Tennessee Innovation Road Map

Building Tennessee's Technology Economy

TENNESSEE
ECONOMIC & COMMUNITY DEVELOPMENT

With funding from the Tennessee Technology Development Corporation

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Mr. Dan Marcum
Chairman
Tennessee Technology Development Corporation

Mr. Eric Cromwell
Director, Technology Development Division
Tennessee Dept. of Econ. & Comm. Development

Dear Gentlemen:

On behalf of the entire team of New Economy Strategies, LLC, I am pleased to transmit the completed and final version of the Innovation Road Map funded and prepared on behalf of the Tennessee Technology Development Corporation. Through the counsel and direction of Chairman Marcum, the conceptual and administrative support of Commissioner Kisber, Eric Cromwell, and the ECD staff, we believe the future of the State and its many institutions, organizations and assets are on a competitive and innovative path.

We expect the findings and recommendations provided initially in February of this year to start to take root in the next steps of economic, technology, and workforce development as led by the Governor. However, the practical steps outlined in the Innovation Road Map calls for increased and measurable collaboration among academic research campuses, federal laboratories, industry, entrepreneurs, and investors. This is not the first time such a charge has been given to the entire range of stakeholders; however, unless and until the bonds of regional and statewide networks are strengthened, the future of Tennessee's capacity to innovate will not reach its full potential.

The State's economy has continued to expand due to a number of unique opportunities to attract corporate expansion and relocations as well as to respond to the trends in the restructuring of traditional business models, especially in the transportation and automotive sectors. To foster a more robust and sustainable broad economic impact, Tennessee will need a portfolio of industry sectors, clusters of competency, and investment tools to compete with neighbor states and global locations.

A powerful collaborative model along with the implementation of key fundamental solutions is now necessary for the State and its regions. The underpinnings of the technology-based economy demand a more integrated approach that only committed civic stewards from the private sector can muster the vital resources of time, reputation, and dollars. The role of local and state officials requires a new appreciation for the future trends facing their constituents and communities; we are more globally linked, interdependent, and facing challenges not foreseen nor expected by previous generations. How Tennessee's residents prepare, anticipate, and respond to these trends calls for social networks, creative and innovative solutions, and a new mindset about job creation, wealth generation, and competitiveness.

We have been honored by the hundreds of individuals that participated in the forums, interviews, and surveys. The Innovation Road Map is truly reflective of their voices, ideas, and hopes for the future of their State. I believe we have captured their insights and direction, and in turn created a 'road map' to the common goals and scenario shaped over the past months. The next challenge is to form implementation mechanisms, performance metrics, and accountability for actions that will move this document from 'report to results.'

Richard S. Seline
CEO & Principal
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0 - Executive Summary

0.1 - Introduction

Several years ago the Tennessee State Legislature called for the creation of a new entity to facilitate technology development in the state of Tennessee - a significant step towards coordinating and aligning clusters of science, technology and entrepreneurial activities across regions and institutions. In 1997, Senate Bill 628/House Bill 861 advocated the creation of a "private, not-for-profit corporation" in order to facilitate technology transfer from research centers to Tennessee enterprises. In response to these bills, the State government formed The Tennessee Technology Development Corporation (TTDC). Specifically, the state tasked TTDC with identifying science and technology related issues in Tennessee, discovering regions with a potential for growth, determining ideal places for investing, and facilitating new financial resources in technology businesses.

The dormancy and questionable effectiveness of TTDC in light of other states' competitive tools and resources has raised concerns about how best to facilitate Tennessee's technology economic growth. A more comprehensive approach tailored to the current scenario in the state as well as a proactive strategy to respond to global competition is necessary for Tennessee to become a stronger national and global participant in innovation-driven technologies. After extensive quantitative and qualitative research, New Economy Strategies (NES) has developed a set of recommendations to reorganize the current structure of TTDC to better achieve the development of Tennessee's technology industries, foster more robust clusters of the economy, and encourage job and wealth creation across a wider set of stakeholders.

Research conducted on the regional economic makeup of technology industries in Tennessee helped to identify mechanisms for more efficient development of the Tennessee economy. Despite the presence of key assets and a history of successes within the technology sector, NES discovered that much more can be done to improve the process of technology development and commercialization in the state. The conclusion was arrived through extensive regionally specific research, and detailed SWOT and gap analyses. As a result, NES recommends the development of a new entity, ***Innovation Tennessee***, named for its role in statewide technology and innovation development.

Innovation Tennessee will be the lead organization in the State for technology-based economic development. In addition to fulfilling TTDC's mission, Innovation Tennessee will lead previously overlooked yet valuable activities. Innovation Tennessee will be an entity with public and private elements that will coordinate technology and innovation development in partnership with federal, state and regional government initiatives. Current gaps in TTDC's strategy were taken into account when determining the potential structure of Innovation Tennessee, and will be further detailed in this report - "Tennessee Innovation Road Map". This plan contains potential returns on investment, a description of Innovation Tennessee's proposed structure, and a suggested five year organizational budget.

- The Tennessee Innovation Road Map Initiative offers a bold innovation agenda for the State that creates a sustainable technology-based economic development program to build innovation capacity within and across regions.

- Innovation is the driver of the US economy and ***Innovation Tennessee*** will focus on developing the pillars of innovation: talent, investment, infrastructure.

- Currently, Tennessee is without a robust technology-based economic development program. ***Innovation Tennessee*** fills the gaps in the state's economic development toolbox to create a comprehensive economic development system that builds on the 2005 Jobs Package and provides leadership in the 21st century.

- ***Innovation Tennessee*** is designed to leverage existing state and federal investments in science and technology infrastructure for economic value.

- ***Innovation Tennessee*** offers a best practice/best principles model on how to effectively work through a private/public collaborative to build innovation capacity in all regions of the state and create a seamless process to take ideas from the "lab to the market".
    - Knowledge → Innovation → Technology → Productivity → Economic Expansion

- ***Innovation Tennessee*** will provide executable solutions that are results-oriented and measurable:
  1. Increase research & development activity in Tennessee
  2. Increase the availability of investment capital
  3. Establish an Innovation Network that connects state's innovators, scientists, entrepreneurs, corporations, and regional hubs/nodes of innovation

0.2 - Understanding and Contrasting Tennessee's Current Assets

To advocate initiatives that can assist Tennessee in improving its technology economy, it is necessary to understand the number of assets the State has in its inventory. To promote synergy between current technology assets in Tennessee and future development initiatives, it is vital to appropriately coordinate existing and required future initiatives. Any efforts not using and building upon the resources already in Tennessee would be a frivolous expenditure. Tennessee's assets have given the state a competitive advantage in certain areas. To become a global competitor, Tennessee must build regional clusters and statewide connectivity. The need to coordinate alongside the assets and obstacles already present in Tennessee necessitates a comprehensive examination of current assets, weaknesses, and specific, focused actions for addressing the lack of competitive results. From this analysis, targets of opportunity for Tennessee have clearly emerged.

The regional forums conducted were undertaken in order to better understand the assets and opportunities in each of the main innovation regions in Tennessee – as well as to take the pulse of innovation contributors to determine their willingness to support and advance a more collaborative statewide agenda. The forums took place in Nashville, Knoxville, Chattanooga, the Tri-cities, and Memphis. Key innovators and regional stakeholders were invited to the forums to provide local insight about each region's assets as well as often unknown opportunities requiring greater attention. Benefits of these forums included preliminary directions for determining opportunities for growth, receiving constructive criticism on data during the research process, understanding perceived strengths, challenges, and opportunities of the region and state in technology, and identifying potential linkages and places for cluster development. Additionally, surveys were conducted in order to better understand perceived strengths, weaknesses, opportunities, and threats in technology development for Tennessee.

Finally, quantitative data of Tennessee was assessed. The type of data collected included a first-ever drill-down into grants and contracts as well as awards of federal funding for research and development, federal funding for small business innovation research (SBIR) and small business technology transfer (STTR), private funding for research and development, patent portfolios by technology sub-sectors, venture capital funding and workforce skills and competencies. Investigating this data allowed an unbiased description of the economic makeup of Tennessee. Observations extrapolated from this data, combined with the information obtained from the qualitative data, led to the discovery of targets of opportunity for Tennessee to pursue in a more aligned and coordinated fashion.

After examining the assets and perceptions about technology development in Tennessee, peer states were reviewed to contrast Tennessee's potential for accelerated growth and the necessary programs to shore-up for competitive ranking. States in this analysis included New York, Michigan, Pennsylvania, Maryland, and California. To direct the process of technology development, an analysis of industries in general along with trends and market sizes was conducted. This analysis highlights the fact that there is much profit to be realized through the opportunities open to Tennessee. Examining the assets that the State possesses along with general industry trends led to the realization of five regionally specific targets of opportunity for Tennessee, as well as the organizational structure and funding necessary to advance a powerful innovation agenda for public and private sector interests.

NES was tasked with analyzing the State's value proposition as a global and domestic contributor to the notion that specific actions in key industries could position Tennessee as a partner for U.S. growth – thereby creating a message that larger corporations, emerging enterprises, individuals and resources must be 'present to win' in the State. What has resulted is an agenda that calls for an immediate 'Jump Start' utilizing $5 million of state funds for a handful of highly focused action steps while catalyzing new partnerships at the regional level around the targets of opportunity. While a significant leap in resource allocation, compared to the billions being spent by other states and nations, NES has attempted to provide the rationale and scenario for which such a Tennessee innovation capacity building exercise will produce the immediate, near-term, and long-term benefits – job and infrastructure expansion, attraction and recruitment of top performers in research and development, and ultimately a continuous cycle of economic growth.

0.3 - Our Approach

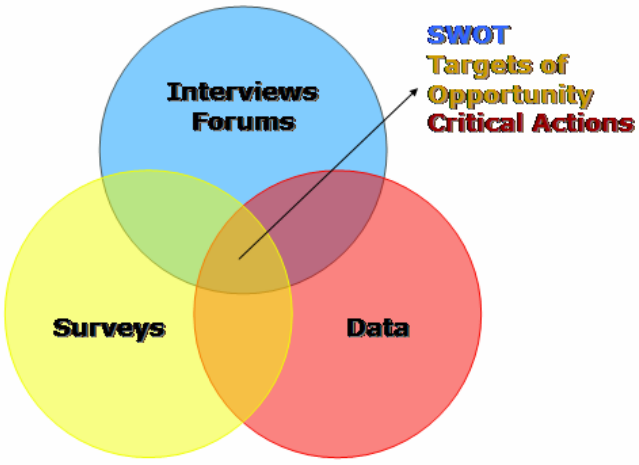
Throughout the following Road Map report, the reader will be introduced to the NES approach for analysis, discussion, and prioritization of findings and recommendations. The so-called SWOT – strengths, weaknesses, opportunities and threats assessment – has led to specific critical actions that if overlooked would cripple Tennessee's capacity to innovate scientific and technological assets for broad and inclusive economic growth among all of the State's citizens. Our approach has been exhaustive – from a very detailed electronic survey to key interviews and regional forums, we sought to capture insights and perspectives that are often not realized in hard facts and data-sets. In our approach to data – we sought to conduct what we term a 'drill-down' into existing and new knowledge – and thereby identify the vital participants in the State's capacity to further commercialize and exploit academic, industry, entrepreneurial, and individual strengths and intellectual property. Over 900 individuals throughout the State and its respective regions and institutions contributed to this approach – and thus the Road Map is a product of their insights, concerns, challenges, and demands for a new systematic and aligned program that will "make them money, save them money or accelerate a result" as one participant described.

0.4 – Findings

As determined through analysis of the data, Tennessee must focus on nurturing new business startups as well as furthering growth firms by assisting these entities in attracting federal and other funding for research as well as the incubation of new ventures. Tennessee has many of the necessary facilities for research and development such as Vanderbilt University, Oak Ridge National Laboratory, University of Tennessee system, Tennessee Board of Regents system, Memphis BioWorks Foundation, St. Jude Children's Research Hospital, Arnold Engineering Development Center, Y-12 National Security Complex, and the FedEx Institute of Technology amongst many others.

However, Tennessee does not have adequate commercialization mechanisms to yield profits from the advanced and expensive scientific innovation undertaken at its research centers. Technology transfer to small entrepreneurial firms as well as larger self-sufficient firms is necessary to turn academic research into profitable consumer products. Broad-based development maturity for technology is necessary to make Tennessee more competitive.

Based on the analysis of the data, targets of opportunity were determined that are specific to Tennessee and economic development in technology sectors. Tennessee, although rural throughout many places, has potential for cluster growth in five key areas. These areas are centered around Nashville, Knoxville/Oak Ridge, Tri-Cities, Memphis, and Chattanooga. The respective industry-specific targets of opportunity were discovered to be Health Management/IT, Nanotechnology, Drugs/Medical Products, Advanced Manufacturing/Design/Logistics, and Energy/Environmental/Transportation Technologies. The importance of regionally identifying targets of opportunity assists in choosing and creating strategies tailored to the unique economic landscape of Tennessee. Statewide implementation of economic development programs in accordance with regional focal points is necessary to make Tennessee into a stronger global competitor.



0.5 - Recommendations

Critical to becoming competitive in the national and global arena is the ability of a state to leverage current strengths and opportunities to achieve excellence. It is impossible to excel in every industry, thus targeting is critical. This focus allows a state to hone in on a particular field and gather the specialized resources, talent, and assets necessary to become a premier destination for scientists, researchers, entrepreneurs, investors, and corporations interested in a specific industry.

The targets of opportunity that will build and improve the existing networks in Tennessee are different but viable in each major innovation region in Tennessee. Nashville is encouraged to leverage existing resources in order to improve its health management and health IT sectors, with an emerging opportunity in digital information distribution for the music industry. With Oak Ridge National Laboratory and the flagship campus of the University of Tennessee, Knoxville should leverage its assets to build a stronger nanotechnology and advanced materials sector. The Tri-Cities region was found to have a large potential for building its drugs, chemicals, and medical products sectors. The cluster for agricultural, environmental and transportation technologies can be improved in the Chattanooga region, and finally advanced manufacturing, design & logistics, and health sciences are ripe for growth in the Memphis region.

These regionally specific targets of opportunity for economic development in technology-centric sectors were determined by connecting existing resources with given market sizes and industry trends. These regionally specific targets of opportunity can be the engines for economic growth in Tennessee in the 21st century. Though at first perceived to be locked into one region, NES recommends that the reader view this from a hub and node concept – for instance Chattanooga would lead a statewide effort in its specific strength by identifying and connecting individuals and institutions throughout the State in a new approach to collaborative work and output. Simply, no region in Tennessee owns all the assets or thinking on the targets of opportunity – and the increased coordination of best-in-class ideas and resources will only enhance the State's competitiveness!

0.6 - Implementation

To take advantage of the targets of opportunity, NES recommends the development of a new entity, Innovation Tennessee, named for its role in technology development along with initiatives to be carried out by this new organization.

Innovation Tennessee will be the leading organization in Tennessee for technology economic development. The organization will begin as a small entity with a limited budget and minimal staff during the first year. During each year, Innovation Tennessee will grow in budget and staff and take on more responsibility for technology based economic development. Promoting federal funding and research will promote the development of new ideas and technology for potential capitalization. Investment will aid successful business development, while innovation networking will promote collaboration in Tennessee, and assistance with marketing technology will satisfy the final step in capitalizing on technology.

The suggested programs and timescale for implementation will take into account the natural process for commercialization. As the organization grows over five years, it is the ultimate goal of Innovation Tennessee to become a self-sufficient entity through the addition of a for-profit management company facilitating new investments and performance. Innovation Tennessee will lead Tennessee to prominence as a strong national and global competitor for technology as it is designed to maximize existing regional strengths, create a bridge between these strengths, and then apply very unique and proven tactics for immediate results in capitalization and job growth.

Of special note to the reader: the Road Map captures a wide variety of data and information which in turn calls for action-taking by a collaborative group of leaders in all sectors of public and private interest. The most critical ingredient for Tennessee's success is not the resource allocation nor the prominence of academic and industry research output – it is simply the role of civic, business, university, industry, and entrepreneurial leaders to take ownership of their personal, professional and inter-related interests. NES' work around the U.S. and abroad has identified the importance of leadership – time, reputation, and funding in that order – as being the key ingredient to a successful innovation recipe. Therefore, throughout the Road Map are indicators that require attention from a group of leaders that are prepared to rollup sleeves and get to work without any expectation that the Governor and/or the Legislature are the drivers. Rather the concept of Innovation Tennessee will only succeed if and when the leadership pattern across the State is aligned around a handful of actions and accountability.

1 - Competitive Environment Assessment

NES conducted a comprehensive assessment of Tennessee's economic landscape to determine its competitive advantages, challenges and emerging opportunities. The analysis consisted of both qualitative ("soft") and quantitative ("hard") metrics. The qualitative measures included a statewide leadership survey, targeted interviews with business, government, academic and civic leaders, and five regional forums. The quantitative measures included federal and private sector research funding, venture capital funding, workforce, academic degrees awarded in the state, and wages and patents.

