for this effort. Therefore, it is too early to determine whether or not this initiative will be successful.
- **Maturation Funding Program** – This is a gap funding program ($15,000 each) to help technologies become more attractive to commercial partners. The latest estimates

indicate that $220,000 of funding over four (4) years has resulted in over $2 million in commitments (i.e., additional research dollars, SBIR funding, licensing fees, projected royalties) back to the university.

- **TN Community Ventures** – A partnership with the TNInvestco fund to help fund university affiliated start-up companies. $1.5 million has been committed to commercialize technology at the University of Tennessee

St. Jude Children's Research Hospital

Table 9: St. Jude Children's Research Hospital Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$190,000,000	$286,000,000	$96,000,000	50.5%
Invention Disclosures	43	36	-7	-16.3%
U.S. Patent Applications	16	18	2	12.5%
U.S. Patents Issued	9	5	-4	-44.4%
Foreign Patent Applications	15	5	-10	-66.7%
Foreign Patents Issued	9	3	-6	-66.7%
Licenses	26	20	-6	-23.1%
Licensing Income	$1,309,000	$3,404,000	$2,095,000.	160.0%
In State Licensees	0	1	1	0.0%
In State Start-ups	0	0	0	0.0%
FTE in Tech Transfer Office	5	5	0	0.0%

Assessment of the Institution's Tech Transfer Performance

St. Jude Children's Research Hospital has an established technology transfer office that is staffed with 5 FTEs. The research enterprise at St. Jude has continued to grow by 51% from FY 2006–FY 2010, which should lead to increased opportunities transfer and commercialize technologies from this medical institution in the future. The intellectual property that is being produced at St. Jude has experienced a decrease since FY 2006—U.S. patents issued decreased by 44% and foreign patents issued and foreign patent applications both decreased by 67%. The prospects for St. Jude to experience an increase in intellectual property could potentially be favorable going forward since they have increased their U.S. patent applications by 13% since FY 2006. The number of licenses at St. Jude has decreased by 23% from FY 2006–FY 2010, but St. Jude has created economic impact through their licensing income that has increased by $2 million since FY 2006.

Institutional Approaches or Programs to Facilitate Tech Transfer

Examples of the approaches and initiatives that St. Jude has started to help foster technology transfer are as follows:

- **Creation of GMP facility**
- **Creation of Chemical Biology Group**
- **Considering creating fund to support prototype creation** – The size internally funded effort would be $100,000/yr and it would be utilized to provide proof of concept support for St. Jude technologies (such as medical devices) that need additional testing or validation before a patent application is filed or licensing occurs.

University of Memphis

Table 10: University of Memphis Technology Transfer/Commercialization Performance FY 2006–2010

Institution Name	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$37,000,000	$50,000,000	$13,000,000	35.1%
Invention Disclosures	3	18	15	500.0%
U.S. Patent Applications	0	5	5	0.0%
U.S. Patents Issued	0	1	1	0.0%
Foreign Patent Applications	0	7	7	0.0%
Foreign Patents Issued	0	0	0	0.0%
Licenses	0	1	1	0.0%
Licensing Income	-	$74,000	-	-
In State Licensees	0	1	1	0.0%
In State Start-ups	0	0	0	0.0%
FTE in Tech Transfer Office	0	2	2	0.0%

Assessment of the Institution's Tech Transfer Performance

The University of Memphis is a Tennessee Board of Regents institution that has just started to emerge in the area technology transfer and commercialization. Their technology transfer office was started in FY 2008 with one (1) full time staff member and has grown to 2 FTEs in FY 2010. The research expenditures at this university have continued to grow by 35% since FY 2006. Some of the research areas that are considered strengths and that may lead to future licensing deals and start-ups at the University of Memphis are chemistry (including nanocapusules, drinking water analysis, and oncology drugs), biomedical engineering (specifically implantable materials), intelligent tutoring systems, advanced sensors, and optimization of complex networks. The breadth of intellectual property is still emerging at this institution with only one U.S. issued patent in FY 2010, but there is the potential for future growth with five (5) U.S. patent applications and seven (7) foreign patent applications filed in FY 2010. The amount of economic impact that the University of Memphis is currently having on the state is limited with only one (1) in-state license executed in FY 2010 that produced $74,000 in licensing income.

Institutional Approaches or Programs to Facilitate Tech Transfer

Some of the approaches and initiatives that the University of Memphis is pursuing to help foster technology transfer are the following:

- **Proof of Concept funding** – Establishment of funding to market, test, and validate early stage university technologies to decrease the technical risk where they will be more attractive for licensing by established or start-up companies
- **Center for Entrepreneurship Participation** – The technology transfer office provides their support and expertise to the companies that will be in this "pre-incubator" on campus.

