

2021 UPDATE

RHODE ISLAND SCIENCE AND TECHNOLOGY PLAN

Science and Technology Advisory Council

2021







RHODE ISLAND SCIENCE AND TECHNOLOGY PLAN 2021 UPDATE

TABLE OF CONTENTS

EXECUTIVE SUMMARY

4-5

INTRODUCTION

OVERVIEW	6
METHODOLOGY	6
RI SCIENCE & TECHNOLOGY ECOSYSTEM	7

INTEGRATED INNOVATION ECOSYSTEM

MARINE SCIENCES	8
LIFE SCIENCES AND PUBLIC HEALTH	10-11
ENERGY	12-13
ADVANCED MATERIALS	14-15
FOOD INNOVATION AND TECHNOLOGY	16-17

CROSS-CUTTING COMPETENCIES IN RHODE ISLAND'S S&T DOMAINS

DESIGN	18
DIGITAL TECHNOLOGIES	18
APPLIED/TRANSLATIONAL SCIENCE	19
SCIENCE COMMUNICATION	19
WORKFORCE DEVELOPMENT	20

RHODE ISLAND S&T RESOURCES

INFRASTRUCTURE	21
PEOPLE	21
FUNDING	22

CONCLUSION & NEXT STEPS

23

EXECUTIVE SUMMARY

In 2009 and again in 2014, the RI Science and Technology Advisory Council (STAC) identified three priority Science and Technology (S&T) domains, marine sciences, life sciences and energy and environment. These domains were recognized economic drivers in the State over the past five years and have persisted through the pandemic. This update includes two additional complementary domains (advanced materials and food innovation and technology), as well as updated focus areas within each domain. All five S&T domains meet the following criteria: 1) tackle complex global societal challenges; 2) demonstrate RI's leadership and expertise; 3) leverage RI's geography, population and assets; 4) provide local to global scalable solutions; and 5) offer clear opportunities for intersection and collaboration across domains.

PRIORITY S&T DOMAINS:

MARINE SCIENCES

As an ocean state with 400 miles of coast and an abundance of S&T marine resources, Marine Sciences and its S&T efforts remain a constant strength for RI. Marine research and businesses have focused on climate change solutions, mitigation of contaminants from land to sea, and marine/deep sea technologies, such as underwater vessels, deep sea camera systems and versatile sensors. RI's marine assets and scientific community, including the U.S. Navy's premiere undersea warfare R&D center, could position the State to take a leadership role in the Blue Economy, which draws on marine assets to drive economic development while preserving and regenerating the ocean ecosystem.

LIFE SCIENCES AND PUBLIC HEALTH

With twelve academic institutions, a connected healthcare system, diverse population and proximity to vibrant life science urban centers, RI supports many life sciences and public health opportunities. RI is already home to significant life science manufacturing facilities (e.g., Amgen, Rubius), successful established life science companies (e.g., Epivax, Ximedica) and has a developing life science start-up ecosystem. Its diverse population of just over one million people supports multiple population health studies across the lifespan that have led to innovation in diagnostics, therapies and preventative interventions.

ENERGY

Rhode Island is a nationally-recognized leader in energy efficiency and has consistently ranked in the top five most energy efficient states in the country. RI's broad energy expertise spans policy, science, startups (e.g., TechStyles Materials) and global businesses (e.g. National Grid, Orsted). The State has made investments that have led Rhode Island to have a global profile in offshore wind, wave and tidal technologies, energy storage, and other clean technologies. Startups and companies continue to grow in renewables and smart grid technologies, both critical parts of the sea-energy supply chain. RI energy companies also have diverse approaches to meeting the global demand for energy and address the urgent challenges of the global climate crisis.