The data are presented both at the state level and the regional level. When appropriate, the state's performance is compared to the national average. For the purpose of this assessment, NES recognized five regions within Tennessee:

- Chattanooga (composed of Hamilton and Marion counties),
- Knoxville/Oak Ridge (composed of Knox, Blount, Anderson, Union, and Sevier Counties),
- Memphis (composed of Shelby, Tipton, and Fayette Counties),
- Nashville (composed of Davidson, Williamson, and Cheatham Counties), and
- Tri-Cities (composed of Sullivan, Washington, and Carter counties).

To guide the roadmap process, an advisory committee of 18-25 leaders was formed. These public and private leaders represented various science and technology fields. Among their key roles, they provided an honest assessment of the current and emerging Tennessee innovation environment, reviewed the roadmap strategy, and identified important players for the regional forums and stakeholder interviews.

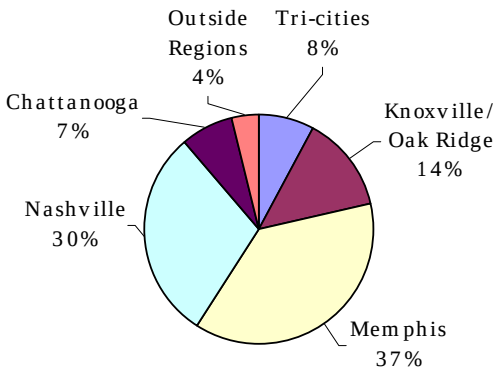
At the end of this eight month long initiative, 162 key leaders were interviewed over the course of several weeks. These leaders offered insight into perceptions about issues such as Tennessee's emerging areas in science and technology, entrepreneurship, and building competitiveness.

Finally, an electronic survey was used to gather even broader information. Over the course of six weeks, this survey was sent to 5,471 individuals with 722 responding. A detailed description of the survey follows.

1.1 - Tennessee Innovation Initiative Survey

The Tennessee Innovation Initiative Survey was designed to understand the motivation and entrepreneurial mindset of the state's key stakeholders and gather qualitative data on current assets, strengths and weaknesses in the business and innovation environment. The online survey was sent to senior level individuals from business, academia/research, government, economic development organizations, and other supporting technology-based institutions.

Location of Survey Respondent's Organization



Of the 40% of respondents that indicated their organizations' primary industry, 63% was business/technology related; 14% was academic and research; 14% was government; and 9% classified themselves as "other." Again, only 40% of the survey respondents indicated the county in which their organization resides. The pie chart aggregates their answers to the regional level as defined by the project. In some cases, the organizations were located between regions, and are reflected in the "Outside Regions" category.

1.2 - Summary of Survey Findings

1. Surveyed leaders are mostly positive about Tennessee's innovation environment for their company.

- Respondents had generally positive opinions of their companies' abilities to innovate. 86% of them believed that it was at least "somewhat strong."

2. Surveyed leaders ranked the state and regions' leadership commitment to new business growth, and the attraction and retention of key skilled talent such as scientist and engineers, technicians and entrepreneurial managers as key challenges for the state of Tennessee. The leaders also indicated significant room for improvement in each of the areas.

- 93% rated the "commitment of state and regional leaders to improve the environment for starting and growing businesses" as critically or very important. 50% stated that the state had made progress or was beginning to make progress in this area.
- 91% rated "retaining talented scientists and engineers" as critically or very important. 40% believed there was progress being made in this area.
- 90% rated "retaining well trained technicians" as critically or very important. 37% of the respondents believed progress had been made or was beginning to be made. This represented the lowest rating in progress for all the factors surveyed.
- 88% rated "attracting well trained technicians" as critically or very important. 43% of the respondents felt progress had been made.
- 86% rated "retaining entrepreneurial managers" as critically or very important. 46% of respondents said the state had made progress or was beginning to make progress in retaining these individuals.

3. Surveyed leaders ranked the quality of life, the quality of K-12 math and science education, and the cost of doing business as the three most important factors impacting potential economic growth in the state. Also notable was the importance placed on the quality of collaboration between business, university, and government and the quality of research universities. The leaders again indicated that progress has been made, but significant room for improvement remained in each area. A notable exception was quality of life in which 57% of the survey respondents observed progress being made.

- 94% rated the "quality of life" as a critically or very important factor impacting the potential for economic growth. 57% said that Tennessee had made progress.
- 92% rated the "quality of K-12 math and science education" as a critically or very important factor. 32% said that Tennessee was making progress in this area.
- 88% rated the "tax burden on businesses/cost of doing business"' as a critically or very important factor. 31% reported progress in reducing the burden and cost.
- 83% rated the "collaboration between business, universities, and government" as a critically or very important factor. 47% said that Tennessee was making progress in this area.
- 82% rated the "quality of research universities" as a critically or very important factor. 45% said that Tennessee had either made progress or was beginning to make progress in this area.

4. Surveyed leaders rated public investment in workforce training, math and science education, and business recruitment and retention as the most critical factors in growing technology-based businesses. Interestingly, the role of the public sector in supporting capital formation and venture funds, and university research was not as unanimous.

- 92% said public sector investment in "workforce training for skilled workers" was either very important or critically important. 40% said that Tennessee was making progress.
- 91% said public sector investment in "math and science educational investment" was either very important or critically important. Only 27% said that Tennessee had either made progress or was beginning to make progress in this area.
- 89% said that public sector investment in "business recruitment and retention" was either very important or critically important. 43% observed progress being made in this area.

- 78% said public sector investment in "capital formation and venture funds" was either very important or critically important. 35% said that Tennessee was making progress.
- 76% said public sector investment in "university research" was either very important or critically important, however only 42% said that Tennessee had either made progress or was beginning to make progress in this area.

5. More than three quarters of the surveyed leaders view entrepreneurship as a viable career, however only a little more than half distinguish between business failure and personal failure.

- 85% agreed or strongly agreed that "entrepreneurship is a viable professional choice." Only 3% disagreed and none strongly disagreed.
- 59% disagreed or strongly disagreed that "business failure equals personal failure." 12% of survey respondents agreed and only 5% strongly agreed.

6. Surveyed leaders point to major deficiencies in their regional business support services in the areas of university technology transfer, recruiting/HR, strategic management and economic development services.

- 35% stated they were either very satisfied or satisfied with their regional university technology transfer programs. 22% said they were dissatisfied or very dissatisfied.
- 40% stated they were either very satisfied or satisfied with the regional HR and recruiting abilities. 21% said they were dissatisfied or very dissatisfied.
- 41% stated they were either very satisfied or satisfied with the strategic management services in their region. 43% said they were indifferent, and 11% were dissatisfied or very dissatisfied.
- 42% stated they were either very satisfied or satisfied with the economic development services in their region. 22% said they were dissatisfied or very dissatisfied.

7. Surveyed leaders rank employees, customers and buyers and competitors as their main sources of innovation. Less than half of surveyed leaders credited suppliers, university, research organizations, trade associations, company acquisitions and government laboratories, suggesting that these resources are underutilized and perhaps difficult to access.

- 90% rated "employees" as a key source of innovation for their firm.
- 71% rated "customers and buyers" as a key source of innovation for their firm.
- 50% rated "competitors" as a key source of innovation for their firm.
- Other sources included: suppliers (46%), university/research organizations (40%), trade associations (39%), company acquisition (36%), and government laboratories (26%).

In all, the surveys illuminated a number of strengths, weaknesses and opportunities that were further explored through the regional forums and stakeholder interviews discussed in the next section.

1.3 - Regional Leadership Forums and Interviews

Leadership forums were held in each of the five regions – Chattanooga, Knoxville/Oak Ridge, Memphis, Nashville and Tri-Cities. These highly facilitated, interactive sessions involved between 30-50 regional stakeholders and were approximately 2 ½ hours in length. Through this process, the following objectives were met:

- the engagement of key regional stakeholders at the beginning of the road map process;
- the sharing of early empirical findings and thoughts;
- the collection of constructive feedback on data;
- input on the perceived strengths, challenges and opportunities of the region and state in supporting and growing technology/innovation dependent industries;
- the determination of individual and regional contributions for building technology industries in the state of Tennessee; and
- the identification of potential linkages, opportunities and champions/leaders for technology sector collaboration.

Leading up to and after the regional forums, stakeholder interviews were conducted. Each interview was structured to gain a candid, "off the record" understanding of the leadership's motivation, priorities and assessment of the state's assets, strengths and weaknesses in the innovation environment. Stakeholders were defined as those individuals in civic, entrepreneurial, venture, business, and academic organizations that are actively engaged in technology and innovation based development activities.

The findings below represent the synthesized comments of the five regional forums and stakeholder interviews.

Scientific and Technological Areas (Established and Emerging)

Leaders were asked to identify specific current or emerging scientific and technological areas that hold the most promise for Tennessee. The most often mentioned areas include:

- Advanced Manufacturing (e.g. micro-chemical processors, design, automotive and aerospace)
- Logistics and distribution (supply chain management has applications to healthcare)
- Nanoscience and nanostructures
- Advanced Materials
- Biotechnology/Biomedical (including medical devices, medical imaging, orthopedics, musculoskeletal, neurological implants, bioinformatics, agricultural biotechnology)
- Computational technologies (applications include astrophysics, fusion, climate, biology, materials)
- Sensors and detectors (applications include RFID tags, homeland security technology applications)
- Information technology
- Environmental sciences

Key Business and Innovation Environment Factors

In the course of the interviews and forums, key business and innovation environment assets and challenges were discussed. Most notably, there was a clear disagreement on whether the state's strong regionalism was a benefit or liability to future economic success. The positive factors highlighted include the low cost of living, the state's strategic location, the good quality of life and an untapped pool of potential investment in Memphis. Negative characteristics included:

- limited entrepreneurial activities and opportunities;
- a lack of venture funding, particularly pre-seed and early stage;
- a lack of critical mass and ease of access to business support members and services;
- a lack of key physical infrastructure (incubators, lab facilities, research parks, etc.);
- a tendency in the State to focus economic development efforts on agriculture and not technology;
- a lack of appreciation and understanding of the value of higher education;
- inadequate education at the elementary, high school and technical school levels, and the State's inability to produce good science and math and entrepreneurial individuals;
- difficulty attracting and retaining talent (particularly top science and engineering graduates, faculty, management, mid-level administrative and sales); and
- a lack of spin-outs from large companies.

Entrepreneurial Mindset

Leaders were asked whether they believed Tennessee had the cultural attitudes and values to compete on innovation. With only a few exceptions, the interviewees did not think Tennessee had a strong entrepreneurial mindset. The challenge of educating the rural parts of the state and the legislature was mentioned repeatedly. Areas of concern included:

- a shortage of entrepreneurial-minded people and an absence of an "entrepreneurial culture" in the State (current culture was viewed as parochial and conservative);
- a tendency to compete on low labor costs, and doesn't recognize that it is Competing nationally and internationally;
- widely varying levels of entrepreneurialism across the state;
- a lack of incentives for entrepreneurialism within the scientific community in Tennessee;
- a difficulty getting people to understand the potential of non-incremental technological innovation, startups and entrepreneurial approaches, and the need to foster rather than discourage collaboration across sectors and organizations; and
- a concern that elected officials and economic development officials do not adequately foster new technology, instead focusing on traditional manufacturing and service industries.

Collaboration

Leaders discussed whether Tennessee's entrepreneurial, technology and business leaders are collaborating enough currently, and whether there are policies and mindsets inhibiting this collaboration. It was nearly unanimous that there is insufficient collaboration in Tennessee. However, one interviewee pointed out that "collaboration happens in science all the time." The responses have been organized by potential collaborating partners, limiting factors and political challenges, and emerging opportunities.

- **Universities:** Universities have the capability to collaborate, but lack sufficient funds. They need to demonstrate value and facilitate collaboration between researchers and businesses on a statewide level and not just institutionally or through *ad hoc* arrangements. The higher education system is fragmented, its missions overlap and conflict, and there is internal competition for funds. There is not much industry involvement in the university system.
- **State Government:** The state government is often seen more as a road block rather than a collaborative partner. Economic development programs are seen as being stronger at the regional level than at the state level. The State does not provide significant sums of money to incentivize collaboration.
- **Limiting Factors and Political Challenges:** Leaders stressed a lack of venues and settings where collaboration might grow, and a lack of incentives such as money and public media coverage. They urged that Tennessee address the limits posed by its geography. Regional political differences were also seen as limiting factors, as well as a lack of a governance structure which fosters collaboration.
- **Opportunities:** Collaboration between the University of Tennessee and Oak Ridge National Laboratory could be expanded. The University of Tennessee could play a greater role in encouraging collaboration. Efforts on the part of Vanderbilt University and the University of Memphis should be encouraged and increased. A Tennessee Technology Corridor initiative currently under discussion has been a forum for encouraging collaborative activity.

Institutional Strengths and Emerging Initiatives

Leaders highlighted a number of institutions and initiatives they believe are strong assets to the state and create a competitive advantage for the state. They include the following:

- Oak Ridge National Laboratory
  - Spallation Neutron Source (SNS) – world's largest science project being completed in 2006
  - DOE Center for Nanophase Materials Sciences – first DOE facility for nanotechnology research
  - National Leadership Computing Facility – world's most powerful unclassified computer
  - State Joint Institutes (Three Institutes: Computation, Life, and Neutron Sciences)
- FedEx Corp and the FedEx Institute of Technology
- GM/Saturn Production Facility
- TVA
- SIM Center in Chattanooga
- Memphis BioWorks Foundation
- Key research centers – St. Jude, Vanderbilt University , Oak Ridge National Laboratory, UT and TBR universities

- East Tennessee Nanotechnology Initiative (coordinated by Tech2020)
- The Nashville Capital Network
- St. Jude Children's Research Hospital
- Cool Springs Life Science Center (south of Nashville)

Metrics for Company/Entity Success

Leaders were asked how they would measure success in their firm, entity or institution given the greater potential for collaboration during the roadmap process. The most frequently mentioned metrics are:

- Company formation
- Products launched
- Housing starts
- Wage and salary increases
- Growth in job creation
- Growth in new start ups, IPOs
- Increased R&D funding
- Number of joint research initiatives
- Growth of entrepreneurial structures and programs
- Higher graduate retention rate in state
- More FDA approvals
- Increased capital investment
- Measures of productivity throughout the university systems (e.g. research expenditures, publications)
- More technology jobs for university graduates

Recommendations for Building Competitiveness

Leaders identified specific actions Tennessee should take to make their state and respective region competitive. The recommendations are summarized below:

1. ***Education and Workforce***
   - Supplement the student education experience with onsite business experience as part of the curriculum.
   - Invest in the recruitment of world class investigators.
   - Improve the S&T programs within the universities.
   - Build a top-tier engineering school.
   - Build a ready workforce for technology companies.

2. ***State***
   - Provide state money to seed big centers, institutes and collaborative efforts.
   - State should give some money to VCs to distribute.
   - Create a state venture fund for start-ups.
   - State should provide money for 'seed grants' that support in-lab development in preparation for spin-off or licensing.
   - Create ventures that address the gap between start-up and commercialization.
   - Create a "triangle" on southern border to connect with Huntsville, Oak Ridge, and others.
   - Review and consider a suite of tax incentives and credits (jobs, R&D, start-ups etc.).

3. ***Organizational***
   - Find ways to leverage Oak Ridge National Laboratory and Vanderbilt into more economic success in the state.
   - Create a not-for-profit entity to manage and implement the plan – "an overarching organization."
   - Create an organization that would force collaboration across campuses and units, with emphasis on multi-campus, interdisciplinary centers of excellence.
   - Re-compete the Tennessee's Center of Excellence program, which is funded by the Tennessee Higher Education Commission.
   - Complete the musculoskeletal institute.

- Support the Tennessee Biotechnology Association, which is coming out of a leadership vacuum, and is lacking momentum.
- Establish an information clearinghouse to track workforce, research funding, collaborations, etc.

4. *Infrastructure*
- Improve the airport in Nashville to improve access to outside investors.
- Expand broadband network access in rural and urban areas.
- Renovate and develop the medical district.

5. *Overarching and Strategic*
- Develop a comprehensive, statewide plan that involves technology, recruitment, entrepreneurship, capital access, and competitive incentives.
- Collaborate to identify areas where specific knowledge could be used to attract researchers, research dollars, other talent and business.
- Look for partnerships outside the state and regions.
- Communicate, market and celebrate successes and capabilities.
- Find ways to build business without spending money, and focus on supporting small businesses.
- Encourage greater collaboration across the state by only funding R&D initiatives that involve two or more schools or programs.
- Host a Technology Day at the Tennessee state legislature.
- Benchmark nearby states and national leaders for best practices.
- Leverage tobacco money to build technology based economy.

1.4 - Federal Research Funding

Research and development (R&D) is widely recognized as a key input to economic growth. By studying the levels and sources of federal R&D grants and contract awards, leaders can make calculated decisions about their relative economic purchasing power in specific research areas, and develop strategies for leveraging current funding. The data are also critical to identifying sources that are underrepresented or emerging, and the need for focused targeting.