Y-12 National Security Complex

Table 11: Y-12 National Security Complex Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$15,000,000	$19,000,000	$4,000,000	26.7%
Invention Disclosures	28	50	22	78.6%
U.S. Patent Applications	8	8	0	0.0%
U.S. Patents Issued	2	8	6	300.0%
Foreign Patent Applications	1	1	0	0.0%
Foreign Patents Issued	2	1	-1	-50.0%
Licenses	2	0	-2	-100.0%
Licensing Income	$130,000	$146,000	$16,000	12.3%
In State Licensees	11	13	2	18.2%
In State Start-ups	0	0	0	0.0%
FTE in Tech Transfer Office	1	2	1	100.0%

Assessment of the Institution's Tech Transfer Performance

Y-12 National Security Complex is a federal government, manufacturing facility that has a small, established staff (i.e., 2 FTEs) that supports its technology transfer efforts. The research expenditures have continued to increase by 27% at Y-12 since the FY 2006. This organization has continued to grow its intellectual property from FY 2006-FY 2010 with a 79% increase in invention disclosures and a 300% increase in U.S. patents issued. The growth in invention disclosures was the direct result of outreach efforts that the technology transfer office implemented to help researchers understand the disclosure process. U.S. patent applications have remained consistent, which should allow Y-12 to maintain their current amount of intellectual property. Foreign patents applications and foreign patents are not a major part of the intellectual property for Y-12 because of export rights, which limit foreign use of the technologies that they develop. The level of economic impact that Y-12 has brought to the state has continued to grow from FY 2006-2010 with a 12% increase (from $130k to $146k) in licensing income and an 18% increase in the number of in-state licenses granted.

Institutional Approaches or Programs to Facilitate Tech Transfer

Y-12 has implemented a variety of approaches and programs to help foster technology transfer, which are discussed in the following:

- **Internal communications to encourage invention disclosure** – The technology transfer office has initiated internal outreach efforts to better inform researchers about the invention disclosure process.
- **Open Innovation** – Y-12 has a contract with Yet2.com, a technology transfer intermediary to help market their technologies through their online portal site

- **Social Media** – Y-12 is using social media (such as Facebook, Twitter, Flickr, and YouTube) to help share information and market their technologies to potential licensees.

Oak Ridge National Laboratory

Table 12: Oak Ridge National Laboratory Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	$890,000,000	$1,275,000,000	$385,000,000	43.3%
Invention Disclosures	167	162	-5	-3.0%
U.S. Patent Applications	85	109	24	28.2%
U.S. Patents Issued	36	73	37	102.8%
Foreign Patent Applications	18	25	7	38.9%
Foreign Patents Issued	44	37	-7	-15.9%
Licenses	25	38	13	52.0%
Licensing Income	$2,046,000	$1,737,500	-$308,500	-15.1%
In State Licensees	1	6	5	500.0%
In State Start-ups	2	4	2	100.0%
FTE in Tech Transfer Office	-	15	-	-

Assessment of the Institution's Tech Transfer Performance

Oak Ridge National Laboratory is a federal Government Laboratory with an established technology transfer office of 15 FTEs that support the transfer and commercialization of technologies produced at the lab. Since FY 2006, the lab has experienced a 43% increase to grow its research expenditures to $1.3 billion in FY 2010, which is the largest among the institutions in the state. This amount of research has a great potential to produce technologies that can transferred and commercialized in the marketplace. The intellectual property portfolio at ORNL has continued to grow since FY 2006 due to a 103% increase in U.S. patents issued. Most of the inventions at ORNL have come from the materials research area. There is the potential for additional intellectual property growth in the future at this institution due to a 28% increase in U.S. patent applications and a 39% increase in foreign patent applications. The only intellectual property area where ORNL has experienced a decrease is with the number of foreign patents issued, and this could be due to global economic environment from FY 2007 to FY 2009 that caused ORNL to pursue less foreign patents. ORNL has continued to provide economic impact to the state since FY 2006 with an increase in the number of in-state licensees (from 1 to 6) and in-state start ups (from 2 to 4). ORNL has continued to help bring economic value to the state despite a 15% decrease in licensing income since FY 2006 from $2 million to $1.8 million in FY 2010. This organization has also contributed to the impact of areas nationally and this was exhibited through its 52% increase in licenses since FY 2006.

Institutional Approaches or Programs to Facilitate Tech Transfer

ORNL has initiated the following approaches to help facilitate technology transfer and commercialization:

- **SPARK Technology Forum** – This is a program that presents technology-based business opportunities (based upon ORNL high potential technologies) to investors.

