Accelerating Innovation Through Collaboration in the Ocean State:

Science and Technology Infrastructure Plan for Rhode Island

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Executive Summary

Rhode Island seeks to leverage its position as the "Ocean State" to become an "innovation ecosystem" where highly trained knowledge workers drive the economy, where world-class researchers flock and remain, and where a culture of creativity and entrepreneurship drives the state's accomplishments and reputation. This plan puts forward a series of coordinated activities that leverage Rhode Island's assets to maximize the economic impact of science and technology. Through a set of specific actions and outcomes designed to increase connectivity and communication, improve infrastructure, and streamline commercialization and translation, the plan charts a course for Rhode Island's future.

In order to provide focus for the Rhode Island Science and Technology Plan, the Rhode Island Research Alliance (of the RI Science and Technology Advisory Council, STAC) performed an assessment of potential areas for research collaboration by interviewing over forty leaders of Rhode Island-based research institutions including universities, hospitals, public agencies, industry associations, military and defense industries, and government agencies. The chief finding of this assessment is that Rhode Island is particularly well-equipped to pursue research in three interrelated areas: (1) life sciences, (2) marine sciences, and (3) energy and environmental sciences. Though these three topics are major research and development areas in their own right, they are interconnected at a higher level; growth in one will help grow the others.

Rhode Island's researchers are already very adept at scientific research, from basic to advanced, employing the latest theories and technologies to push the frontiers of their fields. In order for the Ocean State to create a vibrant and resilient place for itself in the world of science and technology, the state would greatly benefit from developing the following research capacities and tools: (1) information technology, (2) technology transfer and translational research, and (3) strategic thinking, including "design thinking" and scenario planning.

In the next five years, Rhode Island's goals for the development of science and technology are to:

1. Bring together researchers across the state to encourage collaboration in marine science, life science, and energy and environmental science;
2. Improve existing infrastructure for collaborative research, including Rhode Island's capacity for technology transfer within and across S&T sectors;
3. Facilitate business innovation by streamlining the pipeline between research ideas and new venture creation.
4. Communicate research findings and initiatives to public officers and the wider community.

STAC supports the continuous evolution of this plan in order to seize opportunities and incorporate new assets as they emerge in this quickly changing economic climate. The outcome will be an "innovation ecosystem" that builds on Rhode Island's assets and enables the state to succeed as the global research, development, and economic landscapes change.

I. Introduction

Research and the technological innovation it produces is not just a goal, it's a necessity. Innovation is the driving force behind a strong economy, one which creates new companies, opens entire new industries and provides opportunities for high quality jobs and careers. Supporting economic growth through the strategic support of research and development must be embraced as an economic development priority. Timely, targeted and transformative investments that support discovery and innovation and its transfer into the marketplace are key to long term economic security and job growth.

The Rhode Island Science and Technology Plan, *"Accelerating Innovation Through Collaboration in the Ocean State,"* puts forward a series of coordinated activities that leverage Rhode Island's assets to maximize the economic impact of science and technology. The plan identifies niche science and technology sectors that the state is both well- and uniquely positioned to fill and builds on state leadership's commitment to make investments in science and technology. Through a set of specific actions and outcomes designed to increase connectivity and communication, improve infrastructure, and streamline commercialization and translation, the plan charts a course for Rhode Island's future.

Rhode Island is prepared to leverage its compact geography and densely connected networks to create optimal alignment among its key institutions and organizations. Working together toward a common goal, Rhode Islanders can succeed in building a 21st century knowledge-based economy that benefits all of its citizens.

A. Economic Context

Business, government and educational leaders across the state have agreed that Rhode Island must become a strong participant in the knowledge economy. In many ways, the Ocean State is primed to pursue this role; it has a strong history of innovation, and has already committed resources and workers to knowledge-based industries. The latest available data indicate that high wage industry sectors—key pieces of the knowledge-based economy—account for almost 40% of the state's private sector employment.[1] Knowledge-based industry sectors feature prominently in the Rhode Island Department of Labor and Training's prediction of the sectors with the most potential for expansion by the year 2016, including the information sector, finance and insurance, professional, scientific and technical services, management of companies and enterprises, educational services, and health care and social services.[2]

Lacking a substantial natural resource base, Rhode Island has long relied on innovation and entrepreneurship to generate prosperity. Invention, technology, and business acumen made Rhode Island rich during the state's manufacturing era. Since the decline of manufacturing, new areas and forms of concentrated economic activity have emerged in the state. The following geographic areas are the state's economic engines[1] (see Figure 1):

- **The Route 116-99 Corridor.** The corridor contains corporate offices, financial services, and manufacturing, including life science industries. The corridor is strongly connected to the Boston-area labor market.

[1] There are other nodes and distributions of economic activity in the state, but the economic engines described here are the 'foot print' of Rhode Island's current economic geography.

- **The Providence Metropolitan Core.** The core contains hospitals and institutions of higher education, financial services, and state government. As the state capitol, it is the political, economic and cultural heart of the state.
- **The I-95 Triangle.** The triangle has T. F. Green airport in its north corner, Quonset-Davisville business park in the south corner and the West Greenwich industrial park in its west corner. The triangle contains manufacturing, including life science industries, ship building, logistics, and business offices.
- **Aquidneck Island.** The island has the Navy, including the US Naval War College and the Naval Undersea Warfare Center, defense contracting industries such as Raytheon and BAE Systems, and tourism. Aquidneck is the center of the defense-driven component of the state economy.

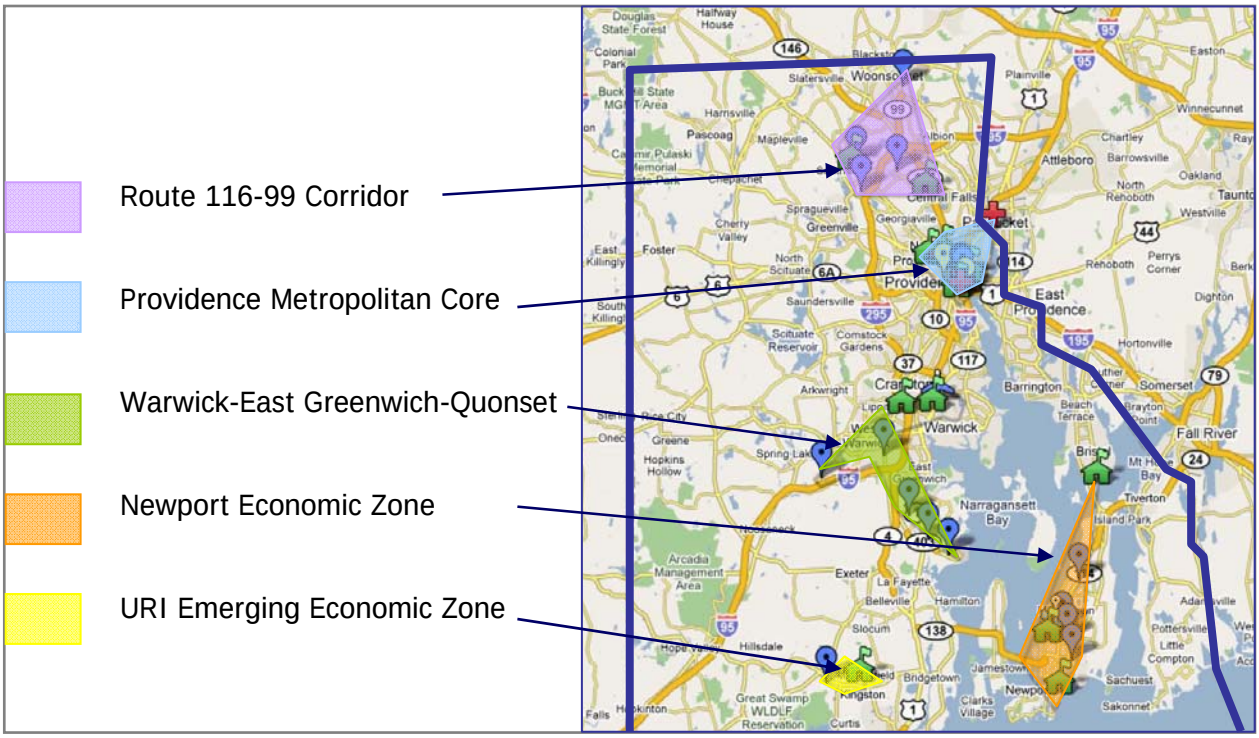

Figure 1. Rhode Island's Major Economic Zones.