This data are a combination of Rand RADIUS (Research and Development in the United States) and the National Science Foundation database for grant and contract awards to institutions and individuals from 1993-2004.

Federal Funding Share for Tennessee by Agency versus U.S. Share

R&D Funding Agency	TN Share	U.S. Share
Dept. of Energy (DoE)	37%	8%
Health and Human Services (HHS)	36%	29%
Dept. of Defense (DoD)	19%	48%
NASA	4%	9%
National Science Foundation (NSF)	3%	4%
U.S. Dept. of Agriculture (USDA)	1%	2%

Explanation: Table 1 segments Tennessee's federal R&D funding sources by agency and compares it to the average U.S. share of each agency.

Findings: First, Tennessee's share of funding received by the Department of Energy is 37% compared to the U.S. average of 8%. This can largely be attributed to Oak Ridge National Laboratory. Second, Tennessee receives significantly less federal funding from the Department of Defense (19%) verses the national average of 48%.

Federal R&D Funding to Tennessee by Agency, 1998 - 2003

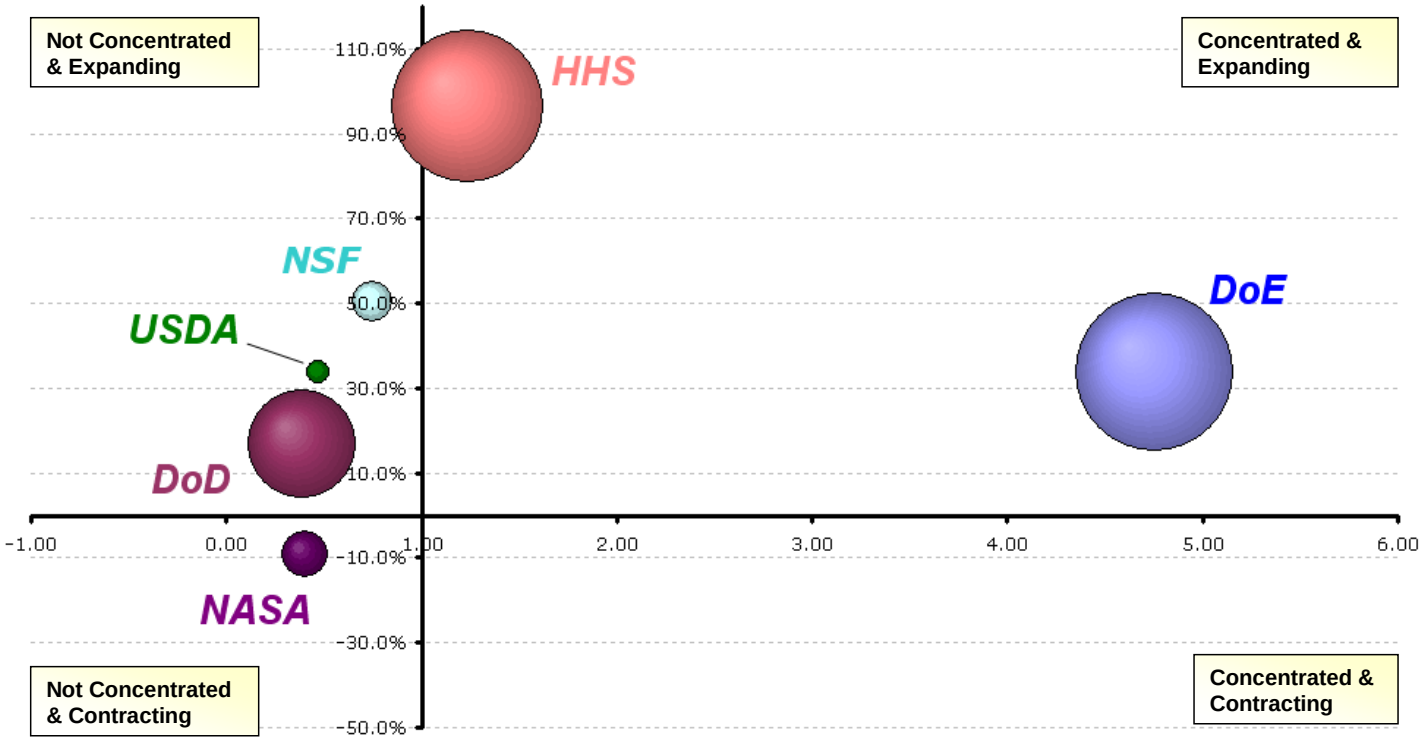
Top Six Federal R&D Agencies	1998		2003		1998 - 2003	
	Thousands of Dollars Awarded	Percent of Total	Thousands of Dollars Awarded	Percent of Total	Net change	Percent change
HHS	$179,406	22.3%	$352,165	33.7%	$172,759	96.3%
NSF	$18,047	2.2%	$27,141	2.6%	$9,093	50.4%
DoE	$294,393	35.3%	$380,668	36.5%	$96,275	33.9%
USDA	$7,378	0.9%	$9,860	0.9%	$2,482	33.6%
DoD	$157,841	19.6%	$184,249	17.6%	$26,408	16.7%
NASA	$40,243	5.0%	$36,579	3.5%	-$3,664	-9.1%
Total for Top Six Agencies	**$687,308**	**85.3%**	**$990,662**	**94.9%**	**$303,355**	**44.1%**
Total Federal R&D	**$805,305**	**100%**	**$1,044,223**	**100%**	**$238,918**	**29.7%**

*Growth rates calculated using current dollars.

Explanation: Table 2 provides a five-year snapshot of Tennessee's federal funding awards and percentage change between 1998 and 2003.

Findings: Most notably, the state has seen significant growth in funding received by HHS, which amounted to a 96.3% increase. Tennessee also saw healthy increases in funding from NSF, DoE, USDA, and DoD. The only posted loss in funding was a 9.1% decrease between 1998 and 2003 from NASA.

Federal R&D Funding to Tennessee by Agency, 2003



Explanation*:* Figure 1 graphically depicts the relative growth and concentration of Tennessee's federal funding portfolio in 2003 compared to the U.S. The strongest funding sources are located in the upper right-hand quadrant. These are funding areas with the fastest growth and greater representation nationally in terms of dollars awarded, indicating a true competitive advantage for the state. The size of the bubbles correlates to the dollar amount of funding received in 2003.

Findings: As supported in the previous charts, Tennessee's federal funding is dominated by the Department of Energy, which is nearly 5 times more concentrated than the national average. Also, HHS shows promising growth in terms of total funding, but it remains at the national average in terms of its concentration.

Action: Tennessee leaders have an opportunity to actively seek and grow the other federal funding sources in the state. It is important to recognize a potential over dependence on the DoE to fuel the research and development activities in the state, and the possible negative consequences should this pot of money decrease due to failed proposals or federal budgetary cuts. Additionally, the state should aggressively seek to increase the funding received by the DoD given the great need for technologies in the security arena. This is an area of research that will grow for the seeable future.

Following is the amount of federal funding awarded to each of the five regions examined. The federal funding amounts are broken down by major federal R&D agencies. Figures are provided for the years 1998 and 2003. Using these figures, percent growth of federal funding was determined in each of the five regions.

Federal Funding Awarded to the Chattanooga Region (1998, 2003)

Chattanooga	1998	2003	1998 - 2003	
	Dollars Awarded	Dollars Awarded	Net Growth	Percent Growth
TOTAL FOR ALL FEDERAL R&D AGENCIES	$81,500	$112,500	$31,000	46.3%
MAJOR FEDERAL R&D AGENCIES				
Dept of Health and Human Services (HHS)	$41,000	$55,115	$14,115	21.1%
National Science Foundation (NSF)	$2,075	$3,180	$1,105	1.6%
Dept of Agriculture (USDA)	$400	$345	-$55	-0.1%
Dept of Defense (DoD)	$10,645	$13,780	$3,135	4.7%
Dept of Energy (DoE)	$21,300	$30,800	$9,500	14.2%
National Aeronautics and Space Administration (NASA)	$3,635	$3,350	-$285	-0.4%
TOTAL FOR TOP SIX AGENCIES	$79,055	$106,570	$27,515	41.1%

Federal Funding Awarded to the Knoxville/Oak Ridge Region (1998, 2003)

Knoxville/Oak Ridge	1998	2003	1998 - 2003	
	Dollars Awarded	Dollars Awarded	Net Growth	Percent Growth
TOTAL FOR ALL FEDERAL R&D AGENCIES	$385,000	$498,500	$113,500	29.5%
MAJOR FEDERAL R&D AGENCIES				
Dept of Health and Human Services (HHS)	$28,400	$44,685	$16,285	57.3%
National Science Foundation (NSF)	$4,950	$6,940	$1,990	40.2%
Dept of Agriculture (USDA)	$975	$1,245	$270	27.7%
Dept of Defense (DoD)	$16,050	$22,560	$6,510	40.6%
Dept of Energy (DoE)	$315,600	$385,000	$69,400	22.0%
National Aeronautics and Space Administration (NASA)	$4,580	$4,260	-$320	-7.0%
TOTAL FOR TOP SIX AGENCIES	$370,555	$464,690	$94,135	25.4%

Federal Funding Awarded to the Memphis Region (1998, 2003)

Memphis	1998	2003	1998 - 2003	
	Dollars Awarded	Dollars Awarded	Net Growth	Percent Growth
TOTAL FOR ALL FEDERAL R&D AGENCIES	$91,450	$125,980	$34,530	37.8%
MAJOR FEDERAL R&D AGENCIES				
Dept of Health and Human Services	$49,580	$77,890	$28,310	57.1%
National Science Foundation	$2,715	$4,157	$1,442	53.1%
Dept of Agriculture	$1,265	$1,540	$275	21.7%
Dept of Defense	$18,450	$24,600	$6,150	33.3%
Dept of Energy	$9,850	$12,560	$2,710	27.5%
National Aeronautics and Space Administration	$4,695	$4,375	-$320	-6.8%
TOTAL FOR TOP SIX AGENCIES	$86,555	$125,121	$38,566	44.6%

Federal Funding Awarded to the Nashville Region (1998, 2003)

Nashville	1998	2003	1998 - 2003	
	Dollars Awarded	Dollars Awarded	Net Growth	Percent Growth
TOTAL FOR ALL FEDERAL R&D AGENCIES	$151,000	$295,000	$144,000	95.4%
MAJOR FEDERAL R&D AGENCIES				
Dept of Health and Human Services	$109,560	$230,560	$121,000	110.4%
National Science Foundation	$3,602	$6,018	$2,416	67.1%
Dept of Agriculture	$1,683	$2,229	$546	32.5%
Dept of Defense	$16,982	$26,037	$9,055	53.3%
Dept of Energy	$12,560	$18,545	$5,985	47.7%
National Aeronautics and Space Administration	$6,227	$6,333	$107	1.7%
TOTAL FOR TOP SIX AGENCIES	$150,613	$289,722	$139,109	92.4%

Federal Funding Awarded to the Tri-Cities Region (1998, 2003)

Tri-Cities	1998	2003	1998 - 2003	
	Dollars Awarded	Dollars Awarded	Net Growth	Percent Growth
TOTAL FOR ALL FEDERAL R&D AGENCIES	$26,450	$38,450	$12,000	45.4%
MAJOR FEDERAL R&D AGENCIES				
Dept of Health and Human Services	$9,740	$17,800	$8,060	82.8%
National Science Foundation	$1,525	$2,450	$925	60.7%
Dept of Agriculture	$250	$475	$225	90.0%
Dept of Defense	$5,420	$7,425	$2,005	37.0%
Dept of Energy	$7,140	$7,880	$740	10.4%
National Aeronautics and Space Administration	$1,150	$1,340	$190	16.5%
TOTAL FOR TOP SIX AGENCIES	$25,225	$37,370	$12,145	48.1%

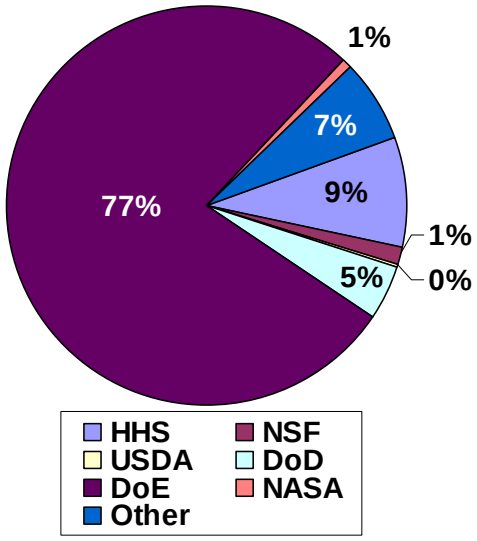
Explanation: The data presented is federal funding awarded to each of the five regions examined in Tennessee. Along with providing aggregate federal funding amounts, these amounts are also broken down by the leading federal agencies providing funding to Tennessee. The years used to determine the rate of growth are 1998 and 2003. Using these figures, it is easier to understand which federal agencies play a major role in supporting R&D, as well as which agencies are gaining more importance in each of the regions.

Findings: Each region examined in Tennessee has, for the most part, experienced growth in federal funding in general as well as from each major federal funding agency. However, each region has experienced different levels of growth in terms of aggregate federal funding for R&D, as well as different levels of growth in funding from each agency. This alludes to different economic landscapes in each of the five regions examined in Tennessee.

Action: Observing the differences between Tennessee's regions points to the different targets of opportunity that each region possesses. Tennessee must recognize these existing differences and use them to form regional competitive advantages. Utilizing existing assets and strengths will bolster regional economies and will result in a better economy for Tennessee overall.

A comparison of the Knoxville/Oak Ridge and Nashville regions clearly presents the difference in these regions regarding federal funding sources. In one community the Department of Energy is the major source of R&D, while in the other the National Institutes of Health contribute significant resources. This diversity suggest that Tennessee has multiple strengths on which to leverage; however what also needs to be encouraged is greater linkage between principal investigators, research projects, and assets to identify interdisciplinary scientific and technological solutions to industry and societal challenges. California, New York, and now Texas have coordinated federal funding strategies among academic and industry vice presidents and chief research officers.

Federal Funding Awarded to the Knoxville/Oak Ridge Region by Agency, 2003

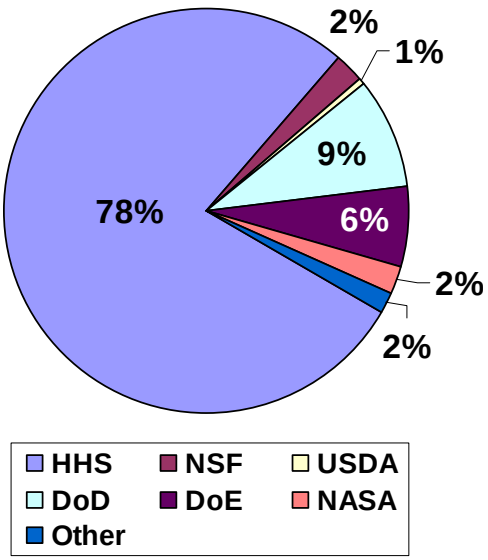


explanation:
This diagram visually describes the percentage breakdown of federal funding to the Knoxville/Oak Ridge region.

implication:
The Department of Energy dominates in Knoxville in providing federal funding. However, different regions receive funding from different federal agencies, as seen in the Nashville Region.

action:
The State should recognize the existing opportunity to better capitalize on the federal funding being awarded to this region by drilling down into the specific projects tied to maximizing the overall targets of opportunity defined in the Road Map.

Federal Funding Awarded to the Nashville Region by Agency, 2003



explanation:
This diagram visually describes the percentage breakdown of federal funding to the Nashville region.

implication:
The Department of Health and Human Services is the leading agency in the Nashville region that provides federal funding.

action:
The State needs to recognize this disproportionate share for health care and life sciences, and focus on improving the regional economy by utilizing the existing funding environment in the region to link with programs in Memphis and Chattanooga.

Federal SBIR/STTR Funding:

Small businesses are the lifeblood of our innovation economy, and yet often their size hinders or precludes them from participating in significant research efforts. According to the Small Business Administration (SBA), small businesses account for 99.7% of our economy and employ nearly half of all private sector employees. These organizations of fewer than 500 employees also engage 41 percent of technology workers. Further, small businesses have generated 60 to 80 percent of net new jobs annually in the U.S. over the last decade.

Two federal programs targeted specifically to address the research funding gap are the Small Business Innovation Research Program (SBIR) and Small Business Technology Transfer Program (STTR). The SBIR is a highly competitive three-phase program designed to encourage small businesses to develop and commercialize their technology. The STTR provides funding to support joint venture opportunities with the nation's premier nonprofit research institutions. Coordinated by the SBA, these two programs represent a critical and often underutilized source of federal R&D funding.