ADVANCED MATERIALS

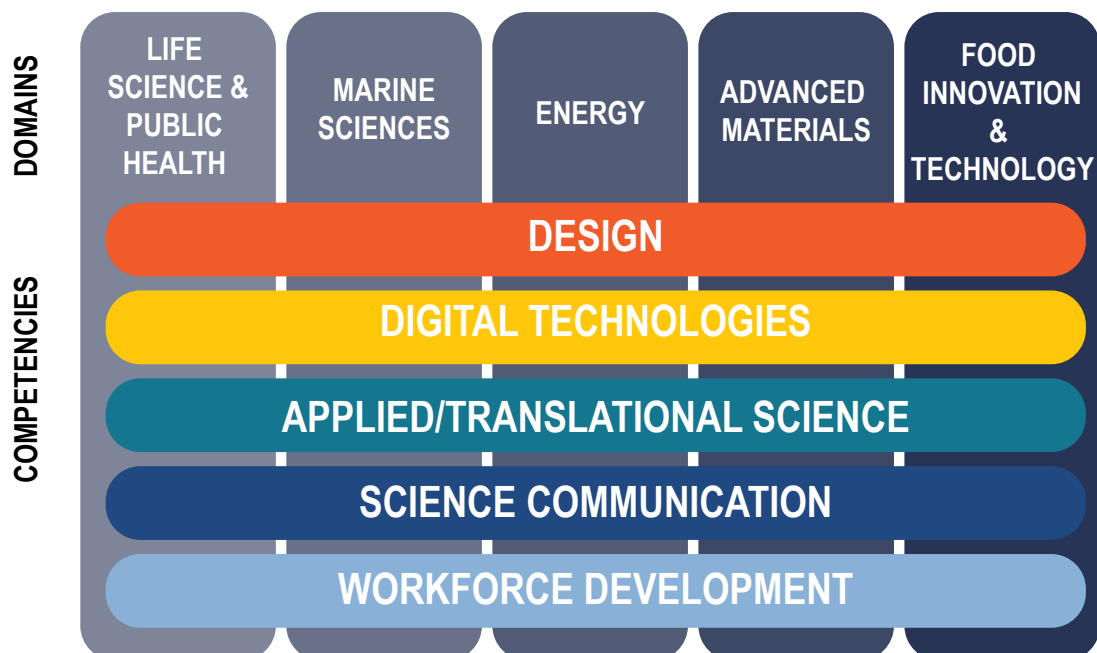
Recent developments in advanced materials technology translate the textile and composites legacy of Rhode Island into the modern era. With the versatility to approach opportunities in major S&T fields—such as aerospace, defense, automotive industry, marine trade, apparel and plastics—this domain consists of a diverse and flexible maker community with the assets and skill sets to lift the economy and scale innovation globally. Last year, for example, the advanced materials sector quickly adapted to manufacture and distribute personal protective equipment (PPE) to people at the front line of the pandemic.

FOOD INNOVATION AND TECHNOLOGY

The pandemic caused significant changes in the food industry, driving rapid changes in supply and demand in the food supply chain, resulting in a need for creative innovations, such as inexpensive and fast-delivered food. In response, many RI entrepreneurs launched digital food distribution platforms and harnessed advances in sustainable agriculture and aquaculture. Given the continued global problem of food insecurity, there is great demand for solutions that simultaneously address both environmental sustainability and human health and wellness. Jobs in this domain cross a wide range of skill sets, and the market has room for companies from startup to global scales. Rhode Island is home to globally recognized culinary arts institute, Johnston and Wales University, and has an economic legacy in tourism and food to leverage and grow awareness for RI's fast growing food innovation and technology activities.

Over the decades, Rhode Island's industries, economic investments and workforce have demonstrated core competencies that are relevant to all five S&T domains, giving each one depth, dimension and character. These competencies include: *Design, Digital Technologies, Applied/Translational Science, Science Communication and Workforce Development*. They are the key strengths that—when integrated into the State's S&T strategy—can make a small state a big player. Such an integrated innovation system (See Figure 1) could be the versatile and flexible framework that allows RI to succeed in a dynamic world.

Figure 1. Integrated S&T Innovation Ecosystem



INTRODUCTION

OVERVIEW

Along with many parts of the nation, Rhode Island is emerging from years of economic and health crises. While world leaders struggled to advance clear priorities during the COVID-19 pandemic, S&T communities across the globe collaborated, shared resources and supported the recovery. With the new administration's focus on global threats, climate change, energy, health care, infrastructure and jobs and the support of state legislators, RI can establish a strong S&T identity and build its profile by strategically investing and growing its key S&T domains.