Despite these assets, Rhode Island needs to seriously consider its level of preparation for leading its way out of the current recession and into the knowledge economy of the future. As a salient example, although the Ocean State has successfully attracted large federal research grants, it trails the national average in terms of commercializing its research. Moreover, start-up formation and small company growth remain well below the region's potential, especially given its strong research base. This situation indicates a need to expand opportunities to connect entrepreneurs from various start-ups and high growth companies to researchers, and to foster the adaption of new technologies and innovative business solutions to existing mature companies.

A knowledge economy is driven by highly-educated and trained workers who can respond quickly to the rapidly changing needs of the market and society. Attracting a skilled workforce to Rhode Island is also a challenge, largely due to lower wage rates. As its manufacturing economy shrank, Rhode Island failed to

keep pace in economic growth with other states in the Boston-Washington Northeast corridor, especially the adjoining states of Massachusetts and Connecticut. Based on Federal Reserve Bank data, per capita income is 25% higher in Massachusetts and 40% higher in Connecticut than in Rhode Island. Rhode Island currently has one of the highest levels of unemployment in the nation.

Compared to other states, the Rhode Island population has room for improvement regarding the educational attainment of its population. In New England, it ranks lowest for percentage of the population aged 25 or over with at least a high school degree (82.7%). Compared to other selected EPSCoR states (those receiving less than 0.75% of NSF funds), Rhode Island is in the middle of the pack for this category. The Ocean State performs slightly better regarding the percentage of the population aged 25 or over with at least a college degree when compared to other states in New England (29.4%, just higher than Maine's 25.9%); and is the highest compared to other selected EPSCoR states (see Appendix A).

The current economic climate in Rhode Island reflects the broader national recession, and presents a considerable challenge to the state. In order to position itself for the long-term recovery, Rhode Island must improve its science and technology foundation to support an economic transformation.

B. Position of the S&T Sector in Rhode Island

Rhode Island has both major assets and major challenges regarding its ability to participate in the "new economy".[2] Despite a ratio of one student per twelve residents, Rhode Island is ranked 20th for workforce education, 23rd for immigration of knowledge workers into the state, and 6th for migration of knowledge workers out of the state.[3] While Rhode Island has significant capacity to train the future STEM workforce, more knowledge workers *leave* the state than enter. An additional challenge is the reduction in infrastructure for new venture creation; Rhode Island's rank for Risk Capital and Entrepreneurial Infrastructure Composite Index decreased from 3rd in the nation (in 2004) to 15th (in 2008).

On the other hand, since 2002, Rhode Island improved in all but one category of the Milken Institute's 2008 State Technology Science Index. [4] (See Table 1 for S&T performance data). The Information Technology and Innovation Foundation ranks the Ocean State third in the nation for industry investment in R&D, second for health information technology, and second for broadband telecommunications. While Rhode Island's neighbors, Massachusetts and Connecticut are the nation's leaders in hosting "knowledge jobs," Rhode Island is just behind California at a rank of 15, and ahead of 35 other states. The study suggests that this could be attributed to RI's high number of defense electronics and biotechnology firms as well as the R&D tax credit the state had in the past few years.

Table 1. Rhode Island's Performance in Science and Technology Relative to the US, 2002-2008.

- Overall ranking improved to 10th (2008) from 11th (2004) and 21st (2002).
- Human Capital Investment Composite Index improved to 15th (2008) from 22nd (2004).
- Research and Development Inputs Composite Index remained the same – ranked 6th in the nation.
- Technology and Science Work Force Composite Index improved to 13th from 21st (2004) and 32nd (2002).
- Technology Concentration and Dynamism composite index improved to 13th from 21st (2004) and 26th (2002).

Milken Institute, State Technology and Science Index, 2008.[5]

[2] "The New Economy is a global, entrepreneurial, and knowledge-based economy in which the keys to success lie in the extent to which knowledge, technology, and innovation are embedded in products and services." (Atkinson R, Andes S. (2008). 2008 State New Economy Index. The Information Technology and Innovation Foundation. Accessed online September 15, 2009: http://www.itif.org/files/2008_State_New_Economy_Index.pdf).

Furthermore, Rhode Island is home to many prestigious life sciences research centers, including the NIH-funded Institutional Development Award (IDeA) Network for Biomedical Research Excellence (INBRE), which has won three awards totaling $41.2 million since 2001. Rhode Island has the highest geographic concentration of NIH-funded Centers on Biomedical Research Excellence, resulting in $124.5 million in funding since 2000:

- Brown University Genetics and Genomics COBRE (est. 2000, renewed 2005)
- Rhode Island Hospital COBRE Center for Cancer Research Development (est. 2002, renewed 2009)
- Women & Infants Hospital COBRE for Perinatal Biology (est. 2003, renewed 2008).
- Roger Williams Hospital COBRE for the New Stem Cell Biology (est. 2003, renewed 2008)
- Rhode Island Hospital COBRE for Skeletal Health and Repair (est. 2007)

While some of the above indicators describe a state on the verge of becoming a strong player in the new economy, it is important to note that many of Rhode Island's assets are controlled by federally funded agencies such as the Naval Undersea Warfare Center (NUWC). While Rhode Island ranks 4th in the nation for non-industry investments in R&D at 1.24% of GSP (behind New Mexico with 7.33%, Maryland with 4.57% and Massachusetts with 1.34%), this ranking is largely attributable to the major federally-funded military R&D facilities in the state.[6] To be successful, Rhode Island needs to move more aggressively to pursue science and technology excellence across disciplines and industries.

II. Opportunity for Rhode Island

In order to secure its economic future, Rhode Island must identify niches in the science and technology sector that the Ocean State is well-positioned to fill. Rhode Island must figure out how to leverage its small size, stable population, history of manufacturing and design innovation, and historically ocean-based economy.

Small Size: Better Access. With borders enclosing just over 1,000 square miles of land, it takes less than an hour to drive the full length of the state. Rhode Island is uniquely positioned to leverage its compact geography and densely connected networks to create optimal alignment among its institutions and organizations, share core resources and expensive investments, and facilitate face-to-face communication across the state. In other words, Rhode Island is designed for collaboration. Dwelling in close proximity to their elected leaders, Rhode Islanders benefit from a high level of personal contact with their public officials. Many government and other public institutions are centralized, a somewhat unusual feature when compared to other states. For example, there is only one department of health for the state (instead of one per county) which makes it easier to work directly with decision-makers.

As a demonstration of the advantage of being a small state, Rhode Island is on a very fast track to developing offshore renewable energy, an endeavor that Massachusetts has been pursuing for over a decade to no avail. In less than two years, Rhode Island has streamlined the approval process for offshore renewable energy and already has a power purchasing agreement in place that ensures the state government will recuperate its investments. As another example, Women and Infants Hospital in Providence performs 70% of the births in Rhode Island. Thus the birth cohort at this hospital reflects the diverse demography of the state. The distinctiveness of this hospital is one reason why it is one of the sites of the NIH-sponsored National Children's Study, which plans to follow children and their parents through many years of their lives.

Stable Population: Better Relationships and Research. The stability of the population also makes Rhode Island attractive to businesses and researchers. The ability to perform research with a population that is

likely to still be available in the future makes it much easier for researchers to undertake long-term studies—whether it is for academically-oriented life science research or business-driven market research. The stable population makes it easier to get to know people, establish relationships and accomplish goals. When combined with the small geography of the state, this stable population also makes Rhode Island an ideal test bed for pilot projects such as electronic medical records.

Legacy of Manufacture, Craft and Design. Rhode Island has a long legacy as a lead innovator in manufacturing and design. The Slater Mill, built in Rhode Island in 1793, is widely-held as the "Birthplace of the American Industrial Revolution" and was the first commercially successful cotton-spinning mill in America with a fully mechanized power system. Throughout the 18th and early 19th centuries, Rhode Island manufacturers and designers continued to lead their peers in innovation. In that era, four industries—cottons, woolens, base and precious metals—steadily expanded and dominated the state's economic life. While the manufacturing era has passed, Rhode Island still relies on craft, design and construction. The Rhode Island School of Design, established in 1877, is still a world premier institution in design and architecture; it was ranked first in the country for masters programs in fine arts (US News & World Report, 2009)[7].