Federal SBIR Funding Comparison

SBIR Federal Funding Agency	TN Share	U.S. Share
Dept. of Energy (DoE)	38%	8%
Health and Human Services (HHS)	35%	29%
Dept. of Defense (DoD)	19%	48%
NASA	4%	9%
National Science Foundation (NSF)	3%	4%
U.S. Dept. of Agriculture (USDA)	1%	2%

Explanation: This table explains the difference in percentage breakdowns of federal SBIR funding for the top six agencies of the federal government granting funding.

Findings: As seen through comparison between the federal government funding to the nation percentage breakdown and the federal government funding to Tennessee percentage breakdown, Tennessee has extremely strong support for research in the Department of Energy, as well as a higher percentage from the Department of Health and Human Services.

Action: Tennessee should continue to leverage the existing competitive advantage for SBIR funding through the Department of Energy and Health and Human Services. The state should address the discrepancy between the Department of Defense SBIR funding to the United States and Tennessee. SBIRs are magnets for angel and early stage venture capital as proof-of-concepts – and thus should be coordinated with a statewide investment strategy.

Federal SBIR Funding to Tennessee by Agency, 1998 - 2003

Top Six Federal R&D Agencies	1998		2003		1998 - 2003	
	Thousands of Dollars Awarded	Percent of Total	Thousands of Dollars Awarded	Percent of Total	Net change	Percent change
HHS	2,340	21.6%	$4,500	31.4%	2,160	92.3%
NSF	222	2.1%	$339	2.4%	117	52.6%
USDA	68	0.6%	$92	0.6%	24	35.8%
DoD	1,939	17.9%	$2,368	16.5%	429	22.1%
DoE	3,587	33.2%	$4,981	34.7%	1,394	38.9%
NASA	504	4.7%	$460	3.2%	-44	-8.8%
Total for Top Six Agencies	**8,661**	**80.1%**	**12,741**	**88.9%**	**4,080**	**47.1%**
Total Federal SBIR Awards	**10,816**	**100%**	**14,339**	**100%**	**3,523**	**32.6%**

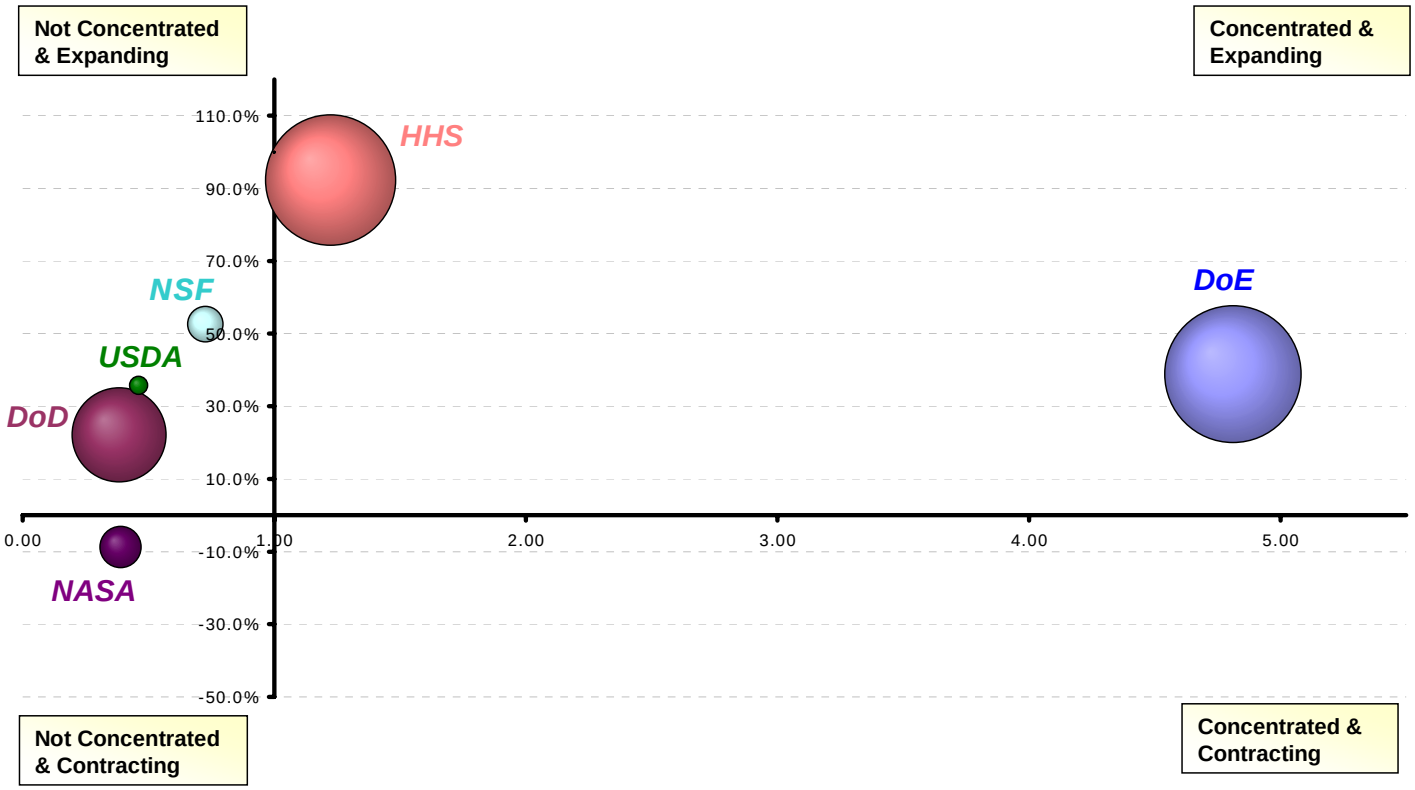
Source: National Science Foundation
Note: Growth rates calculated using current dollars.

Explanation: Table 4 shows the top federal agencies that provide R&D funding to Tennessee through the Small Business Innovation Research program. The agencies are the US Department of Health and Human Services, the National Science Foundation, the US Department of Agriculture, the US Department of Energy, the US Department of Defense, and the National Aeronautics and Space Administration. Years 1998 and 2003 were compared in order to determine the trend of Federal SBIR Funding to Tennessee, and any changes.

Findings: The only major federal agency that reduced funding to Tennessee was NASA. As seen through the data, the Department of Health and Human Services, the Department of Energy, and the Department of Defense send the most Federal SBIR Funding to Tennessee.

Action: While NASA did decrease funding to the state of Tennessee, NASA currently has less of an impact on Tennessee's economy than other federal funding agencies. The incredible growth seen in funding awarded by the Department of Health and Human Services could also be seen in other federal agencies if the state facilitated programs to educate businesses on how to better obtain SBIR funding.

Federal SBIR Funding to Tennessee, 2003



Explanation: This bubble chart more visually describes SBIR funding. The size of the bubbles reflects the amount of funding, and each bubble is charted based on whether funding is expanding/contracting and concentrated/not concentrated.

Findings: The Department of Health and Human Services as well as the Department of Energy are both the largest sources of funding. Only the Department of Energy is significantly concentrated in Tennessee.

Action: Strides to develop concentrated clusters in Tennessee that will drive the economy are important and vital to improving economic development. There should be a focus to develop concentrated regional-specific clusters in Tennessee.

1.5 - Private Sector R&D Funding

According to the National Science Foundation (NSF), industry supported R&D accounts for approximately 92.8 percent of the $195 billion non-Federal support. In 2000, private sector R&D accounted for 68 percent of total R&D in the United States. NSF attributed the growth in private sector R&D to changes in federal support in areas such as defense and space exploration, and success stories in specific fields, such as information technology (IT) and biotechnology. Tracking this type of funding is more difficult than the public monies.

Private Sector R&D in Tennessee, 1998 – 2004

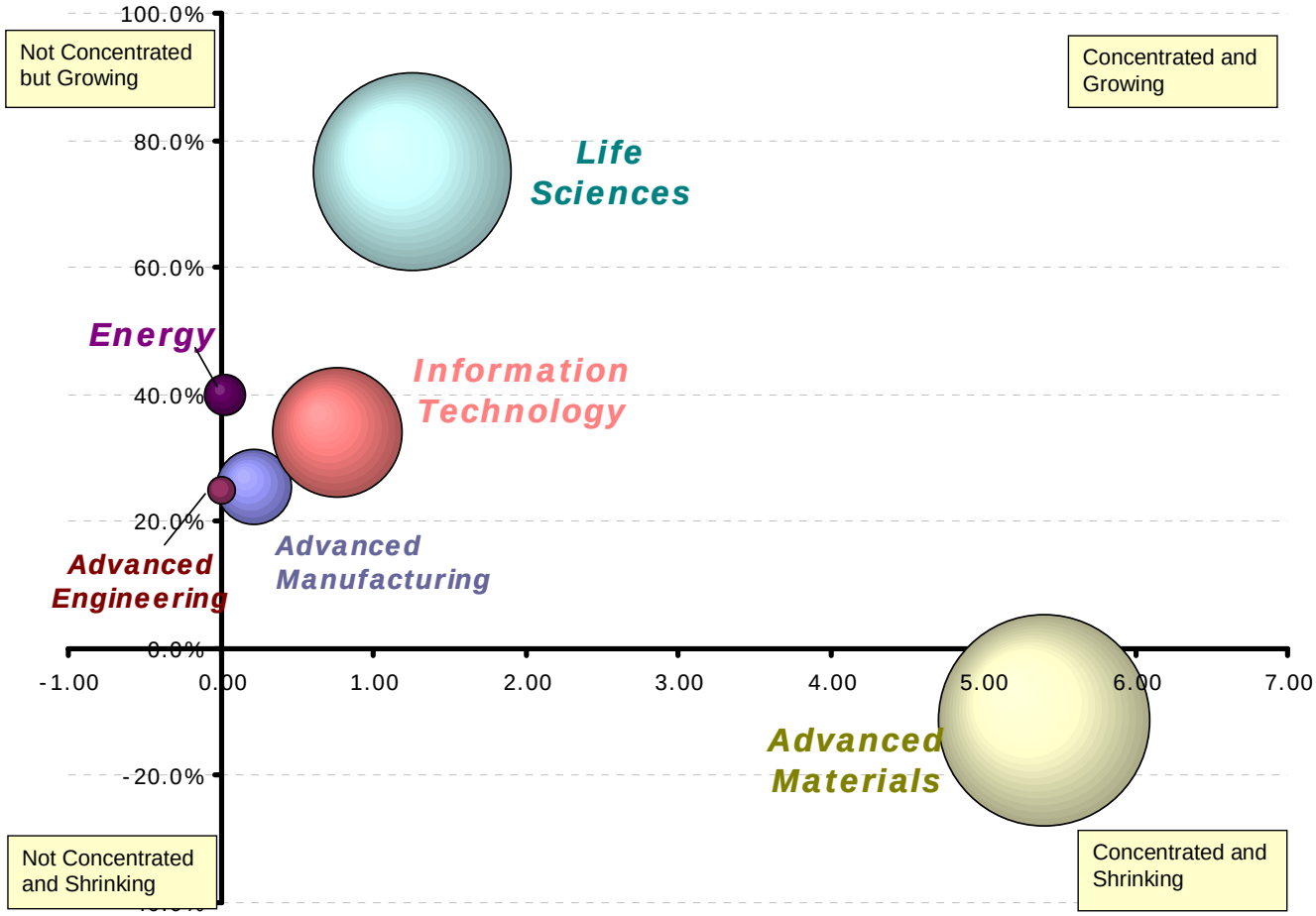
Technology Industry	1998 Investments (thousands of $)	2004 Investments (thousands of $)	Percent Change, 1998 - 2004	*Percent Change, 1998 – 2004, US Total*
Information Technology	$36,100	$48,400	34.1%	*56.2%*
Life Sciences	$64,700	$113,200	75.0%	*25.0%*
Advanced Materials	$147,800	$161,100	9.0%	*10.4%*
Advanced Engineering	$200	$300	50.0%	*62.4%*
Advanced Manufacturing	$13,800	$17,300	25.4%	*42.7%*
Environmental Technology	$600	$800	33.3%	*27.3%*
Energy	$500	$700	40.0%	*56.2%*
Video Games & Tech Toys	$0	$0	0%	*56.0%*
Tech Industry Total	**$263,700**	**$341,800**	**29.6%**	*39.0%*
All Private R&D Total	**$274,700**	**$356,600**	**29.8%**	*37.7%*

Explanation: The table provides the reported R&D expenditures of the private sector in Tennessee by technology area for the years 1998 and 2004. The percent change between 1998 and 2004 is also calculated along with the U.S. change for the corresponding investment areas. The nationwide comparison offers one important means of gauging the state's performance.

Findings: Life sciences and environmental technology were the only areas in which Tennessee's growth outstripped U.S. growth in private sector R&D. Tennessee investment in life sciences grew 75% from 1998-2004 in comparison to 25% nationally. Environmental technology posted a more modest gain of 33.3% compared to the national average of 27.3%. Notable laggers in investment include: information technology, advanced manufacturing, and energy. According to the available data, Tennessee has no private sector R&D in video games and technology toys. It is important to note that percent change in private sector R&D is subject to fluctuate more rapidly than at the national level since state levels of private R&D can easily be influenced by a few companies moving in or out of the state.

Action: With two of the five targets of opportunities in the life sciences, Tennessee leaders should leverage the significant up tick in the private sector R&D by providing incentives for university-industry research partnerships, and assistance in identifying and applying for federal research money. Focus should be placed on the areas within the life sciences sector that show particular promise in the state such as health management and human biological products. Leaders should also reach out to their private sector energy companies to understand their research spending patterns, and how the preponderance of federal funding received by Tennessee from the DoE can encourage more investing. This will require high level leadership from the Oak Ridge National Laboratory, which receives the majority of the DoE funding.

Private Sector R&D in Tennessee, 2004



Explanation: Figure 5 graphically depicts the relative growth and concentration of Tennessee's private sector R&D funding in 2004 compared to the U.S. The strongest investments are located in the upper right-hand quadrant where the funding grew faster then the national average, and the amount of funding is greater than the national average. The technology areas found in this quadrant represent a potential competitive advantage for the state. The size of the bubble correlates to the dollar amount of investment in 2004.

Findings: Tennessee's private sector R&D investment in advanced materials is nearly five and half times more concentrated than the national average, however it is also showing more contraction in funding compared the national trend. The second largest source of private sector R&D is the life sciences, which has seen excellent growth in the dollars invested, but remains a relatively small overall investment compared to other regions across the nation. The remaining technology sectors all posted positive gains in funding, but are in a rather weak position compared to other regions across the country. A flag should be raised in the energy sector, which has relatively small private sector investment compared to the other technology areas in the state and nationally, and disproportionate low levels compared to the federal funding received by the DoE.

Action: Each technology area in this chart requires focused support by the state. As with the life science strategy discussed in connection to the previous table, leaders should look for ways to make federal funding opportunities and local university research more apparent to the private sector. When possible, the state should provide small grants and technical assistance when applying for federal funding, including SBIRs and STTRs.

1.6 - Venture Capital Funding in Technology Areas

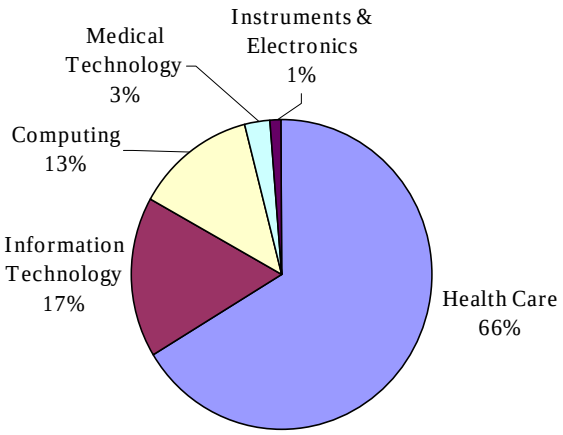
Venture capital is money provided by professionals who invest in young, fast growing companies believed to have the potential to contribute significantly to the economy. Venture capital is a critical source of equity for start-up companies. Thus, tracking venture capital funding is an excellent bellwether of the robustness and market viability of a state or region's technology sector. The data source used in this section is the MoneyTree Survey, which is a quarterly study of venture capital investment activity in the United States. The survey is a collaborative effort between PricewaterhouseCoopers, Thomson Venture Economics and the National Venture Capital Association.

Explanation: Figure 6 is the cumulative venture capital investments made in the state of Tennessee from 1995 to 2004 aggregated by technology area.

Findings: The health care sector accounts for approximately two thirds of all venture capital investments made in the state of Tennessee. Conversely, medical technology represents only 3 percent of total investment. Industrial and energy accounted for less than 1 percent of Tennessee's venture capital, and was not included in the pie chart. Information technology and computing were the second and third largest recipients receiving 17 percent and 13 percent respectively.

Action: Some overarching action steps are provided in the next table. Additionally, the state should try to understand the lack of entrepreneurial activity in the energy sector. Clearly the federal research funding awarded to Tennessee by the DoE is not translating into economic success for the state.