In 2009 and again in 2014, the RI Science and Technology Advisory Council (STAC) identified three priority S&T domains, *marine sciences, life sciences and energy and environment*. These domains were recognized economic drivers in the State over the past five years and have persisted through the pandemic. This update includes two additional complementary domains (*advanced materials and food innovation and technology*), as well as updated focus areas within each domain. All five S&T domains meet the following criteria: 1) tackle complex global societal challenges; 2) demonstrate RI's leadership and expertise; 3) leverage RI's geography, population and assets; 4) provide local to global scalable solutions; and 5) offer clear opportunities for intersection and collaboration across domains.

METHODOLOGY

To inform this update, almost 50 key thought leaders from across S&T domains were surveyed or interviewed, including researchers, technologists, business leaders and entrepreneurs. The team also reviewed the latest economic development reports for S&T sectors, best practices from other state's S&T plans, and other relevant data. It is important to note that the COVID-19 pandemic has significantly altered market and employment realities across economic domains. Much of the data collected in this report comes from 2018-2019, before the pandemic began. However, the update does include projections and anecdotal information about the COVID-19 impact. Although COVID-19 has stalled growth in many sectors, the challenges it brought have highlighted the critical role of science and technology, via diagnostics, therapies and vaccination, in solving global challenges.

RI SCIENCE & TECHNOLOGY ECOSYSTEM

Place is a key driver to determine the opportunities and character of innovation. Rhode Island is the nation's smallest state (1,033 square miles) and has 400 miles of coastline and is home to one million people. Twelve institutions of higher education, a significant naval defense presence and a growing and connected health care network also continuously attract and contribute assets to the Ocean State. As one of the oldest states, Rhode Island led the industrial revolution in the U.S. with its power-driven textile mills, built its economy on its coastal resources, and it holds two deep-water ports that have been natural entry points to access manufacturing, trade and naval defense for centuries. The State continues to grow and evolve its blue economy, which draws on marine assets to drive economic development while preserving and regenerating the ocean ecosystem. Rhode Island contributes to the blue economy through its businesses in international shipping; renewable energy from the first offshore wind facility in the northeast; recreational, commercial and military boat building; commercial and recreational fishing; and scalable design and advanced materials production and manufacturing operations. And the blue economy leverages and impacts each of RI's S&T domains.

Over the past decade, including through the COVID-19 pandemic crisis, the small size of the State has enabled S&T domains to regularly intersect and develop resource efficiencies and shared assets. For example, Rhode Island is home to several federally funded research innovation platforms, including the NIH INBRE, NSF EPSCoR, RI IDeA programs, Superfund and STEEP. These public-private research and education/training networks, also supported by the Department of Labor and Training (DLT), leverage the unique strengths of Rhode Island in order to make STEM training accessible to more Rhode Islanders and enhance existing initiatives. The establishment of five RI Innovation Campus projects with a \$20 million bond has expanded physical infrastructure to promote innovation and to support the translation of academic research into commercial products and business. The goal of the Campus projects is to generate new higher paying jobs and grow industries in cybersecurity, data analytics, agriculture, advanced materials and manufacturing, and immuno-oncology. These community assets generate new discoveries, an educated and skilled workforce, and access to networks of human capital across all disciplines that can find solutions to challenges across the region and the country.

Even during the COVID-19 pandemic, Rhode Island showcased the creativity, agility and flexibility it has due to its small scale and diversity of relevant resources. The RI S&T communities came together quickly to address challenges that changed in scope and urgency from week to week. Health care and academic resources connected with life sciences commercialization resources and the statewide public health systems to accelerate the manufacturing and distribution of key technologies (such as Personal Protective Equipment (PPE)), therapies and diagnostics to address the virus.