Unique Opportunities of the *Ocean State*. Rhode Island's economy—and identity—has long been tied to the ocean and its 400 miles of coastline. Rhode Island has a well-known history of boat building, whaling, fishing, sailing, and hosting and training the U.S. Navy. Tourism, yacht-building, fishing and naval industries are still major drivers of the state's economy. The defense sector—largely Navy—employs over 16,000 people and attracts important federal funding and contracts to the state. The lure of the ocean also helps retain residents; especially those who seek a lower cost of living that is close to the Boston/Providence metropolitan core and also near the coast. There is great potential for new areas of economic development centered around marine assets; even the information technology sector could benefit from the application of super-computing to marine and climate data or the use of ocean waters to cool data centers.

The University of Rhode Island is a leading oceanographic research and education institution with strengths in biology, physics, chemistry, geology, archeology, atmospheric sciences, instrumentation, modeling, coastal governance, fisheries and aquaculture, and has placed a new emphasis on molecular biology. Because of this broad expertise, URI has played a critical role in national marine policy development. URI researchers are currently involved with the Ocean Special Areas Management Program for planning offshore zoning. Ocean SAMP is a public/private research and planning process to ensure the protection and enhancement of current uses, including habitat and commercial and recreational uses, while providing for future uses, such as renewable energy development.

URI's ocean-based research provides an exceptional outreach opportunity for promoting Rhode Island's STEM education and training. URI's marine science researchers provide unparalleled learning opportunities for young people. Using the latest technological developments the new Inner Space Center at URI's Graduate School of Oceanography (GSO) allows researchers and students to participate directly in ship based oceanographic and archeological research programs in remote areas of the world ocean. Broad band two-way video satellite links enable remote real-time monitoring, tracking and data transfer from subsurface instrumentation. Production facilities at URI also facilitate transformation of this science into educational programs for immediate broadcast to schools and other institutions. It is widely held that engaging young people in STEM education through hands-on learning opportunities such as this increases their likelihood to enter the STEM professions that drive the knowledge economy.

Brown University also has strength in the area of marine sciences. Research in the Department of Geological Sciences includes environmental remote sensing, hydrology, and estuarine processes. In addition, the Environmental Change Initiative has begun projects to examine climate change and its

effects on a variety of different ecosystems. Brown also has a strong collaborative program with the Marine Biological Laboratories in Woods Hole, Massachusetts, through which additional research is done in this area.

With the oceans covering 71% of the planet's surface, expertise in marine sciences is critical for helping researchers and policy makers understand some of the globe's most pressing issues, especially, climate change. The earth's rapidly changing atmosphere and oceans will have significant impacts on this Ocean State, not only in terms of geographic and geological change with the rising oceans, but also regarding the health impacts that accompany changing climates. For example, the milder winters on the east coast will allow for longer insect life cycles, changing the distribution and risks associated with vector-borne diseases such as Lyme disease and Malaria.[8] Understanding the impacts of climate change is becoming increasingly important to industry, especially those that rely on understanding regional weather-related risk such as fisheries, recreation, real-estate and the insurance industry. Climate change is also important to national defense; for example, the melting of the polar ice caps raises questions about international boundaries and security. These policy questions related to climate change are of great interest for faculty in the Center for Environmental Studies at Brown.

The ocean plays a key role in securing the United State's future energy resources. As mentioned above, the state's small size enabled it to quickly embark an exploration of offshore wind energy. Its expertise in the different areas of ocean science – biology, physics, chemistry and geology – provide the scientific basis for wise planning and ocean management decisions. Combined with its strengths in marine manufacturing, Rhode Island is well-equipped to service wind farms in addition to building them. Supply chain industries, such as building wind turbine blades, jacket support structures and deployment technology will be a natural fit to the Ocean State's existing manufacturing and design infrastructure. Boat building skill sets can be evolved into building wind turbines; mast and sail builders can build blades, and expertise in advanced composites can be applied to building durable turbines.

Rhode Island is uniquely suited to pursue niches in the science and technology sector that would leverage its expertise in marine science and trade, its suitability for collaboration, and its history of converting ideas into reality.

III. Assets for Science and Technology Innovation

A. Rhode Island Science and Technology Innovation Assets

Located in the globally pre-eminent Northeast corridor mega region, Rhode Island has distinct core strengths for participating in and contributing to a science-led innovation economy. Not only does Rhode Island have core capabilities in life sciences, marine sciences, undersea defense systems, and design, it has established capacities in science, technology and innovation. Most importantly, Rhode Island's proximity and orientation to the ocean is a powerful and unique asset, and is currently underutilized. These capacities together constitute a foundation on which Rhode Island can build.

Life Sciences. Rhode Island is home to a diverse and collaborative group of life science institutions, including drug manufacturing, basic research, biomedical devices, cell line development, bio-nanotechnology, biomedical textiles and facility development. Today, more than 35,000 people are employed in the sector, spread across more than 1,400 businesses. The sector is growing so quickly here that the Milken Institute predicts that it will triple by 2014. Among the state's outstanding life sciences assets are the research facilities of Brown University and the University of Rhode Island, a widely-recognized network of 11 hospitals (six of which are associated with the Brown University School of

Medicine), and a vibrant, growing peer cluster of life science companies. Collaborations among these groups have resulted in $124.5 million in support from the NIH since 2000.

A major contributor to the Life Sciences industry is biosciences.[3] According to the Tech Collective (the Rhode Island technology industry association) the biosciences industry currently employs more than 4,700 people within the state and generates an estimated revenue of $526 million (direct and "multiplier effect"). The state has had big wins with significant private sector players, including Amgen, Davol (est. 1874, a Bard Company), EpiVax, Illuminos Medical, and Isis Biopolymer. Rhode Island's biosciences research base has been improving its share of the federal research pool. In fact, the number of awards from the National Institutes for Health (NIH) grew 40% faster for the period 2000-2004 than awards made to other states. NIH funding reached an all time high of $130M in 2007. Bioscience employee rate in Rhode Island grew 259% from 2001-2006 while the nation as an average only grew 4% (Biotechnology Industry Organization, 2008).[9]

Marine Sciences and Trade. As described above, Rhode Island has a strong reputation in marine sciences research, education and industry. In 1966, the University of Rhode Island became the country's first sea-grant institution and now has one of the most active and successful Sea Grant programs in the nation. These thirty federal-state-university partnerships are meant to design and support research, outreach, and educational programs that foster coastal and marine stewardship. In addition to undergraduate and graduate training in oceanographic research at URI, other Rhode Island institutions of higher education offer a broad spectrum of training that are key to the marine industry; marine law (URI and Roger Williams University's Marine Affairs Institute), marine design (the Edna Lawrence Nature Lab at RISD), technical training (New England Tech, the Community College of Rhode Island and the International Yacht Restoration School), and just this year, URI launched the country's first "Blue MBA," which offers a dual masters degree in business administration and oceanography (MBA-MO).

The marine industry employs over 12,000 highly skilled workers in more than 800 companies, including leading edge technology companies such as Blount Shipbuilding, Electric Boat, Eric Goetz Custom Sailboats, and Happ Spars. As a testament to decades of excellent marine sciences research and trade, Rhode Island was recently chosen as a site for one of the six public meetings of the Interagency Ocean Policy Task Force, which is charged with designing a "comprehensive, integrated, ecosystem-based approach that addresses conservation, economic activity, user conflict, and sustainable use of ocean, coastal, and Great Lakes resources." [10]

Energy and Environment. Rhode Island has the lowest energy use per capita of any state and is in some respects a leader in energy efficiency and energy conservation policy. In 2006, Governor Carcieri set the state's goal for renewable energy resources at 20% of the state's energy supplies. Two years later, the Governor selected Deepwater Wind to develop the country's first offshore wind farm, which will produce 15% of the state's energy needs. In June 2009, the state enacted ground-breaking legislation that requires the state's largest electric utility to enter into long-term contracts to purchase power from renewable energy producers in Rhode Island. A program at the Rhode Island Economic Development Corporation provides grants, loans and other financing for renewable energy projects that produce electricity in a cleaner, more sustainable manner and stimulate job growth in Rhode Island's economy (giving $2.6 million to date).

Public/private partnerships in energy and environmental conservation are also gaining strength. IBM has been working for over the past year with a number of Rhode Island stakeholders (government,

[3] For Rhode Island, the largest biosciences industry sub-sectors include Drugs & Pharmaceuticals, Medical Devices & Equipment, and Research, Testing, and Medical Laboratories.

universities, schools, hospitals, non-profit corporations, businesses, and other partners) to identify how they could work together to use high performance computing to address huge inefficiencies in energy usage, performance and storage. The project will focus on the creation of a green shared data center and will create an opportunity for a fundamentally new relationship between government, industry, and universities.