Cumulative VC Investments in Tennessee, 1995–2004



Source: PricewaterhouseCoopers MoneyTree Survey

Venture Capital Investment in Tennessee, 1998-2004

Technology	Total Investments (2004 in $Million)	Growth in Investments (1998-2004)	Investment Concentration Relative to U.S. (U.S. avg. =1.0)
Medical Technology	$32.7	-35.1%	1.49
Health Care	$31	50.6%	17.21
Computing	$10	-244.8%	.47
Information Technology	$.72	29.3%	.09
Industrial/ Energy	$.23	10%	.09
Instrument and Electronics	$.14	-22.7%	.02

Source: PricewaterhouseCoopers MoneyTree Survey

Explanation: The table provides the aggregated VC investment in 2004 by technology sectors, as well as the growth in investments between 1998 and 2004, and the relative concentration of investments visa via the United States.

Findings: Tennessee receives a significant amount of VC funding in the health care sector – a little more than 17 times the U.S. average. Medical technology follows as a distant second, receiving just slightly more VC funding than the national average. However, medical technology also experienced the second largest negative growth in investment between 1998 and 2004. In all other technology categories, the amount of VC funding received is minimal.

Action: Venture capital flows to good deals with products that are close to launch. The state should establish a pre-seed fund to help promising early technology companies overcome the venture "valley of death." Second, the state should look at its technology transfer mechanisms at research institutions to make sure technologies with great economic potential see the light of day. This may require new incentive packages for researchers, mentorship programs, business start up assistance, etc.

1.7 - Postsecondary Degree Production

Tennessee Postsecondary Science & Engineering Degrees and Certificates, 1998-2003

Science & Engineering Disciplines	No. of Degrees Awarded in TN (2003)	Growth Rate in TN Degrees (1998 - 2003)	Degree Production Relative to US (U.S. avg.=1)
Agricultural Sciences	349	5.6%	1.78
Computer Sciences	455	43.6%	0.51
Engineering Professionals	40	-2.3%	0.56
Engineering Technicians	1,119	5.9%	1.15
Biological Sciences	158	1.3%	0.54
Mathematical Sciences	304	-2.3%	1.12
Physical Sciences	465	3.2%	1.07
Science Technicians	752	53.5%	1.60
Health Care Practitioners	125	-12.2%	0.73

Source: National Science Foundation; National Center for Education Statistics
Note: Degrees total include all undergraduate degrees and certificates awarded by universities and colleges in the state of Tennessee.

Explanation: This chart describes the number of postsecondary science and engineering degrees and certificates awarded to individuals by universities and colleges in the state of Tennessee. Additionally, the rate of degrees being produced is contrasted with the national rate.

Findings: The rows highlighted in grey are the fields where Tennessee is not meeting the national average of degrees being produced. These disciplines showing a lower rate include Computer Sciences, Engineering Professionals, Biological Sciences, and Health Care Practitioners. Degrees awarded in Agricultural Sciences and Science Technicians are doing particularly better in terms of the rate awarded.

Action: The state of Tennessee must further leverage the competitive advantage it already has in select disciplines while promoting more individuals to receive degrees in disciplines that it lags in producing when compared to the United States.

Of special note regarding degree and other knowledge measures: NES has determined through its work in other states and nations that degrees – while still vital to the overall knowledge base – are becoming less important than certification of competencies. Industry demands that individuals are certified in their expertise, experience, and abilities to adapt to individual corporate tactics. Therefore, Tennessee must thoroughly examine its entire skills and competency pathway to ensure high schools, community colleges and technical schools, four year institutions, post-doc and post-bac, and industry training are organized into a simple and easily accessible 'workforce continuum' that is seamless.

In turn, ***Tennessee must address the role and importance of engineering as an underpinning to the future commercialization prospects of science and technology by developing a five-year initiative around creating a top-flight engineering school and curricula to meet market needs.***

Tennessee Postsecondary Business Degrees and Certificates, 1998-2003

Business Related Disciplines	TENNESSEE		UNITED STATES	
	Cumulative Degrees Produced 1998 - 2003	Pct of Total	Cumulative Degrees Produced 1998 - 2003	Pct of Total
Business	3,847	1.49%	308,731	1.82%
Business Administration and Management	24,414	9.44%	1,276,803	7.54%
Accounting	6,838	2.64%	373,478	2.20%
Administrative and Secretarial Services	1,856	0.72%	230,633	1.36%
Business Communications	0	0.00%	2,297	0.01%
Business/Managerial Economics	732	0.28%	21,033	0.12%
Enterprise Management and Operation	17	0.01%	10,295	0.06%
Financial Management and Services	2,754	1.07%	205,632	1.21%
Hospitality Services Management	346	0.13%	63,406	0.37%
Human Resources Management	490	0.19%	105,195	0.62%
International Business	172	0.07%	46,976	0.28%
Business Information/Data Processing Svcs	3,412	1.32%	281,458	1.66%
Business Quantitative Methods/Mgmt Science, Other	2,101	0.81%	31,544	0.19%
Marketing Management and Research	3,323	1.29%	183,350	1.08%
Real Estate	60	0.02%	9,047	0.05%
Taxation	0	0.00%	14,280	0.08%
Business Management & Admin Services	294	0.11%	51,719	0.31%
Business Management Total	**50,656**	**19.6%**	**3,215,880**	**19.0%**
Total Degrees Granted (All Disciplines)	**258,526**	**100.0%**	**16,944,400**	**100.0%**

Source: National Science Foundation; National Center for Education Statistics
Note: Degree totals include all undergraduate degrees and certificates awarded by universities and colleges in the state of Tennessee.

Explanation: This chart describes the number of postsecondary degrees and certificates in business related disciplines being awarded to individuals by universities and colleges in the state of Tennessee. The percent share of degrees awarded in each discipline is contrasted to the national percent share of degrees being awarded.

Findings: The rows highlighted in grey are the fields where Tennessee is not meeting the national percent share of business degrees being produced. While Tennessee exhibits strength in some categories of business related disciplines, it lags in many more.

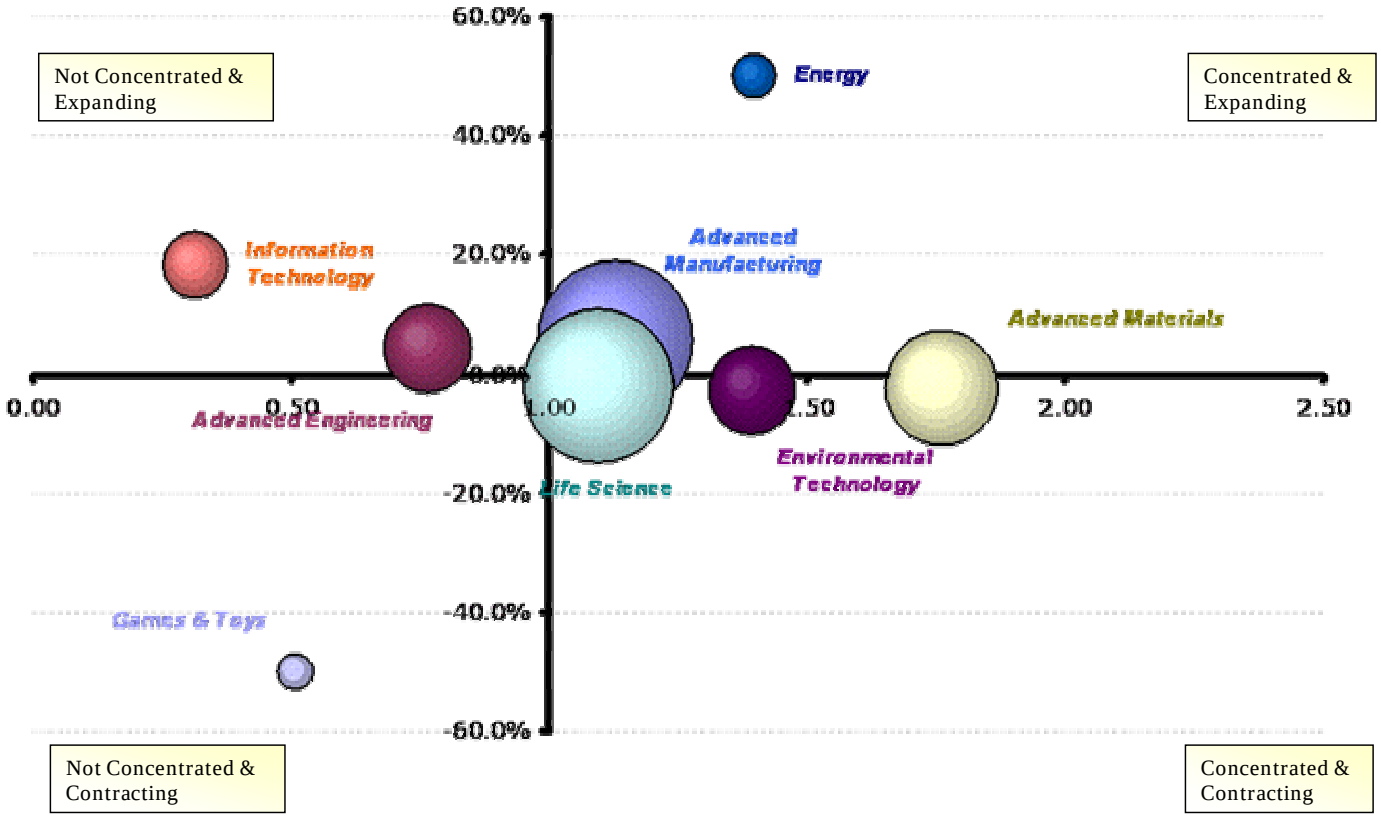
Action: The state of Tennessee must promote business education in order to succeed in technology development. It is essential to undertake research and promote science and technology. However, in order to capitalize on research there must be an effort to promote the business of technology and commercialization. ***The unique ties between general business, law, entrepreneurial and process manufacturing are now a cross-disciplinary strategy that Asian and European competitors are addressing.***

1.8 - Patent Data

In the knowledge economy, the key to success lies in obtaining, creating, developing, and commercializing intellectual property. Intellectual property assets in the form of patents are a key indicator of innovation output and are often the result of federal and private sector R&D investments. Technology leadership depends upon better leveraging of intellectual property assets. Examining the patent data helps determine the critical outcomes from research application and are precursors of potential commercialization. Patenting, as well as licensing can be the result of newly conceived companies, government or university researchers or mature companies. The analysis reveals that Tennessee has demonstrated leadership in the advanced materials and energy sectors, but also shows that all sectors must be supported in Tennessee.

Patent activity is often correlated with R&D spending but is not correlated with any other measure of success. As a rule, big companies have a lot of patents and small companies have fewer. Success depends, however, on having a few high impact patents rather than having a lot of mediocre patents. A driving force in technology-based economic development is the ability to convert such intellectual property into new products and services. This, in turn, has positive residual effects for attracting venture and corporate investment. One of the most important questions facing Tennessee, therefore, is 'how can it best support its creators of intellectual property?'

Patents in Technology Industries in Tennessee, 1998 - 2003



Explanation: Figure 1 shows patent activity in eight technology industries in Tennessee. The graph measures three key pieces of informati0n: The number of patents in an industry in 2003 (represented by the diameter of the bubble), the percent growth in patents in an industry from 1998 – 2003 (represented by the bubble's position on the Y-axis; bubbles above the X-intercept are growing), and the concentration of patents in an industry in Tennessee compared to their concentration in the overall US economy (represented by the bubble's position on the X-axis; bubbles to the right of the Y-intercept are more concentrated than the national average).

Implication: Three important technology industries, Advanced Materials, Advanced Manufacturing, and Life Sciences, are all more highly concentrated in Tennessee than the national average. Additionally, growth in patents from 1998 – 2003 has been very strong in the IT and Energy industries, and moderately strong in the Advanced Engineering and Advanced Manufacturing industries. These data suggest that Tennessee may have a comparative advantage in certain technology areas, such as Advanced Materials, Advanced Manufacturing, and Energy, and a good foundation for competing within the Life Sciences. The IT sector in Tennessee is small and relatively unconcentrated in terms of patents, but its 18.2% growth rate is cause for optimism.

Action: Tennessee should not ignore any of its technology industries. Although some of these are more important at a regional level, this is not visible from this graph. Tennessee must continue to maintain and strengthen existing competitive advantages in technology industries, and also must examine which smaller industries have a realistic capacity to improve significantly.

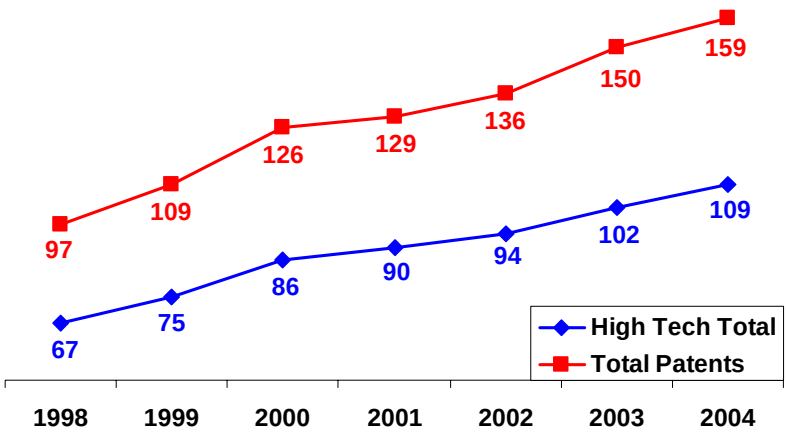
Table 6 - Patent Performance in Tennessee by Technology Industry, 1998 - 2003

Technology Industry	2003 Patents in TN	Percent Change, 1998 – 2003	Patents in High-Tech Cluster as Percentage of Total High-Tech Patents in TN	Patents in High-Tech Cluster as Percentage of Total High-Tech Patents in US
Information Technology	39	18.2%	5%	16%
Life Science	209	-1.9%	28%	25%
Advanced Materials	116	-2.5%	15%	9%
Advanced Engineering	71	4.4%	9%	12%
Advanced Manufacturing	219	5.8%	29%	26%
Environmental Technology	70	-2.8%	9%	7%
Energy	18	50.0%	2%	2%
Video Games & Tech Toys	11	-50.0%	1%	3%
Tech Industry Total	**753**	**--**	100%	100%

Column 2 in Table 6 above shows the actual number of patents in Tennessee in 2003 in each of the eight technology industries (corresponding to the diameter of the bubbles in the previous figure), while column 3 shows the change over time (corresponding to the bubbles' positions on the Y-axis in the previous figure). Column 4 shows what percentage of the total technology patents in Tennessee (753 in 2003) each industry represents, while, for the sake of comparison, column 5 displays the national averages for each industry. By comparing columns 4 and 5, it becomes evident that Life Sciences, Advanced Materials, Advanced Manufacturing, and Environmental Technology all play a more important role in Tennessee's patent performance than they do nationally, while the opposite is true for Information Technology, Advanced Engineering, and Video Games and Tech Toys.

Again, the regions examined are the Tri-Cities region (composed of Sullivan, Washington, and Carter Counties), the Knoxville/Oak Ridge region (composed of Knox, Blount, Anderson, Union, and Sevier Counties), the Memphis region (composed of Shelby, Tipton, and Fayette Counties), the Nashville region (composed of Davidson, Williamson, and Cheatham Counties), and the Chattanooga region (composed of Hamilton and Marion counties). There were considerable differences in patent performance between regions in Tennessee. Below are a few highlights:

Technology and Total Patent Performance in the Nashville Region, 1998 - 2004



explanation:
The blue line in Figure 2 shows the combined number of patents in the 8 high-tech industries in the Nashville region, while the red line shows the number of overall patents.

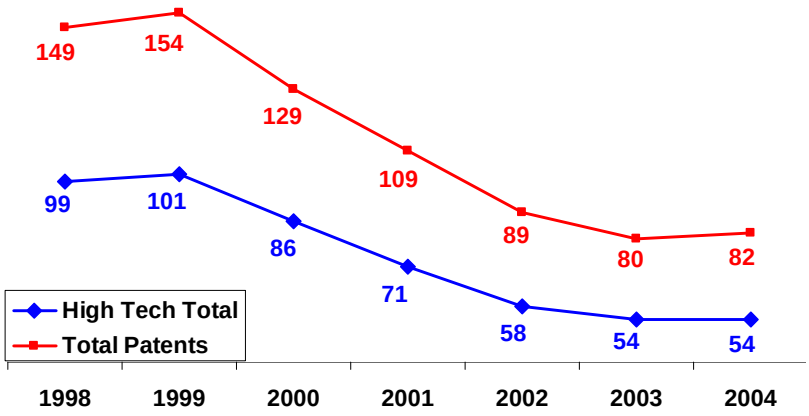
implication:
Nashville was the only region that showed a positive trend in patents.

action:
The State needs to discover why Nashville's success in patent performance has not been duplicated in the other regions.

Across the state, it was generally true that technology patent performance and total patent performance tracked each other closely, whether patents were increasing or decreasing (in graphical terms, the red and blue lines did not diverge significantly in any of the regions, regardless of the slopes of the lines).