Place-based and community-supported resources such as these make Rhode Island a hotbed and a laboratory for accelerating disruptive and innovative ideas, collaborations and opportunities in science and technology. Examples are shown throughout this report.

RI SCIENCE & TECHNOLOGY ECOSYSTEM

Life science, marine sciences and energy remain S&T domains with high growth potential; however, through this assessment process, two additional S&T focus areas have re-emerged from Rhode Island's legacy industries: advanced materials and food innovation and technology (see Figure 1). Each of these five S&T domains met the State's criteria: 1) tackle complex global societal challenges; 2) demonstrate RI's leadership and expertise; 3) leverage RI's geography, population and assets; 4) provide local to global scalable solutions; and 5) offer clear opportunities for intersection and collaboration across domains. The matrix in Figure 2 demonstrates a few examples of how the five S&T domains can intersect. This framework allows Rhode Island to pursue a strong S&T identity that can compete at a national and global scale to build a vibrant, flexible and diverse economic future.



The Wexford Innovation Center is at the center of a growing professional innovation ecosystem emerging in Providence's Innovation and Design District. Co-tenants such as the Cambridge Innovation Center (CIC), RIHub and the Brown School of Professional studies demonstrate Rhode Island's investment in developing infrastructure necessary to support a pipeline of talent and ideas.

INTEGRATED INNOVATION ECOSYSTEM

MARINE SCIENCES

As the “Ocean State”, Rhode Island’s historical maritime and evolving identity and economy are dependent on its most valuable asset: the sea. The State S&T plan will continue to cultivate strategic and cross sector innovations that also protect its coastal and ocean resources.

Rhode Island’s marine resources have direct and indirect impacts across all of the S&T domains in this report. The URI and Sea Grant report, *The Value of RI’s Blue Economy Report*, March 2020, breaks the blue economy into defense, marine trades, ports and shipping, tourism and recreation (adjacent to coast), fisheries, aquaculture and offshore renewable energy. According to the report, the “economic direct impact [of the ocean-based economy] is more than \$5 billion with the indirect value being potentially billions more.” This does not include ports and shipping, nor academic or government grants in oceans sciences. It also states that 6-9% of Rhode Islanders work within the state’s ocean economy (36.5K), which is considerably higher than states like CA, MA and CT whose portion of workers in the ocean economy only account for 3% of the population.

Rhode Island boasts many marine sciences strengths and resources, including the URI Graduate School of Oceanography and several naval defense resources such as the Naval Undersea Warfare Center (NUWC), US Naval War College (NWC), and the National Institute for Undersea Vehicle Technologies (NIUVT). Civic and government organizations, like Save the Bay, Department of Environmental Management (RI DEM) and the Coastal Resource Management Council (CRMC) play pivotal roles in supporting, advocating, educating and managing marine resources.

Collaborations across this domain provide agility and adaptability to new trends or crises. For example, marine trades have experienced declines nationally, yet Rhode Island maintains stability by working with other sectors to reinvent and retrain within the industry.

The 401 Tech Bridge Innovation Campus in Portsmouth is developing to be a critical intermediary for advanced materials and marine sciences to support a network of makers and innovators.

Rhode Island’s work in marine and life sciences has been infused with design principles and creative insights provided by artists and designers at the **Rhode Island School of Design (RISD)**. For example, RISD’s Nature Lab—funded in part by the National Science Foundation—has facilitated coastal ecology research and the translation of scientific knowledge into visual understanding.



Photo courtesy of the University of Rhode Island

Several Rhode Island companies have used innovative applications of maritime composites/ textiles, undersea vehicles, sensors, and technologies:

- Bluetech platforms, like **SeaAhead** and **MassChallenge RI**, have helped activate and support innovators in the space.
- The \$94 million **Ocean Exploration Cooperative Institute**, which is comprised of five research partners and housed at URI's GSO campus, supports seafloor and ocean exploration, responsible resource management, and improved scientific understanding of the deep sea.
- URI's ocean engineering **Underwater Robotics and Imaging Laboratory** designs soft robotic grippers to identify and safely collect fragile undersea species at depths up to 1,200 meters. To reduce dependence on large research vessels to place the tool in the ocean, the ocean engineering team is developing a tool that can be deployed from a much smaller boat.