The University of Rhode Island has many important initiatives for energy efficiency, and URI researchers lead the state in developing bio-fuels from sources with reduced negative environmental impact, as well as new battery technologies and other energy efficiency innovations. URI is also home to a powerful resource for environmental management, the Rhode Island Geographic Information System (RIGIS). RIGIS is the most detailed database in the country, and contains information on almost all aspects of Rhode Island's natural and cultural resources.

URI's commitment to energy efficiency is clearly demonstrated by the recent completion of a 140,000 sq. ft. state of the art LEED Silver certified building to house the Center for Biotechnology and Life Sciences. A new ocean-front building at Johnson and Wales University will be the first LEED-certified culinary arts building in the country, and will revitalize a previous industrial site to include open green space, public access shoreline reconstruction, a walking trail, and a protected salt marsh.

Brown University has also made substantial investments in research in energy and the environment. As mentioned above, the Environmental Change Initiative and the Center for Environmental Studies are examining fundamental scientific questions and policy questions in this area. The environmental change initiative examines questions on climate change, the effect of land use change on climate, biogeochemistry, and the resilience of natural and social systems to environmental change. The Center for Environmental Health and Technology is home to a large Superfund Grant, which examines questions such as the toxicity of nano-materials, the effects of various environmental exposures on pregnancy, and problems of vapor intrusions.

Brown also has research programs on basic and applied energy sciences. Carbon sequestration, the development of novel fuel cells, and examination of ways to develop the smart grid are among the research interests of the faculty. In March of 2009, Brown signed a Memorandum of Understanding with Draper Labs of Cambridge, MA, to form the Consortium for Smart Energy Research.

Finally, it should be noted that all three of these areas, life sciences, marine sciences, and energy and the environment overlap in their intention to improve the entire earth ecosystem and its inhabitants. This broader theme is one that Rhode Island can develop and capitalize on as it moves forward with research, development, and commercialization.

Design and Craft. Rhode Island has a skilled workforce and outstanding design capabilities. Rhode Islanders have a time-honored reputation for turning ideas and knowledge into things. The Rhode Island School of Design, for example, is a world class institution, and an invaluable resource for locally applying "design thinking" (see page 15).

Academic Research Institutions. Set amid the largest concentration of higher-education facilities in the United States, Rhode Island offers access to a rich talent pool. Both Brown and the University of Rhode Island have areas of significant research strength. Brown currently brings in over $ 135 million in research grants and awards; URI brings $86 million. Graduating over 1400 STEM students between them, the two universities are committed to expanding their research capacities and to connecting research with commercial application through innovation.

Higher Education. Rhode Island's eleven colleges and universities have 80,000 students—which equates to about one person in twelve in the state. Rhode Island ranks 3rd nationally for six year undergraduate

program graduation rates (NCES, IPEDS Graduation Rate Survey, 2007). The size of this asset in relation to the size of the general population should enable Rhode Island to develop a strong focus on STEM education. Rhode Island's technical training schools graduate almost 1000 people in science and technology programs each year, not including the additional 1200 graduates from Brown University or the University of Rhode Island who obtain research degrees in science and technology (National Center for Education Statistics, 2008). Also excluded from these numbers is Johnson and Wales, one of the nation's leading culinary institutions, because its does not offer degrees in S&T technology. However, the school offers important additional capacity in technical training; J&W has expertise in developing practice-based curricula and has the potential to develop programs to meet the growing interdisciplinary needs of the S&T sector in the state.

Workforce Development. Rhode Island has many coordinated programs and activities offered by a broad spectrum of organizations to support STEM workforce development. The Governor's Workforce Board recently published a visionary strategic plan for 2009-2014 that streamlines workforce development program from student to worker to employer to policymaker in order to efficiently respond to the changing needs of the market. Other programs include the Governor's Pre-K-16 Council (see page 11), the Tech Collective (the technology industry association), the EPSCoR Academy, healthcare workforce training initiatives, and the STEM Center at Rhode Island College.

Defense Sector: the Newport Naval Base. The Rhode Island defense industry — comprised of more than 100 organizations — employed more than 16,000 people and generated $2 billion in revenue in 2006. In the same year, more than $115 million in Homeland Security spending was invested in Rhode Island defense organizations. The Newport Naval Base employs 2,500 civilians and 3,500 officers. The Naval Undersea Warfare Center (NUWC) is an important federal laboratory—an enterprise of $460 million annually, including about $200 million in contracts and $60 million in pure science research. NUWC offers powerful expertise in engineering, chemistry, and communication. It generates about one quarter of the annual patents in Rhode Island. Also at the Newport Naval Base, the U.S. Naval War College is a world leader in international law and strategy, with world-class facilities for gaming and scenario analysis. The college has a research budget of $4.5 million. According to the president of the US Naval War College, the Navy's long term strategic interests revolve around the successful operations of global systems, including trade, energy, and natural resources.

Hospitals. Rhode Island's teaching hospitals are linked with medical science research, and many are networked into two outstanding medical systems, Lifespan and Care New England. Rhode Island hospitals as a whole have an estimated economic impact of $5.9 billion and they employ 20,370 health care professionals, representing a payroll of $1.6 billion.[11] In 2008, Rhode Island's research hospitals combined received over $70 million in grant awards from the National Institutes of Health.

Industry. From biopharmaceuticals to gaming to textiles to boat building, Rhode Island companies have established capacities for innovation. Business R&D expenditures in proportion to payroll are the second highest in the nation (ITIF, 2007). Rhode Island's largest industry sectors, according to the twenty divisions established by the Bureau of Labor Statistics, are Education and Health Care Services (20.75%), Trade, Transportation and Utilities (16.05%), Government (13.17%), Professional and Business Services (11.34%) and Leisure and Hospitality (10.56%) (see Figure 2).[12] Rhode Island ranks 7th nationally for total research and development expenditure per $1000 of Gross State Product.[13]

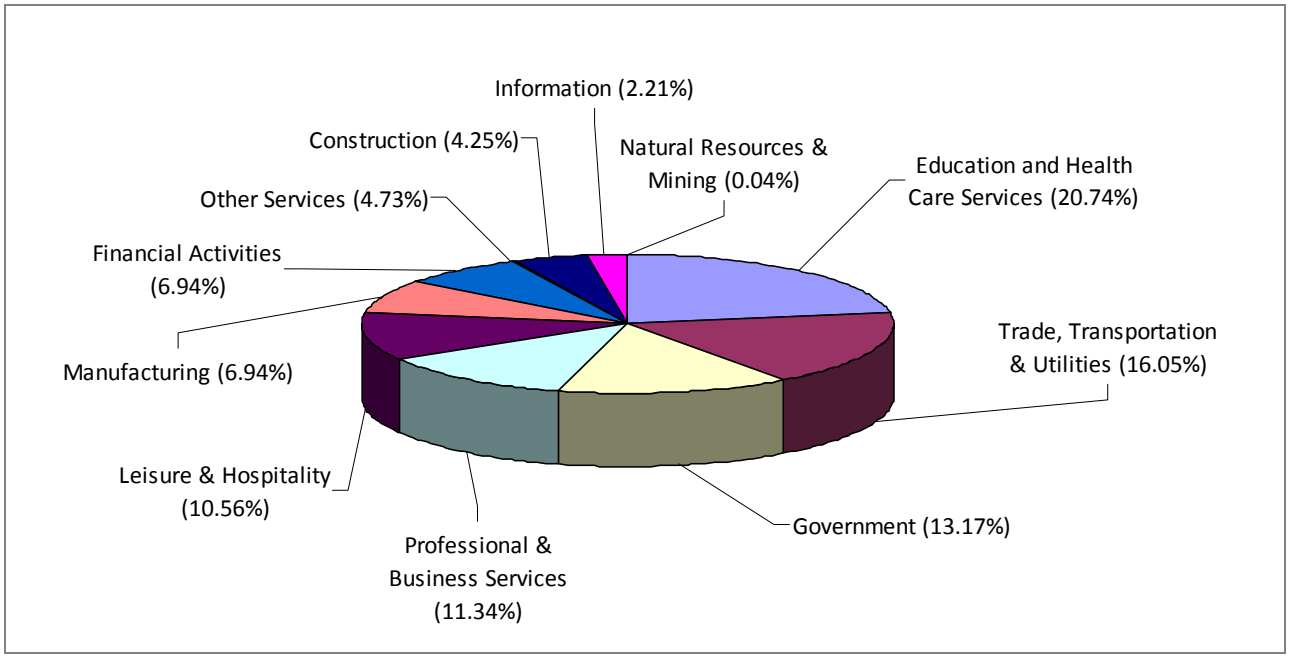

Figure 2. Rhode Island Industries (% of total non-farm payroll employment). (U.S. Bureau of Labor Statistics, 2008).