In the Tri-Cities region, patents have been dropping for four straight years – from a high of 110 technology and 142 over-all patents in 2000 to 74 technology and 98 over-all patents in 2004. In the Memphis region, patenting peaked in 1999 with 101 technology and 154 over-all patents, while 2004 numbers (54 technology and 82 over-all) were little more than half of that. Even in the Knoxville/Oak Ridge region, long a center of innovation in Tennessee, patents were at a seven-year low: There were 100 technology and 151 over-all patents in 2004, versus a high of 132 technology and 181 over-all patents in 2002.

Technology and Total Patent Performance in the Memphis Region, 1998 - 2004



explanation:
The blue line in Figure 3 shows the combined number of patents in the 8 high-tech industries in the Memphis region, while the red line shows the number of overall patents.

implication:
Patent performance has dropped precipitously since 1999 in the Memphis region.

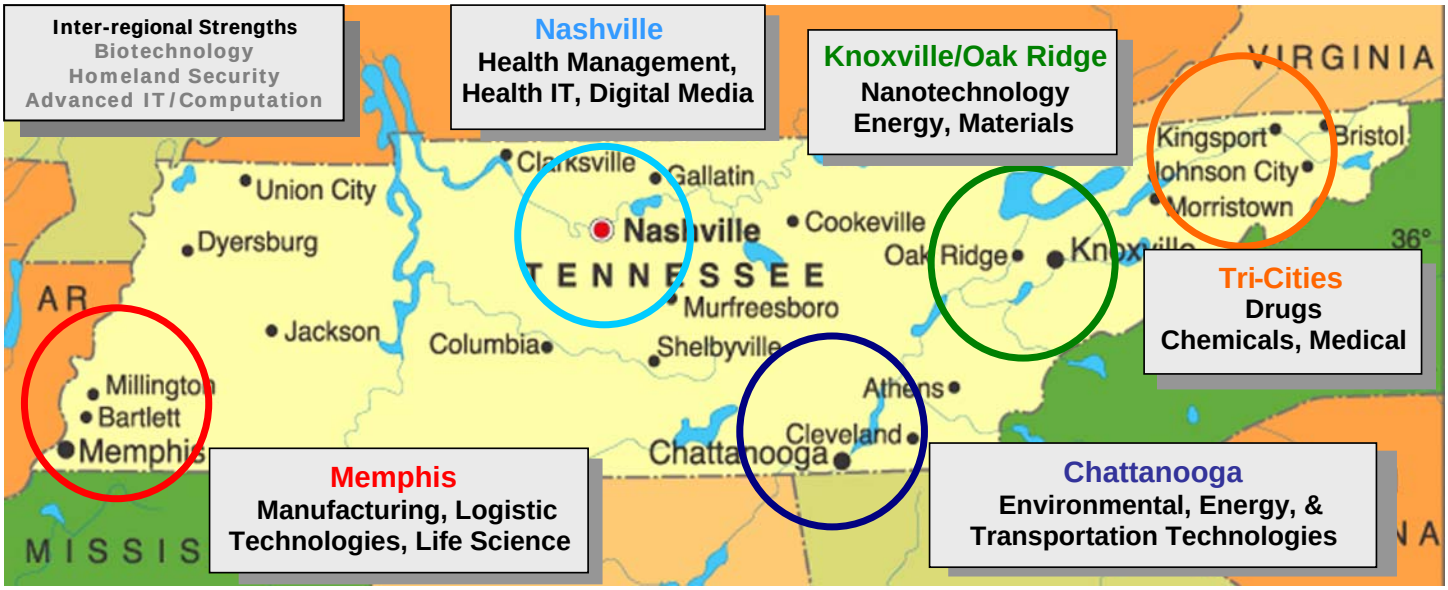
action:
The State needs to take strong steps to identify the causes of this drop and to reverse it.

2 - Targets of Opportunity

2.1 - Determining Regional Targets of Opportunity

As noted previously, targeting the opportunities for Tennessee to compete domestically and globally in a handful of cluster sub-sectors is paramount – such targeting aligns existing assets with future resource allocation to ensure a successful build-up of the critical mass necessary to compete in emerging industries and entrepreneurial endeavors.

In 2004 and 2005, Tennessee's State Committee on EPSCOR (the Experimental Program to Stimulate Competitive Research, a National Science Foundation program) explored the needs of its academic research community to determine if the State could capture more federal dollars and thus advance to a higher ranking among competitor states. For such a result, the State's higher education system joined with other institutions and interest to conduct forums across the regions so as to refine and prioritize research programs. These forums and resulting analysis caused academic research to determine focus areas and ultimately similar targets of opportunity for economic growth and competitiveness as will be found below.



To make such targeting effective, NES has taken the relevant data about Tennessee's asset base and analyzed current and future market trends in business models and economic growth potential. For instance, rather than identifying what appears to be an unique opportunity, NES must consider the relative size and scale of the market so as to recommend its worthiness for attention by public and private sectors through the State. In certain cases, the data – both hard and anecdotal – tell only one aspect of the compelling story for the identification and support of the targets; our national and international perspective provides key insights to recognize where the State and its regions could leverage current capacity to advance a competitive strategy.

When examining the federal funding, patent, industry investment and other datasets, it becomes clear that Tennessee amassed certain levels of competitive strength for attracting the ingredients of industry clustering. For instance, when reviewing federal funding in the five major regions of the State – Chattanooga, Knoxville/Oak Ridge, Memphis, Nashville, and the Tri-Cities – the average 56% growth in federal funding of research from 1998-2003 suggests that academic institutions and the private sector are poised to advance new ideas and products into the market place. Note charts on pages 15-19 describe the regional perspective of federal funding – and the significant difference in the resources for academic and industry R&D; viewed from a 30,000 foot perspective, the need to connect people and assets in various regions across the State is imperative to the success of these targets.

The knowledge creation coupled with nationally and globally mature industries spread throughout the State require increased targeting of commercialization demands; larger firms with internal research-product development-manufacturing can conduct business anywhere in the world – and thus must recognize why being in Tennessee positions their growth more favorably than other locations.

At the same time, the hard data does not recognize the intensive corporate and industry networks comprised within key institutions and organizations – the global market capabilities and relationships that cause the best in the market to consider Tennessee based firms to be vital to growth and expansion. While NES did not measure the extent of these innovation networks outside of the State, anecdotal evidence suggest that strong ties and linkages exist among corporate vendor-supplier chains, executive level management, and customer partnerships. In the construct of a future Tennessee *Community of Innovation* portal, such networks must be captured and fully exploited.

Thus, the statewide data assessment, interviews, and forums have served as the basis for determining initial strengths; NES then considered market potential and how economic trends would require differentiation by connected and linked institutions, organizations, and individuals throughout the State. Therefore, the following five targets of opportunity build from Tennessee's current assets while also requiring additional resources and the 'stretch' of civic and business leadership to create a so-called 'value proposition' – a business strategy on why key sector stakeholders must be 'present-to-win' in the State for economic growth and bottom-line impact.

2.2 - Target Market Descriptions

Energy, Environmental, and Transportation Technologies (Chattanooga):
Chattanooga's recent transformation around environmental and transportation related investments has become a national benchmark for not just sustainable development interests but increasingly for industry-based activities in research and product development. Through its center of excellence and expansion of academic research in the engineering arena, Chattanooga continues to drive the opportunities for aligning the commercialization pathway with market demand. However, certain additional opportunities are emerging – for instance the interests in converting biowaste into biofuels and thus leveraging the State's agricultural capacities in the western counties, the fuel cell research in and around ORNL, and general transportation knowledge from one of the nation's most heavily traveled interstate, trucking, and logistics centers. Previous investments in Tennessee-born transportation-related technologies in the 1990s by both federal and state resources now align with the country's recent linkage of energy independence and national security. Federal agency programs at the U.S. Department of Energy, Department of Commerce and the Environmental Protection Agency are increasingly going to require state pilot projects and innovation-focused settings. Current federal investments in Tennessee from the Department of Defense, the Department of Energy, and the National Science Foundation include specific grants and contracts in several contributing elements for sub-sectors. Though the Department of Agriculture has decreased its research budget, a number of agricultural related activities at the state and regional levels must be organized to connect with newer sources of discovery and development – and thus a more thorough assessment of people and institutions that must collaborate will strengthen this target of opportunity.

Advanced Manufacturing, Design and Logistics (Memphis):
One of the vital strengths for the State's economic and technological growth is the depth of engineering capacity spread throughout various industry sub-sectors in spite of not having a nationally-ranked engineering school. Though private sector, industry research in advanced manufacturing-design-logistics – approximately $17 million in 2004 – is clearly undervalued, additional drill-down into the data suggests that traditional views of manufacturing are being overwhelmed by new capabilities among Tennessee's industrial sectors. For instance, production around automotive includes just-in-time inventory management from vendor-supplier chains, robotics, new materials and polymers, design of both the vehicle as well as the production process. Similar linkages between the up- and downstream 21st century manufacturing require more and application of new knowledge, data, and supporting information from thousands of inputs including consumers, engineers, shop-floor production, delivery and transportation logistics including digital and web-based tools.

Through the Fed-Ex Institute on the University of Memphis' campus, applied research, learning, and a host of new tools are addressing the design, manufacturing, and logistics as an interdisciplinary and collaborative system. Information technology – from CAD-CAM design to virtual reality and artificial intelligence – is *the* underlying foundation for the successful application of any advanced manufacturing scenario.

Thus utilizing assets like ORNL's supercomputer, the requirements for broadband access, and existing programs in the regions around IT training and skills, there is a significant opportunity – and a market-pull – for targeting advanced manufacturing and associated interests in design and logistics.

Drugs and Medical Products (Tri-Cities):
Memphis' role in the State through the University of Tennessee Health Science Center, the rapid emergence of St. Jude's commercialization capabilities and Memphis BioWorks as a regional driver of new enterprise development have fostered a regional critical mass in human biologicals and pharmaceutical opportunities. At the same time, medical device companies in various locations throughout the State – accessing manufacturing capacities, academic research, and product testing-certification expertise – are making for an unique opportunity in the life sciences. Coupled with capabilities in Nashville through Vanderbilt's cancer center and comprehensive research enterprise with strengths in pharmacogenomics and proteomics, Tri-Cities' chemical research and health care facilities, and other specific assets around clinical trials – Tennessee is poised to play an important but limited role unless these efforts are targeted. Over forty regions in the U.S. and some 28 globally are competing to be a biotechnology, life science competitor – therefore Tennessee must identify its specific competencies – cancer, neurology, and/or pediatrics.

Nanotechnology and Advanced Materials (Knoxville/Oak Ridge):
When examining nanotechnology as a target, NES' concern is that almost every other region in the U.S. is now seeking to adopt a strategy around the next generation of research in this 'hottest topic of the day.' Several regions throughout the country have created extensive programmatic initiatives in the nanotechnology arena – New Mexico resulting from its home to two federal laboratories, Southeast Pennsylvania with Philadelphia-Wilmington-Princeton collaborations and Texas with two Nobel prize-awardee consortiums. Therefore, the analysis of what positions Tennessee in the highly competitive environment for nanotechnology must begin with the role of Oak Ridge National Laboratory and the surrounding capabilities in Oak Ridge and Knoxville. However to make the analysis instructive towards what differentiates the State from other locations, drilling down into sub-sector funding and research output obviously centers on energy, battery performance, alternative fuel sources and environmental remediation.

The challenge for nanotechnology as an emerging cluster is the transition from research to commercial sector product development and manufacturing. Human biologicals, energy, materials and consumer products appear to be the leading products for revenues based on the National Nanotechnology Initiative analysis and reports. The fastest-to-market scenarios – common consumer products such as paints, cleaners and solvents, and related materials – are attracting significant venture capital; however the long-term prospects for energy and biologicals has attracted several forms of financing including corporate R&D dollars, federal research programs, and industry consortia. In 2004, over $161 million in advanced materials private sector research and a comparable amount from three federal agencies funded Tennessee's current agenda in nanotechnology.

NES recognizes that Tennessee has important interdisciplinary reasons for advancing a nanotechnology agenda – not withstanding the excellent results from Oak Ridge National Laboratory – including the regional automotive, medical device, and agro-biotechnology sectors. By drilling down in the numbers, the statewide agenda can be defined into a Fuel Cell Initiative – for a new age of transportation, medical devices that require monitoring, and agro-biotechnology for biomass conversion.

Health Management and IT (Nashville):
Nashville-based health care, hospital management firms such as HCA as well as insurance/payer companies, the Vanderbilt Center for Better Health, and the Health Care Council have created a national hub in the health management and associated information technology arena. Regions with similar but not as extensive knowledge – Boston, New York City, Los Angeles, Houston – have no systems in place to focus on the vital management opportunities in financing, operations, facilities and infrastructure, purchasing and acquisition, and personnel/human resources. Such knowledge for the construction, operations, and maintenance of billion dollar institutions engaged in a very complex set of deliverables in a highly regulated environment demands a broad range of understanding and capability.

In turn, the negative implications for raising health costs to corporate and national competitiveness have caused public policy-makers to seek new approaches to operations and maintenance of providers and delivery systems. While several other regions – such as Boston's Tufts University drug development analysis or Philadelphia's Wharton program on health care – are widely regarded endeavors – no other region in the U.S. has the stature or the collective experience as found in the Nashville community.

By no means are the opportunities outlined in the targets exhaustive; based on the qualitative and quantitative data available, NES has determined that these five areas are obvious strengths for Tennessee. The Road Map recommendations seek to continue the 'drill down' to identify the top performers and contributors to potential innovation in these targets – and thus a "skunk-works" type of team-building will both identify and solidify the bonds among these performers of research, commercialization and market-building.

NES has learned from previous experience that if a state or region stops at just the suggested target of opportunity identification process, it will fail to exercise the fullest level of engagement for truly building the cluster, the national or global hub for attracting the resources and talent necessary to remain competitive. Thus, targeting opportunities is just the first step in a process that over the next 3-5 years it is expected Innovation Tennessee will facilitate and catalyze deeper understanding and connectivity among all performers and interests.

3 - Peer State Benchmarking

3.1 - Best Practices in Leading States

Tennessee is now compared to leading states not to play the ranking game but to suggest vital actions to remain competitive and even find a leap-forward strategy. These states are considered leading states, because they not only pull in the most federal funding, but also have successful technology economies, and often long-standing pro-active technology-based economic development programs.

Best Practices in Technology-based Economic Development in Leading States

Economic Development Best Practices	Leading States							
	TN	MI	CA	NY	TX	MA	PA	FL
Coordinated, Long-term Federal Funding Strategy				✓[1]		✓		
Coordinated, Long-Term Strategic Approach to Federal Funding between State and National Political Representation								
Targeted Recruitment of Leading Researchers and Investigators		✓[2]		✓[3]	✓	✓[4]		
Strategy for Attracting SBIR/STTR Funding, Including State Matching Grants		✓[5]	✓[6]	✓[7]	✓[8]		✓[9]	✓[10]
Focus on Building, Maintaining, and Improving Key Infrastructure	✓[11]	✓[12]		✓[13]	✓[14]		✓[15]	✓[16]
Washington, DC Presence for Universities and Research Centers		✓[17]	✓[18]		✓[19]	✓		✓[20]
Web-based Tool for Providing Easy Access to Federal Grant Information				✓[21]	✓[22]	✓[23]	✓[24]	
Targeted R&D Tax Incentives		✓[25]	✓[26]	✓[27]	✓[28]	✓[29]	✓[30]	✓[31]
State Initiatives for Enhancing Commercialization		✓[32]	✓[33]	✓[34]	✓[35]	✓[36]	✓[37]	
State Fund for Investing in R&D in Emerging Technology Areas		✓[38]	✓[39]	✓[40]	✓[41]	✓[42]	✓[43]	
Promoting the Formation of Seed Capital	✓[44]				✓[45]		✓[46]	
Implementation of a Workforce Development Strategy	✓[47]				✓[48]	✓[49]	✓[50]	✓[51]
Concentration on Growing Small and Medium Enterprises			✓[52]	✓[53]			✓[54]	✓[55]
Creation of a Network of Top Researchers, Inventors								
R&D Voucher Program for Small Businesses								
Focus on Increasing International Investment Opportunities and Attracting Foreign Direct Investment		✓[56]	✓[57]	✓	✓	✓[58]	✓[59]	✓[60]

A blank cell indicates that the specific best practice is not being pursued in a significant way by that state. A check mark in a cell indicates that there is a significant level of activity in that state regarding that best practice. For more detailed and specific information regarding a state's activities, look up the number next to the check mark in the endnotes section located at the end of this document.