Adapting to climate change will require much from the marine sciences, including technological innovations, new discovery and investigation tools, and collaboration across industry, academia, government and communities. The S&T community and its deep-sea explorations, marine technologies and materials are contributing innovative approaches to combat climate change and the emerging marine contaminants, such as microplastics, with innovative mitigation solutions and sustainable marine technologies. This domain recognizes its dependence on marine resources and is strengthening its approaches to sustainability and climate change adaptation. The statewide research networks via RI EPSCoR, STEEP, Superfund, INBRE and many other

collaborative grants and consortiums are public and private partnerships that ensure that the blue economy, leveraging its valuable marine resources, grows in sustainable and healthy ways.



Photo courtesy of MassChallenge

THE NAVAL UNDERSEA WARFARE CENTER (NUWC)

submarines, autonomous underwater systems, and offensive and defensive undersea weapon systems, and stewards existing and emerging technologies in support of undersea warfare. Former Defense Secretary Chuck Hagel once called southeastern New England “the Silicon Valley of undersea warfare” and NUWC is a critical part of this innovative, high-tech sector. Over 400 companies both large and small are also part of this defense cluster contributing to economic growth, generating high-paying jobs, and measuring an economic impact of \$4.3B.

Division Newport provides research, development, test and evaluation, engineering, analysis, and assessment, and fleet support capabilities for



LIFE SCIENCES AND PUBLIC HEALTH

The rapid development and deployment of COVID-19 vaccines demonstrated the critical role of the Life Sciences and Public Health domain to accelerate solutions in health. Rhode Island hosts an integrated life sciences and public health innovation ecosystem with twelve academic institutions and increasingly connected hospital and healthcare center systems. RI has an emerging MedTech startup ecosystem, translational development facilities, and a growing number of private investment groups and a closely aligned design and manufacturing network. Sandwiched between Boston and NYC, its place-based assets can be used to the State's advantage. Rhode Island's small scale and relatively diverse population allows inventors to test new ideas quickly and then tap into surrounding regional strengths to take successful findings to scale.

Life sciences' growth area accounts for approximately 1% of Rhode Island's private sector employment, employing 3,673 life sciences workers (not including healthcare workers) here in Rhode Island. The healthcare sector, which is closely aligned with life sciences, adds another approximately 16% of private sector employment. For example, Amgen's RI facility employs 600 and will soon host next-generation biomanufacturing capabilities. RI also hosts CVS headquarters and a Johnson & Johnson Health Technology Center and new home to Rubius Therapeutics.

Recent large-scale investments and partnerships have resulted in several promising ventures for understanding and tackling neurological diseases, called the next frontier for life science innovation by the CEO of Biogen. Paired with existing resources across the state, these assets will raise Rhode Island's profile and support pioneering research in neuroscience and healthy aging:

- The URI George and Anne Ryan Institute for Neuroscience;
- The Carney Institute for Brain Science at Brown, including its \$30M investment in the new Center for Alzheimer's Disease (2021);
- The IMPACT Collaboratory at the Brown School of Public Health and Hebrew Senior Life, funded in 2019 with a \$53.4M award from the National Institute on Aging. Built at the Center for Long-Term Care Quality and Innovation at Brown, the program is a nationwide effort to improve health care and quality of life for people living with Alzheimer's disease and related dementias, as well as their caregivers;
- The Butler Hospital Memory & Aging Program (MAP), an affiliate of the Warren Alpert Medical School of Brown University established in 1989, has a national reputation for excellence in clinical care, training, and cutting-edge research in the detection, treatment and prevention of Alzheimer's disease and related dementia;
- URI's nursing, pharmacy and other applied health sciences and practitioners (nutritionists, physical and occupational therapists).
- The stable and growing aging population in RI along with URI's relationship with the RI chapter of
- Osher Lifelong Learning Institute (OLLI) and its 1100 members/partners over the age of 50, provides a population for collaborative studies that can support and guide S&T solutions.