Public Leadership. Governor Carcieri, General Assembly leaders, and the RI Economic Development Corporation (RIEDC) have provided strong and creative support for advancing the causes of science, technology, and innovation. Since 1997, the state has contributed $20 million in support of new venture creation through the Slater Technology Fund, which has helped finance and establish over 90 companies that raised more than $174 million in private, venture capital and additional government investment. The RIEDC has championed innovation and collaboration as key strategies for Rhode Island. In 2005, the governor established by statute the Science and Technology Advisory Council, hosted at RIEDC. In 2009, STAC supported the creation of the new Rhode Island Center for Innovation and Entrepreneurship (see below).

B. Collaboration Capabilities

Rhode Island has several established platforms for multi-institutional collaboration, including:

OSHEAN (2000). OSHEAN is a consortium of 26 non-profit entities (institutions of higher education, hospital systems, public libraries, and government agencies) working towards the collaborative provision of economical, ultra broadband, Internet-based, communications infrastructure.

NSF-EPSCoR (2004). The Rhode Island Experimental Program to Stimulate Competitive Research (RI EPSCoR) builds partnerships between state government, institutions of higher education and industry to effect lasting improvements in Rhode Island's research infrastructure and national R&D competitiveness.

STAC (2005). The Science and Technology Advisory Council (STAC) brings together leaders from research universities, hospitals, business, and economic development sectors to provide guidance for Rhode Island's science and technology efforts. STAC established the Rhode Island Research Alliance in 2008 to facilitate greater connectivity among collaborative research efforts in the state. In addition to providing its own Collaborative Grants Program, the Research Alliance works with research institutions in the state

to attract support from federal funding programs such as the National Science Foundation's EPSCoR program and the National Institutes of Health's IDeA program.

Pre-K to 16 Council (2005). The Council, which is chaired by the Governor, includes the leadership of higher education, elementary and secondary education, labor and training, and economic development; the Council's chief purpose is to "produce a more competitive workforce and promote economic development through quality education, research and workforce development."

Business Innovation Factory (BIF) (2005). BIF is a non-profit organization where private and public sector innovators can work across boundaries to "quickly and cost-effectively test new ways to deliver value." BIF showcases the importance of innovation culture.

Rhode Island Center for Innovation and Entrepreneurship (RI-CIE) (2009). RI-CIE launched in April 2009 to answer calls for more collaborative efforts to boost business growth in Rhode Island. RI-CIE is meant to dovetail with city and state efforts already underway to strengthening entrepreneurial connectivity and enhance services and offerings to spur innovation and new venture creation in Rhode Island. A result of truly multi-institutional cooperation, RI-CIE is supported by Brown University, RI Economic Development Corporation, City of Providence, Greater Providence Chamber of Commerce, Association of Independent Colleges & Universities of RI, Johnson & Wales University, Lifespan, Rhode Island School of Design, Science & Technology Advisory Council, Slater Technology Fund, and University of Rhode Island.

OSCAR (Ocean State Consortium for Advanced Resources): While still in the planning stages, OSCAR is a consortium of key academic and health organizations, industry and government stakeholders committed to making core resources available to enable and grow an interconnected research enterprise that provides access and interoperability of infrastructure through a seamless and shared interface 1) to facilitate collaborations across the state, 2) to leverage strengths of individual organizations, and 3) to provide cost efficiencies and capacity building opportunities.

IV. Strategic Objectives

Rhode Island seeks to leverage its position as the "Ocean State" to become an "innovation ecosystem" where highly trained knowledge workers drive the economy, where world-class researchers flock and remain, and where a culture of creativity and entrepreneurship drives the state's accomplishments and reputation. By successfully pursuing this science and technology plan, Rhode Island will become a place of social, environmental and economic vitality.

In the next five years, Rhode Island's goals for the development of science and technology are to:

5. Bring together researchers across the state to encourage collaboration in marine science, life science, and energy and environmental science;
6. Improve existing infrastructure for collaborative research, including Rhode Island's capacity for technology transfer within and across S&T sectors;
7. Facilitate business innovation by streamlining the pipeline between research ideas and new venture creation.
8. Communicate research findings and initiatives to public officers and the wider community.

A. Areas for Research Focus

In order to provide focus for the Rhode Island Science and Technology plan, the Rhode Island Research Alliance (of STAC) performed an assessment of collaborative research opportunities in Rhode Island.

During the summer of 2009, RIRA held one-hour interviews with over forty leaders of Rhode Island-based research institutions including research universities, teaching universities, hospitals, public agencies, industry associations, military and defense industries, and government agencies. Reflecting the fact that the state's largest research institutions are hospitals and universities, almost half of the interview participants were from research universities, and almost half represented biomedical research (see Appendix B).

The interviewer asked about each institution's current strengths, past successes, emerging research foci, and ideas for future research collaborations. Discussions identified Rhode Island's strengths as marine science, life science, defense, engineering and design. Appendix C summarizes the assessment's findings regarding past successful collaborations, lead research institutions, and potential areas for future research collaboration.

The chief finding of this assessment is that Rhode Island is particularly well positioned to pursue research in three interrelated areas: (1) life sciences, (2) marine sciences, and (3) energy and environmental sciences. Interviewees emphasized the importance of Rhode Island's excellent research capacity and internationally-known researchers in life science specialties such as orthopedics, oncology, cardiovascular science, pharmacology, genetics, women's health and tissue repair. Given its long history as a national center for marine research, interviewees underscored the importance of Narragansett Bay as one of the best understood models of estuarine ecology. Complementing this coastal focus is the stature of the state's oceanographers who maintain highly successful research activities from the Antarctic to the Arctic and around the world ocean. These research activities provide a powerful basis for understanding climate change, both at the global and local level, and also the role the ocean can play in helping in the adaptation of our social and environmental systems, such as fisheries, recreation, real estate, and weather. Regarding energy and the environment, discussions reflected cross-sector participation and growing momentum towards alternative energy and environmental protection; Rhode Island is poised to become a leader in the alternative energy and green technology industries.

The most important finding from this assessment was the significant opportunities that emerge where these three areas overlap. For example, with the Ocean SAMP (described above), Rhode Island could become a leader in offshore wind research and development. Understanding how global warming will affect the oceans and weather patterns will help life sciences researchers understand the potential impacts on human health. Projects to build energy efficient data centers may benefit biosciences researchers as their increasing dependence on bioinformatics is limited by power, cooling, and cost. Rhode Island's potential to become a strong player in science and technology research and development will depend on the state's ability to seize these opportunities and align them with our unique positioning and research strengths. Thus we see that these three areas, though major research and development areas in their own right, are also interrelated at a higher level; growth in one of these areas will help growth in others.

B. Research Capacities and Tools to Leverage and Grow

Rhode Island's researchers are already very adept at scientific research, from basic to advanced, employing the latest theories and technologies to push the frontiers of their fields. In order for Rhode Island to create a vibrant and resilient place for itself in the world of Science and Technology, the state would greatly benefit from developing the following research capacities and tools: (1) information technology, (2) technology transfer and translational research, and (3) strategic thinking, including "design thinking" and scenario planning. (See Figure 3).

1. Information Technology

Information technology is seen as one of the major drivers of the knowledge economy, and is expected to grow 16.2% in Rhode Island by 2014 (RI Department of Labor and Training). IT workers in the United States, however, have more than technical knowledge, since jobs requiring only technical know-how are quickly sent offshore to cheaper labor. According to the Tech Collective, IT workers in the knowledge economy also have "soft skills" such as the ability to work in teams, handle relationships with clients, and manage complex projects.[14]

As a tool, IT is in high demand across industry sectors and areas of research. Managing data systems is core to the success of researchers and most business operations. For example, Lifespan has been recognized nationally for its use of IT to improve health care by streamlining patient medical records and improving the affiliated hospitals' capacity for personalized medicine. Another example is the recent partnership established between Brown University, IBM and other state stakeholders. This partnership will be transformative in its ability to stimulate and facilitate research collaborations, innovations and a wider usage of advanced cyber-infrastructure across the public and private sector to propel productivity, innovation and competitiveness in key global grand challenge areas of health care, environment, energy and education.