3.2 - Additional Examples of Best Practices from Around the Country

The following are additional examples of best practices from states around the country in the areas of federal funding, commercialization, R&D promotion, seed capital promotion, infrastructure promotion, and workforce development.

federal funding:

- Kansas Department of Administration -- A clearinghouse of information provided by the Kansas Department of Administration for federal funding opportunities.
- Maryland Educational Technology Council, (2004) -- Develop a Maryland-based forum that enables consortia of universities, government labs and the private sector to more competitively respond to large-scale federal funding opportunities.
- Oklahoma Applied Research Support -- Helps to attract federal funding for research and development.
- Texas Legislative Budget Board's *Federal Funds Watch* -- Disseminates information about federal funding in the state of Texas.

commercialization:

- Kansas Alliance for Technology Commercialization -- To develop communication between academia and businesses to foster technology transfer and the development of new products.
- Maryland Brainchild -- To commercialize Maryland's rich intellectual property and generating jobs and wealth.
- The Arizona Center for Innovation -- To incubate companies in aerospace, advanced composites and materials, information technology, environmental technology, life sciences and optics/photonics.
- Kentucky Commercialization Fund (created by HB 572) to enable university faculty to translate their research into marketable products and the Kentucky Science Engineering Foundation to explore homegrown concepts likely to become viable products and breed technology-based Kentucky companies.

promoting R&D:

- Maryland University Technology Development Fund -- Supports research in academia for projects that are likely to lead to commercialization.
- Pennsylvania Ben Franklin Technology Partners -- Offers assistance to technology-driven companies in the Commonwealth of Pennsylvania in preparing high quality SBIR and STTR grant proposals for submission to federal funding agencies.
- Kentucky Rural Innovation Fund (created by HB 572) – To enable small rural-based Kentucky firms to undertake research and development work.
- Texas Emerging Technology Fund -- Will provide $25 million for the fiscal years of 2006 and 2007.

promoting seed capital:

- Kansas Angels Initiative -- Provides accredited investors with tax credits against Kansas Income.
- Arizona "Angel Investors" tax credit – To spur investors in new firms.
- Kentucky Commonwealth Seed Capital, LLC -- To provide early stage investment funds to Kentucky start-up companies to capitalize on the most promising technologies through statewide and regional VC funds.

promoting infrastructure:

- Pennsylvania Infrastructure and Facilities Improvement Program -- The Infrastructure and Facilities Improvement Program is a multi-year grant program for certain types of infrastructure and building projects.
- Oklahoma Finance committee of Statewide Management Systems -- To find the most effective ways to streamline processes and utilize technology in order to make the most efficient use of financial human resources.
- Texas Senate Bill (S.B.) 1701, 78th Legislature -- To build a better state-wide technology infrastructure.

workforce development:

- Kansas Workforce Investment Act of 1998 -- Helping to produce lifelong learners, a highly skilled and productive workforce, and highly skilled and salaried careers.
- Maryland Business Works Program -- Support existing Maryland businesses in the retention and growth of their workforce.
- Arizona Job Training Program -- To support the design and delivery of training plans that meet unique industry standards and challenges.
- Kentucky Postsecondary Improvement Act of 1997 -- To "assure that Kentucky's postsecondary education and technical education system is positioned to provide the human capital needed to allow the Commonwealth to be a leader in the global economy of the 21st Century."
- Oklahoma Department of Career and Technology Education -- Promotes technology education in the state of Oklahoma

4 - Path to Building Engine of the Economy

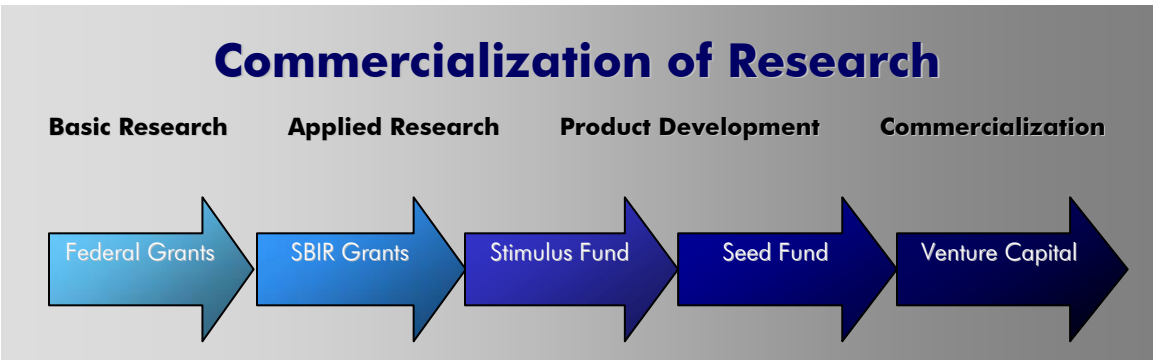
4.1 - Returns on Investing in Tennessee

In supporting the path from research to commercialization, it is important to ensure that all hurdles are cleared. Funding early-stage research without supporting development, for example, is likely to result in wasted resources as innovations are unable to advance. Accordingly, while the returns from many of the initiatives listed below can be directly measured as cash revenues, the objective of certain initiatives is to clear hurdles and maximize the impact of other initiatives in a synergistic matter. Assessing the financial impact of a Skunk Works project, for example, is challenging, as it is dependent upon outcomes that may take years to fully realize. The role of the Skunk Works, however, is crucial, as the objective of the initiative is to orient statewide activities for long-term success. It is therefore important to differentiate between the two categories of returns on investing in Tennessee.

There is the return on investment that is quantifiably measurable. An example of this would be federal Small Business Innovation Research grants. The money granted towards private companies would be the investment and the resulting return could be measured by the number of patents resulting in the funding of innovation research. Returns on investment of this nature are directly measurable and compartmentalized within a single firm.

However, there is the return on investment that is not as quantifiably measurable, but equally as important. There are many links in forming a complete chain of driving forces in the Tennessee economy. Without each part the process is broken, yielding fewer results or even none at all. When there is research being undertaken and a market for technology products, it is necessary to foster business growth through general government funding like a seed fund, for example. Benefits of disseminating information about technology industries may not have a measurable return on investment, but it can facilitate the starting of new enterprises in Tennessee. The impact of new businesses improves many aspects of society. These include the increase in the number of jobs, higher wages, more government tax revenue, and a general improvement in social welfare. Without filling this gap, one can invest more into research but will not reap any benefits without a complete path to commercialization.

4.2 - The Path from Research to Commercialization



The process of advancing an innovation from basic research to a commercially viable product requires years of research and funding from numerous sources. These funding sources differ in their desired endpoints, risk tolerance, and demand for equity.

Basic research is generally funded by federal grants. These equity-free sources of funding are aimed at supporting basic research, that is, research without an immediate application. Federal funding is also used to support applied research, that is, research directed at developing useful applications from the knowledge gained through basic research. Federal agencies with extramural research and development budgets over $100 million are required to administer SBIR programs to support innovative research and development that has the potential for commercialization and public benefit.

Federal funding is the most common source of equity-free funding, and generally only funds basic and early applied research. While late-stage commercial research is generally funded by venture capital, a gap often exists between the early

and late-stage funding sources. To bridge this gap, angel and stimulus funding are often used to fund critical proof of principle research and help a company develop sufficient infrastructure to attract seed and venture funding. See funding is the early-stage equity funding that generally 'starts' a company. Progressing from this stage, a company may continue to tap federal and SBIR grants to support individual research projects, but more aggressive forms of funding such as venture capital are required to support corporate growth.

Because commercialization of research takes many different paths and involves many different players, a variety of initiatives are necessary to cover the spectrum of support necessary to translate research into commercial successes. The initiatives described below have been selected because of their overlapping roles in supporting innovation. By focusing on discrete and overlapping elements of the innovation process, these initiatives can synergistically support progress from a diverse set of actors, maximizing their impact.

4.3 - Emphasize the NES augmentations to 'Skunk-works'

Given Tennessee's strong research base, the key to leveraging the resident knowledge and talent is to focus resources around lucrative opportunities.

The Skunk Works concept originates from Lockheed Martin's innovative Advanced Development Projects Unit that brought together top engineers and broke with traditional project management practices to produce a number of revolutionary aircraft, including the U-2, the SR-71, and the F-117 in a relatively short amount of time. In our implementation, we seek to create teams of the best minds in the state to work on focused long-term positioning projects to set directions and objectives for new products and solutions to meet private sector industry and entrepreneurial demand. An additional benefit to the original intents of Skunk Works will be the networking in each region in Tennessee as well as between the regions in Tennessee.

Expected Return on Investment:
The return on investing in 'Skunk-Works' initiatives more easily falls under the second category of returns. Not easily quantifiable, the returns would be more apparent through the development process by filling this initial gap. The added social benefit of networking to the economy is extremely valuable for facilitating more technology development.

4.4 - Acquisition of Research Teams

The research commercialization process starts with basic research, funded by federal grants. Because of the granularity of research, and in order to support a leadership position, five leading research teams will be recruited at an estimated cost of $2.5 million each.

Economic benefits generated by research teams reach the state in two ways. First, these teams acquire federal grants to fund their research efforts. These funds are used to pay 'maintenance' fees to their research institutes, to pay wages and salaries for research team members, and to purchase goods and services from other Tennessee businesses. The second means for economic benefit to the state derives from the novel research these teams engage in, which leads to license grants and the formation of new companies in the state. License grants benefit researchers and the institutes that house them as well as local lawyers, while new companies benefit the economy through the creation of new jobs.

Expected Return on Investment:
Based on estimates from the University of Utah, it is estimated that a top flight research team will generate $3.0 million per year in research funding. It is further estimated that $1.0 million in research funding supports 39 jobs, generating $732,000 in earnings and $59,000 in state tax revenue. Thus, in the absence of any synergistic value-added benefits, it is estimated that the total impact of a one-time investment of $12.5 million to attract five top-flight research teams is 585 jobs, nearly $11 million in recurring annual earnings, and $885 million in recurring annual state tax revenue.

4.5 - Federal Funding

One of the expected outcomes of recruiting top-flight research teams focused on desired themes is that they will lead to the development of new products and services based on these themes.

While most federal funding is designated to advance scientific knowledge, specialized grants such as SBIR grants focus on research and development based on basic research. The SBIR program is administered in three phases: Phase I is for feasibility studies and grants up to $100,000 for six months; Phase II is for research or research and development and

provides up to $750,000 over two years; Phase III is directed at commercialization and involves the use of non-SBIR funds.

Expected Return on Investment:
The economic impact of SBIR grants is significant. Knowledge gained from SBIR-funded research can directly impact the development of new products by the awarded, or can spillover and benefit third products as well. Both these outcomes can lead to better products at lower cost as well as direct gains in employment involved in research, development, manufacturing, or other roles. According to Ann Eskesen, director of the Innovation Development Institute and one of the country's leading authorities on the SBIR Program, it is estimated that for each dollar of SBIR awards granted to a company, the economy of the state in which the company is located gains five to seven dollars of economic benefit. This generous return was witnessed in Texas, as $135 million awarded to Texas companies over the period 2000-2002 were measured to produce an impact of just under $1 billion on the Texas economy.

4.6 - Investment

While SBIR grants fund applied research, they cannot be used to fund a company. The purpose of stimulus funding is to bridge the gap between SBIR-funded research within research labs and independent company formation through seed funding. Because seed funding results in the creation of a new firm, with the associated need for new jobs, services, and infrastructure, its economic impact is large. The average biotechnology company has just three employees in its first year of operations, but that number increases to six by the second year. Wages in biotechnology companies also tend to be higher than overall means, resulting in a greater economic impact through tax revenues and spending.

Expected Return on Investment:
While the expected economic impact of seed funding is a 9-fold return on investment, stimulus funding, with an expected 5-fold return, can greatly facilitate the translation of academic research to nascent start-ups, effectively enabling more companies to form and the creation of more high-paying jobs.

4.7 - Networking

The role of networking is predicated on the Innovation Lifecycle. While the aforementioned initiatives help with the conception, formation, and growth of firms, it is also essential to dedicate resources to support collaboration between mature assets to foster the creation of yet more new firms and to realize greater-than-additive synergies through collaboration.

Regional centers of innovation link and leverage resources, capabilities, and most importantly, they help requirements for industry and entrepreneurs to succeed by providing a one-stop shop network of networks. By creating a center dedicated to a research theme and providing resources to support companies in pursuit of that theme, regional centers act as lightning rods of innovation, guiding and facilitating progress. The regional centers of innovation have profound impacts on the local economy. Beyond the jobs created and knowledge spillover to other firms, which can be significant, regional centers of innovation can also spin off companies based on internal research. The return on investment to the local economy is estimated at 5-fold.

Beyond creating infrastructure to facilitate collaboration, it is also necessary to support proactive actions that can aggressively seek out and fill gaps and leverage unrealized opportunities. This is the role played by the Community of Innovation portal and Sites on Tennessee. The Community of Innovation identifies the individuals who are leading innovation in the State, helping streamline technology transfer activities, acquisition of new grants, and assembly of specialized research teams. The economic impact of the Community of Innovation is realized through increasing the rate and magnitude of these critical elements.

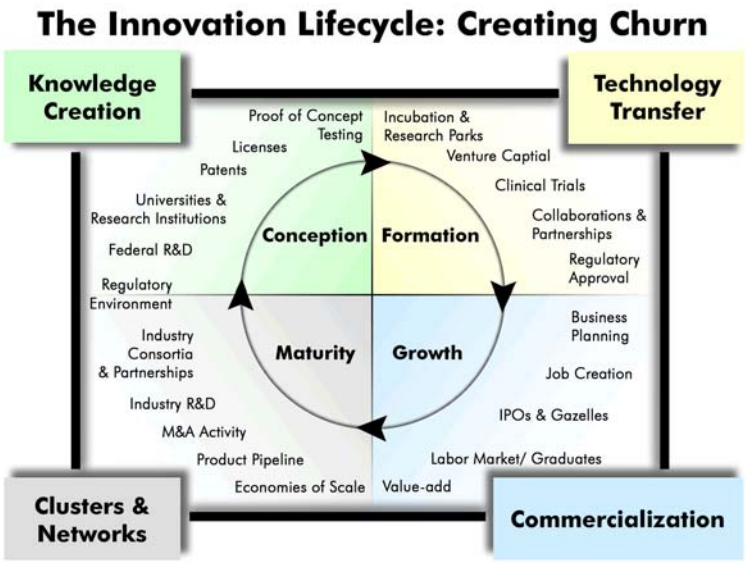
Whereas the Community of Innovation focuses on individuals driving innovation, Sites on Tennessee addresses infrastructure and capacities. By geographically profiling demographic data, Sites on Tennessee makes it possible to visualize the distribution of elements such as business locations, consumer expenditures, occupation and employment data, and educational attainment. These data enhance the returns on investments in infrastructure and other programs by providing the strategic guidance to leverage localized strengths and address weaknesses.

Expected Return on Investment: While the return on investment in the past for regional networking has been charted with a 5-fold return, the Community of Innovation and Sites on Tennessee, like the SkunkWorks initiatives, fall under returns that are not very quantifiable. There would be a clear reduction in the cost of finding individuals to work with as well as the reduction in cost for knowing about the economic geography of Tennessee. Additionally, returns on investment would include the creation of new businesses as a result of networking through the Community of Innovation and Sites on Tennessee.

4.8 - The Innovation Lifecycle

The Innovation Lifecycle

The goal of technology-based economic development is to create churn. Churn is the ability of a region's economic, scientific, technological and entrepreneurial resources to continually and collaboratively produce new ideas and new enterprises. In this model, funding granted to universities and research institutes is turned into knowledge (clockwise from upper-left quadrant), which leads to mature concepts and patents. These patents and concepts can be developed within research labs or licensed to start-ups and existing firms, which harden the concepts and patents into marketable products through additional research and product refinement. A key challenge in this 'technology transfer' from researchers to developers is to compel researchers and developers to cooperatively identify valuable technologies and foster their development. As technologies are moved to existing or newly formed entities for development, a need for additional scientists, engineers, and technicians emerges, benefiting the local economy by creating new high-paying jobs. The progression from development to manufacturing and commercialization leads to a further expansion in employment and creating opportunities for workers with less specialized skills. This growth also enables founding managers develop a broad set of skills, positioning them to assist in the formation, creation, and growth of new firms. The emergence of firms with access to national and global customers and suppliers also leads to synergies which can expand capacities for technology transfer and commercialization of products. These national and global connections can bring revenues from distant regions into the local economy, benefiting all community members. As a critical mass of stable companies and regional networks develops, economies of scale emerge. This leads firms to specialize in discrete elements of an industry value-chain, and merger and acquisition activities among technology firms increase. At this point, a region will possess many experienced managers and directors who are well positioned to use their existing competencies to start and grow new companies. The key to repeating the cycle – developing churn – is to aggressively support communication between players at all stages of the innovation lifecycle, creating a self-perpetuating progression from idea generation through company maturation.



5 - Initiatives for the Development of Tennessee's Technology Sectors

5.1 - Background Information

The following are initiatives to facilitate the development of Tennessee's technology sectors through the new organization, Innovation Tennessee. These initiatives are designed in stages over the course of five years and thus have a chronological implementation strategy. Early thinking and networking by technology sector leaders will help determine where to invest future capital. The initiatives are grouped into the categories of federal funding/research, investment, innovation networking, and outreach.