- **Technology Maturation Funding** – This is internal gap funding at ORNL that is used to allow the inventor to perform further work on the technology in an effort to advance it or qualify beyond its current state, to help decrease the technical risk, and to make the technology a more attractive candidate for licensing.
- **Science & Technology (S&T) Park** – S&T Park is established research park facilities for private companies either directly on campus of ORNL that offers the lab's scientists an opportunity to collaborate with these companies and form partnerships between the lab and the company.

Tennessee Board of Regents (Excluding Univ. of Memphis)

Table 13: Tennessee Board of Regents (Excluding Univ. of Memphis) Technology Transfer/Commercialization Performance FY 2006–2010

Key Indicator	FY 2006	FY 2010	Net Change from FY 2006 to FY 2010	% Change from FY 2006 to FY 2010
Research Expenditures	-	-	-	-
Invention Disclosures	2	5	3	150.0%
U.S. Patent Applications	3	9	6	200.0%
U.S. Patents Issued	1	0	-1	-100.0%
Foreign Patent Applications	1	0	-1	-100.0%
Foreign Patents Issued	0	0	0	0.0%
Licenses	1	1	0	0.0%
Licensing Income	$0	$0	0	0.0%
In State Licensees	0	1	1	0.0%
In State Start-ups	0	1	1	0.0%
FTE in Tech Transfer Office	0.3	0.3	0	0.0%

Assessment of the Institution's Tech Transfer Performance

The Tennessee Board of Regents (excluding University of Memphis) does not have a technology transfer office to support its five other universities primarily because these institutions do not generate enough technology to justify an office. Tennessee Technological (or Tennessee Tech) University is the only Tennessee Board of Regents institution that reported utilizing very limited resources to provide support for these activities with a staff member only spending about 1/3 of their time (i.e., 0.3 FTE) on tech transfer. These schools have traditionally been viewed as teaching colleges with an engineering focus, but are starting to increase their interest in research and technology transfer. The research expenditures for these institutions were not available from FY 2006–FY 2010 to determine whether or not a pipeline of inventions is being created that could be potentially commercialized. Despite the minimal number of U.S. or foreign patents issued (i.e., one U.S. patent issued and no foreign patents issued), the future growth prospects for additional intellectual property by the Tennessee Board of Regents look favorable based upon the 150% increase in invention disclosures and the 200% increase in U.S. patent applications since FY 2010. These institutions have had a limited economic impact through its technology transfer activities providing one (1) in-state licensee, one (1) in-state start-up and a very small amount of licensing income, which has not been tracked.

Institutional Approaches or Programs to Facilitate Tech Transfer

The Tennessee Board of Regents has started the following approaches to help facilitate technology transfer and commercialization:

- **Leverage their relationship with the Tennessee Board Regents** – Tennessee Tech's close working relationship with Tennessee Board of Regents' counsel has been very helpful.

- **Willingness to work with inventors** – This has been a process where the technology transfer office at Tennessee Tech has been more active in communicating with inventors regarding the technology transfer.

The following could be a program that is being considered to potentially help the Tennessee Board of Regents schools in the future:

- **Recruitment Fund to Hire Research Talent** – This potential initiative would involve the establishment of a fund that would allow the Tennessee Board of Regent institutions to hire faculty with a research interest in their areas of strength to help change the culture (from a teaching to research focus) at the respective institutions.

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Appendix A:

Tennessee Institutional Survey Data, FY 2006–FY 2010

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Tennessee Institutional Survey Data FY 2006–FY 2010