2. Technology Transfer and Clinical Translational Research.

An assessment performed by the Rhode Island Research Alliance found that Rhode Island is well-suited to accelerate the conversion of intellectual property to marketable applications. Looking at the pipeline from research idea to commercial application, the state's history of manufacturing, craft and design could position the private sector well to receive product ideas from researchers. The reverse is also true; close tracking and excellent communication will enable the market to provide ideas for researchers. Furthermore, not only are the state's universities adept at training researchers, our primarily undergraduate institutions have the potential to provide the professional training to help develop an appropriately skilled local workforce.

3. Design Thinking and Scenario Planning

Design thinking, which underlies most of RISD's work, engages a creative process that deliberately questions and looks beyond traditional frameworks for new opportunities and solutions to complex problems. This approach calls for input from multiple disciplines and is more effective the more diverse the perspectives of people involved. In this context, "diversity" refers to different academic fields and industries as well as diversity in demographics. Recently, businesses seeking to remain on the cutting edge of their market are engaging design thinking in order to find better business strategies, products and services.[15] This creative approach to problem-solving could be a powerful driver for successful collaboration, and should be a major priority for the implementation of this plan.

The US Naval War College on Aquidneck Island offers international expertise and technology in decision science. Their computer-based decision support system, called Web IQ, is a form of scenario planning that streamlines the collaborative problem solving process in order to more quickly and effectively find solutions to pressing challenges. The War College offers a masters degree in decision science, and uses its facilities to develop the US Navy's strategies on broad topics ranging from warfare to the security threats of climate change, global disease epidemics, and other international issues. Such a resource could be "game changing" for Rhode Island as it develops its S&T strategies going forward.

Other local experts include a gaming and production facility at Hasbro, Inc, Brown University's Center for Computation and Visualization, and the Quality Institute, which is a national leader in health care technology design, such as electronic medical records.

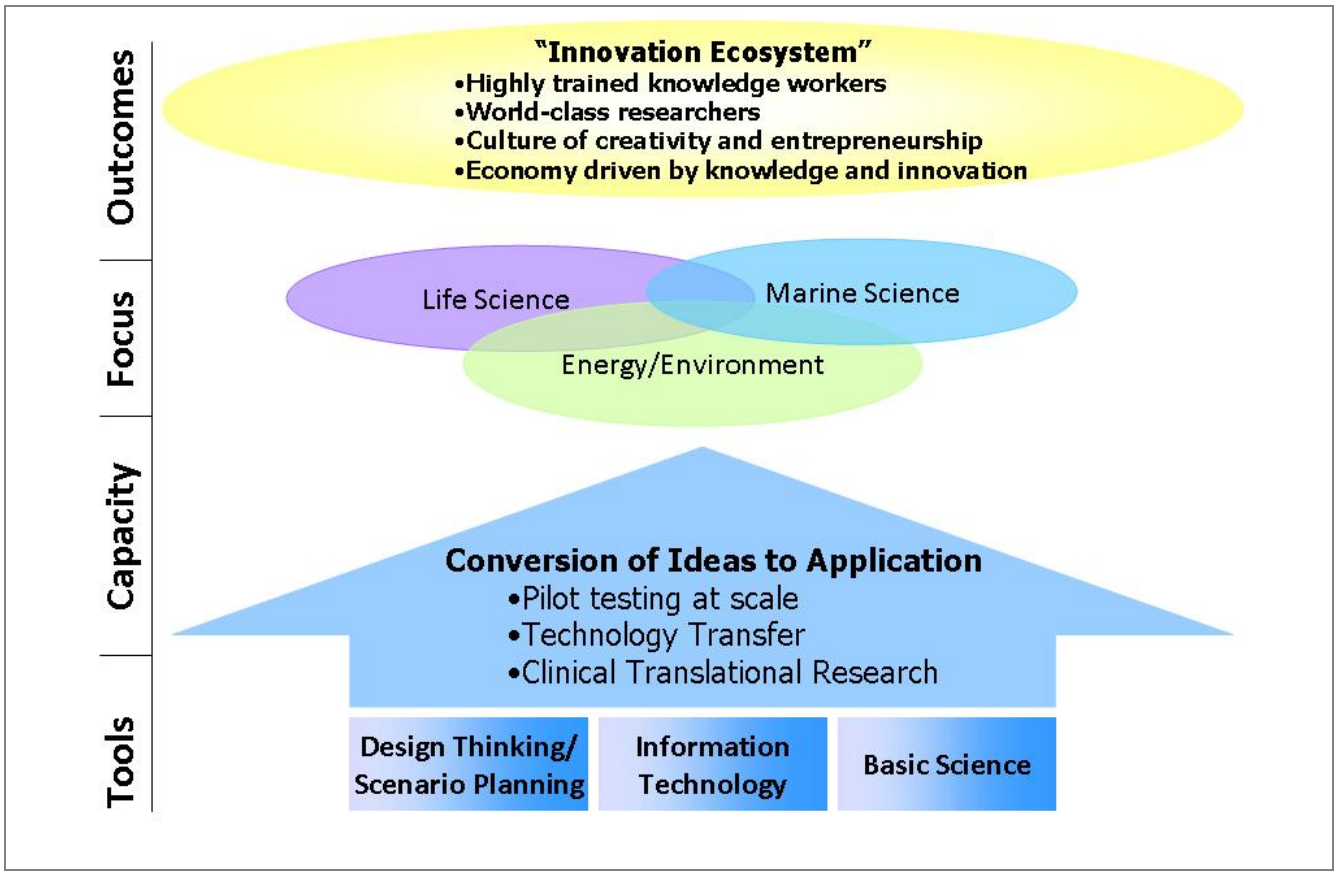

Figure 3. Strategy for Science and Technology Research, Development, Training and Retention

V. Implementation Plan

The vision of Rhode Island as a community people commit to, where innovation can be tested on a small scale, and where and science and technology are elements of collective identity is a picture of fundamental change. Placing this vision in the context of our long history as an ocean-oriented state, however, will ensure that we build on Rhode Island's strengths. To successfully implement this plan, Rhode Island must leverage the unique assets it already has in the hands of science and technology institutions across the state, including expertise in information technology, technology transfer, and design thinking and scenario planning. As a result of this work, Rhode Island will be a place of social, environmental and economic vitality. We now consider each of those goals and how they will be implemented.

Goal 1: Bring Researchers Together

Goal 1: Bring together researchers across the state to encourage collaboration in marine science, life science, and energy and environmental science.

As a result of a preliminary assessment of potential areas for research collaboration, the Rhode Island Research Alliance recommends to the state that it increase research capacity in marine science, life science, and energy and environmental science. In particular, the assessment recommends that the latter category focus on the intersection of energy and the environment and its manifestation in climate

change. There is great potential for collaboration where these areas overlap, given the strengths of research institutions and industry in Rhode Island. Multi-institutional collaborations will quickly become world-class if they involve Rhode Island's leading researchers in marine and life-sciences research (i.e. cell and molecular biology, ecology, evolutionary genomics, physiology, cardiology, oncology, orthopedics, emergency medicine, and pharmacy, as well as hard sciences such as ocean engineering, computational mathematics, and chemistry).

Objective 1a: Identify areas to focus research collaboration in Rhode Island.

Action: Perform a detailed investigation of areas to focus research collaborations within Rhode Island.

During the summer of 2009, the Rhode Island Research Alliance (RIRA) conducted one-hour interviews with over forty leaders of the state's research institutions in order to identify potential areas to focus research collaborations. To further investigate and confirm the findings of this assessment, in the fall of 2009 the Alliance will facilitate feedback meetings with three groups, including STAC Members, lead researchers and research administrators from public and private sectors. Findings from the interviews and feedback meetings will be complemented by web-based research and relevant reports from other institutions, and published by the state in January of 2010.

Measure of Success:

- RIRA Assessment Report published by January, 2010.

Objective 1b: Increase collaboration among Rhode Island researchers.

Action 1: Establish a networking website to promote collaboration among researchers and coordinate the creation of collaborative grants.

The Rhode Island Research Alliance will work with research administrators from the state's research institutions to expand connectivity currently available through the RIRA web portal to facilitate research collaboration, grant proposal development, recruitment, publication and communication of the research activities within the state. The desired outcomes of this resource are:

- Increased funding for RI research from national funding competitions
- Increased profile and support for research in RI
- Better allocation of scarce resources in the RI research community
- Improved recruitment and retention of top students and researchers
- Increase the quality and connectedness of the RI research community

Measure of Success:

- Website piloted in the third quarter of 2010, and opened for public use in 2011.