5.2 - Federal Funding/Research Initiatives

Research Initiatives:

SkunkWorks Design Teams. Tennessee has already supported the formation of research teams this year by allocating $3 million towards developing teams partnered between the University of Tennessee and Oak Ridge National Laboratory. The purpose of this initiative is to continue to bring the best and brightest researchers in Tennessee together to develop ideas that have the potential to increase commercialization and formation of new business ventures in the state of Tennessee. These teams will be comprised of a small number of individuals to reduce the cost of communication, facilitate collaboration, and produce results in a short amount of time with a limited number of resources. An additional objective and benefit will be to improve networking in Tennessee. There will be one team for each of the five key regions of Tennessee to account for the regionally specific assets that will help create regionally specific research leading to technology development. Each team will be allotted funds to start with and the most economically viable idea will be given an additional round of funding to develop a project around the research during the first year.

Industry Research and Development Vouchers. Vouchers for industry-specific research and development will focus funding on the first steps of the development process in Tennessee. It is recommended that Innovation Tennessee finds one or two promising areas to direct a voucher for research. The objective of providing funding via vouchers to research and development is to produce findings in science that have a potential for commercialization. Funds will be allocated every six months starting in the third quarter of the first year and every subsequent first and third quarter of the following years.

Commercialization Training. It is recommended that a program is developed to train researchers and entrepreneurs about commercialization. Focusing on research leading to business development is an essential goal of Innovation Tennessee, and this attitude must pervade all stages of the development process. Business planning around a focus of commercializing technology research is essential to the goals of long-term technology development.

Federal Funding Initiatives:

SBIR Statewide Conference Training. The federal government's Small Business Innovation Research program (SBIR) through various agencies enables nascent firms and small businesses to undertake research for innovation and eventual commercialization. Training individuals and organizations on how to obtain SBIR funding from agencies in the federal government is an active method to increase research in the state of Tennessee.

Federal Grant Assistance Program. While extensive funding available from the federal government via federal grants, many potential recipients are unfamiliar with how to most efficiently and effectively obtain these funds. To better equip firms in Tennessee in obtaining federal grants, Innovation Tennessee will offer training and assistance to select firms in Tennessee to increase the chances of winning federal grants.

Research Teams. Additional funding should be provided for the recruitment of research teams at the state's public universities. These research teams will spur research in the state of Tennessee, bring previous knowledge to Tennessee from past experience, and encourage synergy between institutions and organizations in Tennessee.

Commercialization Grants. Commercialization grants will be provided to companies that have demonstrated research that could likely be commercialized and profitable. Each year, Innovation Tennessee will reward a specified number of technology-based firms with grants to assist them with turning their research into commercially successful products in the third quarter.

SBIR Consulting. SBIR Consulting, whether conducted by Innovation Tennessee or outsourced to a development vender, would assist firms at becoming more efficient at attracting Small Business Innovation Research grants from the federal government. This consulting would assist in workforce training, research screening, and providing technical assistance to firms in Tennessee.

SBIR Grant Writing Assistance. Assistance with the actual grant requests to the federal government for Small Business Innovation Research is the last vital part that a firm has control over to more efficiently win federal funding. Innovation Tennessee will assist Tennessee firms in writing these grants. Innovation Tennessee will select firms on a competitive basis each year to offer funding assistance in writing grants for the SBIR program.

5.3 - Investment Initiatives

Investing Forums. These forums will help determine the best avenues of investment and help realize the power of angel capital in Tennessee. Quarterly forums during Innovation Tennessee's first year of operation will help determine courses of action for later initiatives. By holding these forums, Tennessee companies will also better understand Innovation Tennessee's overall mission as well as funding opportunities provided by Innovation Tennessee.

Capital Formation Gap Analysis. A critical step in technology development is the understanding of processes that drive capital formation. The factors influencing capital formation need to be assessed in order to properly allocate funding and assistance. Therefore Innovation Tennessee needs a preceding gap analysis analyzing the shortcomings of the capital formation process before moving forward with other initiatives.

Technical Assistance to FedEx Institute. Innovation Tennessee will work in partnership with the FedEx Institute to develop quarterly logistics boot camps designed to help emerging strong companies develop better logistics technology. Innovation Tennessee will allocate funding to the FedEx institute in organizing these boot camps for the next four years.

Logistics Boot Camp. Five successful small companies (revenues of $10-$30 million) in each of the five Tennessee regions will be selected to train these emerging companies to perform their networking and logistics more efficiently. A stipend will be given to the selected firms for attending the boot camp at the FedEx Institute. The goal will be to transform these companies into large successful firms (revenues of up to $100 million).

Pre-seed Stimulus Fund. Funds should be allocated to transition research centers into places of innovation for the purpose of commercializing technology.

Stimulus Fund. Although SBIR funding is useful for funding research, transforming that research into a potential commercial product necessitates even more funding. This stimulus fund would fund the gap between innovation research and actually starting small businesses.

Venture Fund. This fund will fill the gap between the stimulus and seed fund.

Seed Fund. The seed fund would finalize the business development process by funding the starting capital for new ventures created around new research in Tennessee. This fund will be the largest funding initiative.

5.4 - Innovation Networking Initiatives

Community of Innovation. The Community of Innovation is a tool to foster collaboration, scientific advancement and technological innovation. Using a series of objective measures, the Community of Innovation would identify and profile leading researchers, enablers and infrastructure in order to facilitate communication and networking in Tennessee.

Regional Innovation Centers. In addition to the Community of Innovation, regional centers of innovation would be useful in addressing local targets of opportunity. These centers would be focused around key regional Tennessee clusters.

5.5 - Outreach Initiatives

Research Guides. Four research guides will assist decision-makers, entrepreneurs, and companies in expanding research and business development in Tennessee. They are as follows:

Innovation Guide. An innovation guide published in Innovation Tennessee's first year would help technology firms innovate towards technology that would be profitable and help Tennessee's economy.

Entrepreneurial Guide. This guide published in Innovation Tennessee's first year would assist aspiring entrepreneurs in developing a business model around a viable technology.

Innovation Workforce Resource Guide. This guide published in Innovation Tennessee's first year would assist organizations in improving the Tennessee workforce and develop programs to attract the nation's top talent to their organizations.

Innovation Metrics Guide. This guide would track measures and successes of innovation in Tennessee, allowing the government, universities, and businesses to know where they stand in relation to Tennessee, the United States, and other countries.

Sites on Tennessee Selection Tool. This tool profiles infrastructure and capacities geographically in order to understand the spatial makeup of the Tennessee economy. It will allow entrepreneurs, researchers, and organizations to more efficiently locate operations by being able to observe many relevant data including consumer expenditures, employment data, and education.

Sponsorships, Conferences, and Forums. Various forums, conferences, and sponsorships in the state of Tennessee will be produced or partnered with by Innovation Tennessee in order to increase the state-wide visibility of technology development.

In-State National Forums. Innovation Tennessee will hold national forums to increase the visibility of Tennessee as a center for technology development and promote research centers and Tennessee businesses in the US economy.

Other Forums. In addition to holding forums, Innovation Tennessee will maintain a Tennessee presence in other forums and conferences happening around the country as well as outside of the United States in order to display the strength of Tennessee's technology economy to key national and global centers of innovation.

Statewide Assessment. At the end of the fifth year, there will be a statewide assessment of the impact of Innovation Tennessee's initiatives and conclusions will be drawn on how to improve technology development efforts.

6 – Leveraging Tennessee's Science & Technology Resources

To design, launch, and sustain this ambitious agenda requires a new partnership among government, industry and philanthropy. In no way should this set of recommendations imply that the State of Tennessee will be the sole source of funding and provider of sustainable resources. However, in order to spark and catalyze new partnerships, new ways of doing business, and effective interventions on the innovation process, the state of Tennessee must take the initial lead on critical funding and convening appropriate non-government partners to co-invest and ultimately lead aspects of the recommended tactics.

Tennessee possesses regionally specific targets of opportunity in which to expand and develop the economy. After analyzing the economic landscape of Tennessee, potential clusters or improvements on existing bases for clusters were recognized in the five key regions of Tennessee.

By recognizing existing resources in Tennessee and where to target growth, Innovation Tennessee, with the initial help of the government, will be able to leverage existing organizations to facilitate the execution of the initiatives described in the previous section. It is important to utilize these existing organizations in Tennessee for the purpose of making this new technology development strategy a truly networked one. Some relationships for implementing specific Innovation Tennessee initiatives with their prospective partners are summarized in the following table:

Innovation Tennessee Initiative	Partner(s)
Capital Formation Gap Analysis	Nashville Capital Network
SBIR Training, Consulting, & Assistance	Technology 2020, University of Tennessee
Logistics Boot Camps	FedEx Institute of Technology
Pre-Seed, Seed, & Stimulus Fund	To Be Determined
Sites on Tennessee	TN Dept. of Economic & Community Development
Community of Innovation	Multiple Partners
Federal R&D Funding Strategies & Assistance	TN Academic Institutions & Corporate Delegations
R&D Vouchers	Academic Provosts & Vice Presidents of Research; Industry Chief Technology, Research, & Science Officers

The ultimate goal to be achieved by the end of the fifth year of government support of Innovation Tennessee is for Innovation Tennessee to become less reliant on the government for funding support. Innovation Tennessee will eventually earn operating revenues through fees for its services, grants, and the for-profit management company, which will act very similarly to a venture capital company. In this way Innovation Tennessee will be motivated by itself to promote technology development.

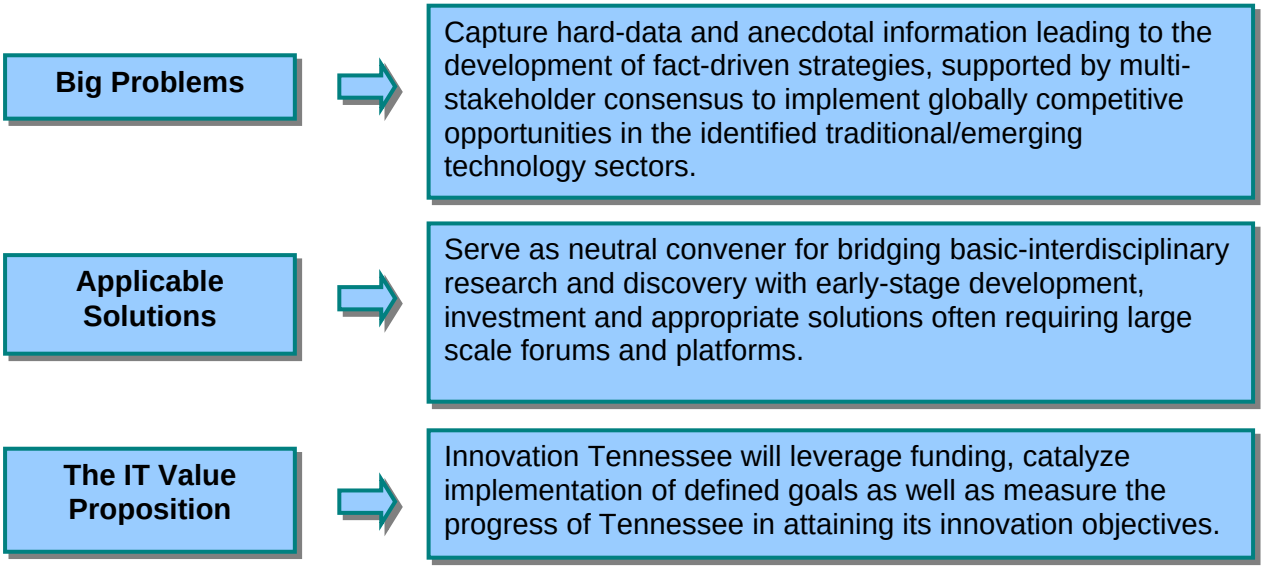
7 - Implementation

7.1 - Objectives of Innovation Tennessee

1. **Address Big Problems:** Emerging technologies, interdisciplinary understanding, off-shoring of traditional services, transition from basic to applied training, lack of skills pipeline, unfamiliar options beyond large corporate-laboratory-public sector scenarios
2. **Identify Immediate, Near-term, Long-term Solution Sets:**
   - Immediate: Increase connectivity of best minds around 3-5 skunk-works types of activities that raise the bar on Tennessee's innovation and competitiveness value proposition globally
   - Near-term: organize resources of capital investment, management talent, and capacities for commercialization
   - Long-term: 'clusters of competencies' and 'communities of innovation' become Tennessee's single best lead generator for technology-based economic development
3. **Develop and Apply Performance Metrics to Catalyze Response:**
   - Determine workforce skill gaps and develop pipelines of appropriately aligned technology skill sets
   - Identify appropriate early stage and SME opportunities for funding and investment across Tennessee
4. **Adapt to Global, National and Regional Competitiveness and Innovation Trends:**
   - Addressing the challenges of off-shoring knowledge, design, manufacturing
   - Linking and leveraging regional nodes of skills and capabilities to national hubs of technology innovation
   - Accelerating technological solutions based on state and regional competencies

Focus of the Network:

To be a regional and statewide solutions mechanism – whereby federal and regional public sector interests collaborate with industry, entrepreneurial and technological innovators to connect competencies with product and service development invested in by private funding



End Notes:

[1] One of NYSTAR's two primary goals is to "increase the total amount of federal and private research dollars…"
[2] The Jobs for Michigan Fund, recently passed by the State House will target the recruitment of leading researchers
[3] New York STAR Centers and Advanced Research Centers
[4] Massachusetts Workforce System
[5] Michigan Emerging Business Fund
[6] California Larta Institute
[7] NYSTAR Matching Grants Leverage Program
[8] Texas Emerging Technology Fund, Subchapter E
[9] Pennsylvania Innovation Partnership
[10] Florida High Tech Corridor Phase II SBIR/STTR External Investment Program
[11] Appalachian Regional Commission Program
[12] Michigan Community Development Block Grants
[13] New York STAR, ARC, CAT, RTDC, CoE
[14] Texas SB 1701, 78th Legislature
[15] Pennsylvania Infrastructure and Facilities Improvement Program
[16] Rural Infrastructure Fund Program
[17] University of Michigan Government Relations
[18] The University of California System has a strong presence in Washington, DC to help attract federal funding
[19] University of Texas System Office of Federal Relations
[20] University of Florida, Florida State University System, Florida Institute of Technology
[21] NYSTAR Funding Opportunity News
[22] Market Texas Clearinghouse
[23] Mass.gov
[24] Pennsylvania Department of Community and Economic Development, NewPA
[25] Michigan Jobs and Investment Act
[26] California enacted R&D credit in 1986 and has since been modifying its tax credit legislation to attract R&D
[27] Investments in research and development facilities are eligible for a 9% corporate tax credit
[28] SB 441, 76th Legislature
[29] Massachusetts Emerging Technology Fund
[30] Pennsylvania Economic Stimulus Package, Research and Development Tax Credit Assignment
[31] Expenditures on research equipment and research-specific labor are tax-exempt in Florida
[32] Jobs for Michigan Fund, Life Sciences Corridor and Technology Tri-Corridor initiatives
[33] California Institute for Telecommunications and Information Technology originally funded by the state legislature
[34] Industrial and Technology Assistance Program
[35] Senate Bill 831, 79th Legislature, Texas Emerging Technology Fund
[36] Massachusetts Technology Collaborative, Industry Support Program
[37] Pennsylvania Keystone Innovation Zone
[38] $1 billion in funding for life sciences over 20 years
[39] State funding to California universities
[40] New York Centers of Excellence and Gen*NY*sis
[41] Texas Emerging Technology Fund
[42] Massachusetts Emerging Technology Fund
[43] Pennsylvania Economic Stimulus Plan
[44] Small Business Energy Loan Program
[45] SB 275, 2003
[46] Life Sciences Greenhouse of Central Pennsylvania
[47] Job Training Assistance Program, Department of Labor and Workforce Development
[48] Texas Workforce Commission, Texas HB1863, 1995
[49] Massachusetts State Plan for Workforce Investment Act and Wagner-Peyser Funding
[50] Workforce Development in Pennsylvania
[51] A+ Plan for Education, Workforce Florida, Inc., Employ Florida Marketplace
[52] California Small Business Development Program
[53] New York Small Business Technology Investment Fund
[54] Pennsylvania Small Business First Program, Pennsylvania Economic Stimulus Plan
[55] The Florida Small Business Development Center Network
[56] Michigan Economic Development Corporation
[57] California Foreign Trade Zones
[58] Massachusetts Office of International Trade and Investment
[59] Pennsylvania Department of Community and Economic Development, NewPA
[60] Enterprise Florida's International Office Network

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Venue Hosts & Organizational Support

Bristol Motor Speedway
Chattanooga Technology Council
EmergeMemphis
Memphis Technology Council
Memphis BioWorks Foundation
Nashville Healthcare Council
Nashville Technology Council
Northeast Tennessee Technology Council
Oak Ridge National Laboratory
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