Institution/ Organization:	All Institutions	Meharry Medical College	Vanderbilt University	UT Research Foundation	St. Jude Children's Research Hospital	University of Memphis	Y-12 National Security Complex	Oak Ridge National Laboratory	Tennessee Board of Regents (Excluding Univ. of Memphis)
Total Research Expenditures:									
FY 2006	$1,809,432,107	$40,000,000	$387,857,107	$240,000,000	$190,000,000	$37,000,000	$15,000,000	$890,000,000	-
FY 2007	$1,983,318,342	$40,000,000	$411,092,342	$236,000,000	$212,000,000	$43,000,000	$15,000,000	$1,014,000,000	-
FY 2008	$2,176,074,462	$40,000,000	$444,332,462	$242,000,000	$236,000,000	-	$18,000,000	$1,184,000,000	-
FY 2009	$2,366,099,428	$40,000,000	$457,357,428	$276,000,000	$282,000,000	$54,000,000	$18,000,000	$1,227,000,000	-
FY 2010	$2,484,632,448	$40,000,000	$491,632,448	$323,000,000	$286,000,000	$50,000,000	$19,000,000	$1,275,000,000	-
Invention Disclosures Received:									
FY 2006	468	1	132	92	43	3	28	167	2
FY 2007	472	1	144	66	50	13	19	177	2
FY 2008	475	1	133	90	39	19	20	167	6
FY 2009	482	2	150	84	43	15	22	161	5
FY 2010	496	1	133	91	36	18	50	162	5
Total U.S. Patent Applications Filed:									
FY 2006	289	0	99	78	16	0	8	85	3
FY 2007	298	0	119	62	20	4	10	79	4
FY 2008	303	0	129	58	21	11	6	68	10
FY 2009	298	0	107	67	19	17	8	74	6
FY 2010	319	0	110	60	18	5	8	109	9
U.S. Patents Issued:									
FY 2006	78	0	15	15	9	0	2	36	1
FY 2007	91	0	27	15	7	0	2	40	0
FY 2008	58	0	16	15	5	0	3	18	1
FY 2009	71	0	17	19	5	1	2	27	0
FY 2010	128	0	19	22	5	1	8	73	0
Total Foreign Patent Applications Filed:									
FY 2006	168	0	32	101	15	0	1	18	1
FY 2007	187	0	48	94	34	0	0	10	1
FY 2008	181	0	27	106	48	0	0	not recorded	0
FY 2009	172	0	19	97	31	3	1	21	0
FY 2010	143	0	47	58	5	7	1	25	0
Foreign Patents Issued:									
FY 2006	115	-	41	19	9	0	2	44	0
FY 2007	105	-	23	19	3	0	3	57	0

Institution/ Organization:	All Institutions	Meharry Medical College	Vanderbilt University	UT Research Foundation	St. Jude Children's Research Hospital	University of Memphis	Y-12 National Security Complex	Oak Ridge National Laboratory	Tennessee Board of Regents (Excluding Univ. of Memphis)
FY 2008	68	-	25	18	21	0	4	not recorded	0
FY 2009	124	-	15	28	33	0	1	47	0
FY 2010	85	-	11	33	3	0	1	37	0
Number of Licenses & Options Executed:									
FY 2006	115	0	47	14	26	0	2	25	1
FY 2007	119	0	38	13	40	1	1	24	2
FY 2008	123	0	46	18	20	0	2	36	1
FY 2009	124	0	46	19	25	1	2	29	2
FY 2010	141	0	65	16	20	1	0	38	1
Licensing Income Received: (This includes: license issue fees, payments under options, annual minimums, running royalties, termination payments, the amount of equity received when cashed-in, and software and biological material end-user license fees equal to $1,000 or more, but not research.)									
FY 2006	$12,992,468	$0	$8,553,468	$954,000	$1,309,000	-	$130,000	$2,046,000	$0
FY 2007	$15,552,184	$0	$9,010,684	$1,238,000	$2,529,000	-	$127,000	$2,647,500	$0
FY 2008	$17,327,478	$0	$8,322,536	$3,834,000	$2,580,000	-	$479,000	$2,111,942	$0
FY 2009	$17,878,965	$0	$11,329,700	$2,167,000	$3,135,000	$35,000	$145,000	$1,067,265	$0
FY 2010	$10,800,315	$0	$4,809,815	$629,000	$3,404,000	$74,000	$146,000	$1,737,500	$0
Number of Licensees with Primary Place of Business in TN:									
FY 2006	21	0	3	6	0	0	11	1	0
FY 2007	25	0	7	4	0	1	12	1	0
FY 2008	29	0	4	7	0	0	12	6	0
FY 2009	27	0	2	9	0	0	13	3	0
FY 2010	29	0	4	3	1	1	13	6	1
In-State Start-ups Formed as a result of the Institution's IP:									
FY 2006	6	0	2	2	0	0	0	2	0
FY 2007	5	0	2	2	0	0	0	1	0
FY 2008	8	0	1	2	0	0	0	5	0
FY 2009	11	0	1	5	0	0	0	5	0
FY 2010	8	0	0	3	0	0	0	4	1
Number of Full-Time Equivalent (FTE) Employees in the Tech Transfer Office:									
FY 2006	32.1	0	15	10.8	5	0	1	-	0.3
FY 2007	50.05	0	16.25	11.5	5	0	1	16	0.3
FY 2008	51.55	0	14.75	13.5	5	1	1	16	0.3
FY 2009	52.3	0	16.5	12.5	5	1	1	16	0.3
FY 2010	50.55	0	15.75	10.5	5	2	2	15	0.3