Action 2: Hold annual statewide networking forums for Rhode Island researchers for each of the focus research areas: (1) marine sciences, (2) life sciences and (3) energy and environmental science.

The Science and Technology Advisory Council held the first annual research symposium for Rhode Island researchers in June 2008, in cooperation with the COBRE, INBRE and EPSCoR statewide networks. At this day long event, local investigators from around the state showcase their current research in the fields of biomedical and life sciences to over 300 attendees. Forums will continue with focus on specific interdisciplinary research areas.

Measure of Success:

- Statewide networking forums grow in attendance and spectrum of participation each year
- Increased number of multi-institutional research collaborations established and funded

Action 3: Develop working groups to guide the development of Rhode Island's research capacity in the marine sciences, life science, and energy and environmental science.

In addition to representatives from the state's research institutions, STAC will invite colleagues working in relevant Rhode Island industries to participate in these working groups. The groups will be charged with making research recommendations that leverage existing research strengths and equipment, and position the state to be as competitive as possible for funding, human resources recruitment, and industry contracts.

Measure of Success:

- Working groups established for the three focus areas (marine science, life science and energy and environmental science); industry representatives included.
- Increased number of multi-institutional collaborations for research in life sciences, information technology and energy and environmental science established and funded

Goal 2: Improve S&T Infrastructure

Goal 2: Improve existing infrastructure for collaborative research, including Rhode Island's capacity for technology transfer within and across S&T sectors.

Objective 2a: Increase cooperative use of STEM facilities

Action: Develop an online clearing house for the coordination of use of equipment

Last year, STAC established an online platform for the sharing of equipment in Rhode Island. Currently it is difficult to tell how much this resource is used. To promote the use of this tool, STAC will evaluate current use and promote the tool throughout the state. STAC will also link this tool to the online researcher data-base described in Action 1 of Objective 1b.

Measure of Success:

- Use rate of online equipment sharing platform doubled from 2009-2010 and increased by 25% each year after.
- Increase number of pieces of equipment added to sharing platform.

Goal 3: Facilitate the R&D Pipeline

Goal 3: Facilitate business innovation by accelerating the pipeline between research ideas, businesses of all sizes, and new venture creation.

Increasing new company creation by enabling entrepreneurship, innovation in existing companies—including Rhode Island's many smaller businesses—and the resulting growth of new ventures is key to creating a 21st century economy that provides higher wage jobs for all Rhode Islanders. Developing the state's capacity for technology transfer—particularly in clinical translational research—is a natural fit for Rhode Island's existing core competencies. This practical focus would enhance the demand for research

and facilitate the flow of ideas from bench to marketplace back to bench. Furthermore, the resulting new jobs will complement the goals of the Governor's Workforce Development Board, which include training and retraining of workers for STEM professionals.

Objective 3a: Streamline the pipeline between research ideas and new venture creation.

Action 1: Identify the gaps in the pipeline between research ideas and new venture creation.

STAC will work with public and private institutions in the state to define the components of the research to market pipeline, and engage the appropriate actors to support the flow of activity along it. These actors include representatives from the public and private sector, such as RICIE, the Slater Technology Fund, the Tech Collective, the Bio-Group, Providence Geeks, the Greater Providence Chamber of Commerce, RI Manufacturing Extension Partnership (RIMES) and university technology transfer offices.

Measure of Success:

- Development of an agreed-upon description of the research to market pipeline in science and technology.
- Identification of the gaps along the pipeline and a strategy for addressing them.

Objective 3b: Increase the number of new ventures created using research developed in Rhode Island.

Action: Organize an annual exposition to showcase new research discoveries to interested entrepreneurs, and showcase industry needs to experts in research institutions.

With help from RICIE and the state's research institutions, STAC will organize a moving showcase of research discoveries and entrepreneurial ideas that will enable researchers and entrepreneurs to learn more about each other's work and needs. One premise of this program is that often the most significant barrier preventing a concept from becoming marketable product or service is the actual connection between the researcher and the entrepreneur. Another premise is the finding that top researchers are attracted to states that have strong technology transfer programs, strong connections to venture capital, and a flourishing entrepreneurial sector.

Measure of Success:

- Increased number of new ventures created from ideas developed by Rhode Island researchers.
- Increased number of top researchers recruited to Rhode Island research institutions.

Goal 4: Communication

Goal 4: Communicate research findings and initiatives to public officers and the wider community.

Objective 4a: Enhance existing relationships with local and federal public offices.

Action 1: The Rhode Island Research Alliance will work with research institutions and S&T industry groups to educate public officials and community opinion leaders concerning the latest research discoveries and activities in Rhode Island. STAC will become a catalyst for relationship building between Rhode Island S&T institutions and federal government and funding agencies.

Measure of Success:

- Increased number of public officials and opinion leaders attending S&T events across the state.

- Continued state funding for investment in the S&T sector.

Action 2: Develop a statewide publication to chronicle research and development in Rhode Island.

Measure of Success:

- Pilot publication in 2010; launch bi-annual publication in 2011.

VI. Conclusion

In order to secure its economic future, Rhode Island must identify niches in the science and technology sector that leverage its small size, stable population, history of manufacturing and design, and historically ocean-oriented economy. The plan identifies four goals that spell out how the state can bring S&T professionals together, improve the S&T infrastructure, streamline the conversion of S&T ideas into marketable products and services, and communicate the state's S&T accomplishments to the wider public. The Rhode Island Science and Technology Advisory Council supports the continuous evolution of this plan in order to seize opportunities and incorporate new assets as they emerge in this quickly changing economic climate. The outcome will be an "innovation ecosystem" that builds on Rhode Island's assets and enables the state to succeed as the research, development, and economic landscape changes.

Appendices

Appendix A. Educational Attainment in Selected States

Table 1. Percent Educational Attainment in Selected States, 2007. (Selected Social Characteristics in the United States: 2005-2007. 2005-2007 American Community Survey 3-Year Estimates).

	RI	***MA***	***CT***	***ME***	***NH***	***VT***	***DE***	***KY***	***MS***	***MT***	***SC***
Less than 9th grade	7.3	5.1	4.8	4.2	3.1	3.7	4.5	8.9	7.8	3.3	6.4
9th to 12th grade, no diploma	10.1	7.0	7.5	6.9	7.0	6.6	9.6	11.8	14.3	6.6	12.3
High school graduate (or equiv.)	29.3	27.9	29.6	36.4	30.9	32.4	33.5	34.8	31.9	32.3	32.4
Some college, no degree	16.5	15.4	16.7	17.7	18.1	16.3	18.6	18.5	20.0	23.4	18.2
Associate's degree	7.5	7.5	7.2	8.8	9.1	8.3	7.2	6.3	7.4	7.6	7.9
Bachelor's degree	17.9	21.4	19.4	17.0	20.4	20.0	16.0	11.7	12.2	18.5	14.9
Graduate or professional degree	11.5	15.7	14.8	8.9	11.3	12.7	10.6	8.0	6.4	8.2	7.9
Percent high school graduate or higher	82.7	87.9	87.8	88.8	89.9	89.7	85.9	79.3	78.0	90.1	81.4
Percent bachelor's degree or higher	29.4	37.1	34.3	25.9	31.8	32.7	26.6	19.7	18.6	26.7	22.8
Total Pop. 25 years or over (million)	***0.7***	***4.3***	***2.3***	***0.9***	***0.89***	***0.4***	***0.5***	***2.8***	***1.8***	***0.6***	***2.8***

Appendix A. Educational Attainment in Selected States (cont'd)

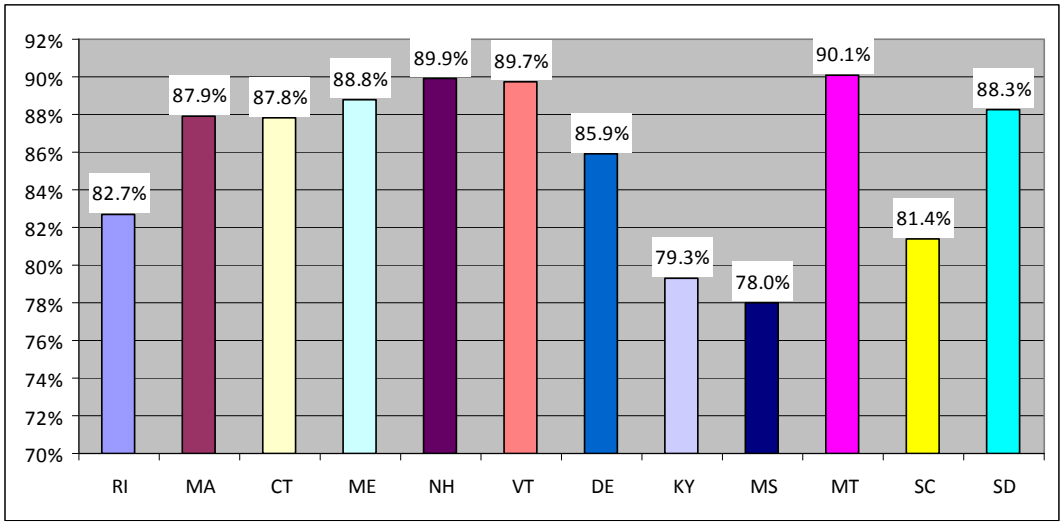

Figure 1. Educational attainment in selected states: percentage of population aged 25 or over with a high school degree or higher. (Selected Social Characteristics in the United States: 2005-2007. 2005-2007 American Community Survey 3-Year Estimates).

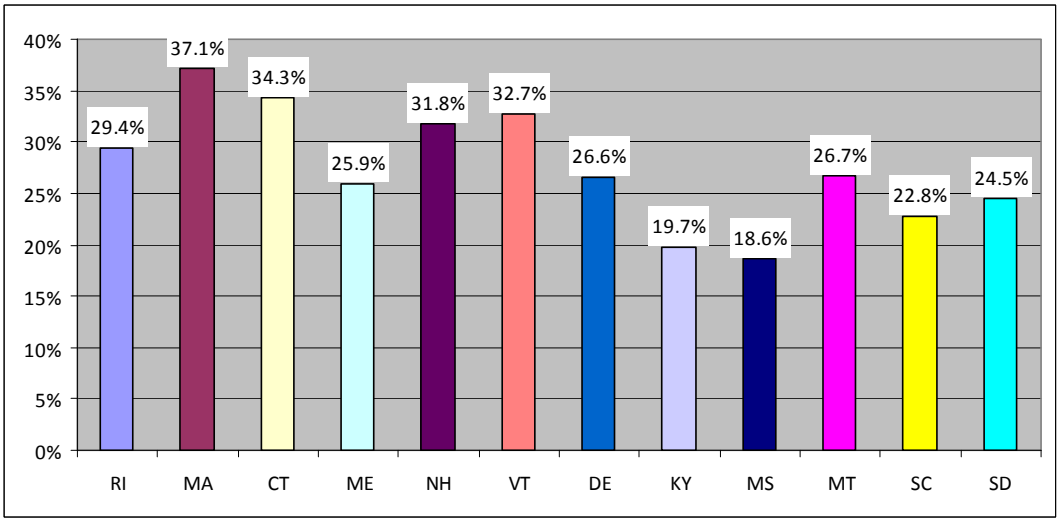

Figure 2. Educational attainment in selected states: percentage of population aged 25 or over with college degree or higher. (Selected Social Characteristics in the United States: 2005-2007. 2005-2007 American Community Survey 3-Year Estimates).

Appendix B. Summary of Institutions Represented in RIRA's Assessment of Opportunities for Research Collaboration

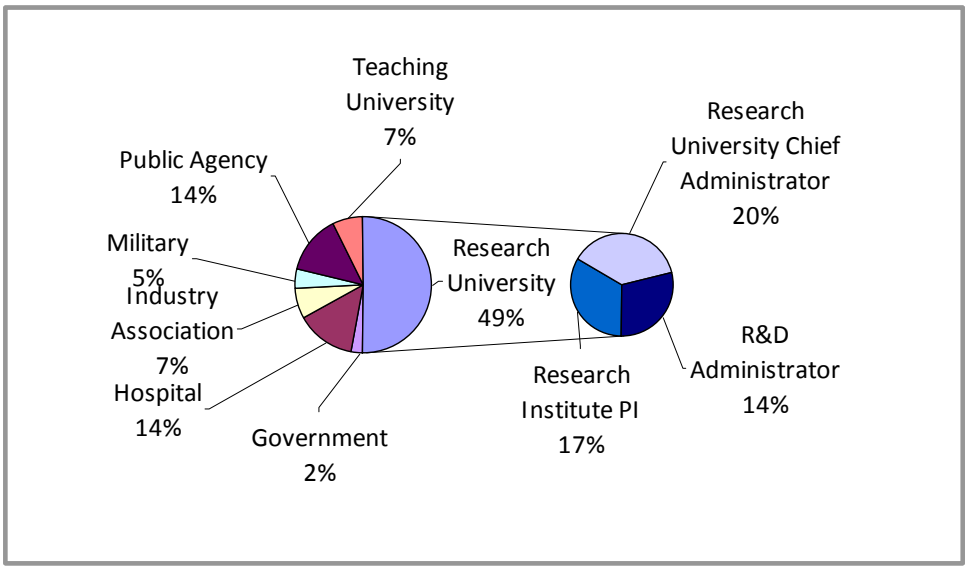

Figure 1. Institutions represented in RIRA's Assessment of Opportunities for Research Collaboration

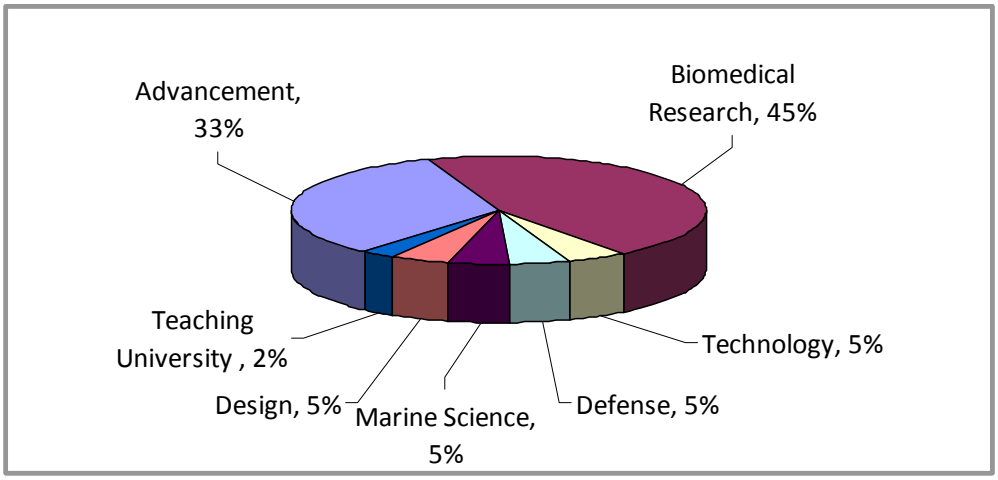

Figure 2. Sectors represented in RIRA's Assessment of Opportunities for Research Collaboration

Appendix C. Summary of RIRA's Assessment of Opportunities for Research Collaboration.

Table 1. Past Successful Collaborations in Rhode Island

- Campus Compact
- Experimental Program to Stimulate Competitive Research (EPSCoR)
- IBM Partnerships
- Maternal Fetal Medicine Network
- Marine Biological Laboratory-Woods Hole
- National Child Study
- Rhode Island Center for Innovation and Entrepreneurship (RI-CIE)
- RIRA Collaborative Grants Program
- RISD/Brown Dual Degree Program

Table 2. Lead Research Institutions in Rhode Island

- Universities- research focused (Brown, URI)
- Schools of higher education- training focused (e.g. RISD, JWU, NE Tech, and PUI's*)
- Four COBREs* and INBRE*
- Hospitals
- RI-based business development organizations (RI-CIE, Slater, GPCC)
- Elected officials who see the connection to economic development

** PUI: Primarily Undergraduate University; COBRE: Center of Biomedical Research Excellence; INBRE: IDeA Network for Biomedical Research Excellence*

Table 3. Areas for Potential Research Collaboration (Number of people supporting)

Life Sciences	***(n)***
Liver Disease	3
Cardiovascular Research	4
Neurology	4
Orthopedics	5
Pharmacology	5
Bio engineering	6
Genetics	6
Oncology	6

Information Technology	
Green Data Center	1
Personalized Medicine	6
High Performance Computing	10

Climate Change/Environment	
Marine Sciences	3
Energy	4

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