ximedica®

Ximedica is a prime example of a company that has benefited from RI's design competencies in the life sciences, and takes advantage of the state's smaller scale. Founded by two RISD graduates, Ximedica partnered with Moderna this year to develop a prototype for rapid mobile manufacturing of vaccines and therapeutics as part of the Defense Advanced Research Projects Agency's (DARPA) Nucleic Acids On-Demand World-Wide (NOW) Program. Ximedica was recently acquired (6/21) by Veranex to provide the first concept-to commercialization global service provider dedicated to the medtech industry.

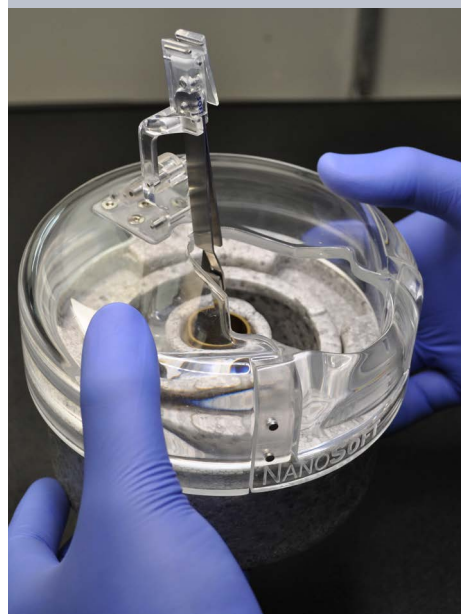


Photo courtesy of Nanosoft, LLC

RI has several statewide centers and programs supported by the NIGMS' Institutional Development Award (IDeA) program which supports biomedical research, enhances investigators' competitiveness in securing research funding, student training, and enables clinical and translational research in states where NIH research funding levels have historically been low. These programs have played a critical role in supporting innovative biomedical and translational themes in RI. Among these is the Rhode Island IDeA Network of Biomedical Research Excellence (RI-INBRE) program -- statewide network designed to build the biomedical research capacity of Rhode Island institutions by supporting and developing talented individuals committed to research careers in Rhode Island. The research themes of the RI-INBRE program are: cancer, environmental health sciences, and neuroscience. The program is aligned with the IDeAAdvance Clinical and Translational Research (Advance-CTR), a partnership established in 2016 between Brown University, the University of Rhode Island, Care New England, Lifespan, Providence VA Medical Center and the Rhode Island Quality Institute. It serves as a central hub to support and train the next generation of clinical and translational researchers in Rhode Island. RI research institutions have hosted several IDeA Center of Biomedical Research Excellence (COBRE) grants, specialized research centers. The IDeA funding fuels discovery, networking and collaboration.

The economic impact of the IDeA support for the State is enormous. In 2020, RI received a total of 16 IDeA awards amounting to \$32M (7.4% of the total IDeA funding). RI is a lead site in the ECHO3 (Environmental Influences on Child Health Outcomes) and ISPCTN4 (IDeA state Pediatric Trials Network). This major NIH initiative investigates the impact of environmental exposures on children's health and development and provides underserved and rural populations the opportunity to participate in high quality clinical trials (Impact of NIH's Institutional Development Award (IDeA) Programs in Rhode Island, RIMJ March 2021, Cho and Padbury).

In recent years, many RI-institutions have invested in each component of the pipeline for life science innovation, from discovery to clinical application. The Brown Institute for Translational Science (BITS) supports integrated research teams in which researchers and clinicians collaborate along a common continuum, such as a disease, investigative approach, or public health challenge. Several life science incubators and accelerators have been established, such as the Brown Biomedical Innovation to Impact fund (BBII), which provides pilot funding for up to four projects per year that have high potential to advance innovation in life sciences and attract industry partners and investors. The new Wexford Innovation Center, located adjacent to Rhode Island's largest medical care complexes and teaching centers, is a hub of science, technology and business innovation resources including the Cambridge Innovation Center, RIHub, Innovation Studio, and District Hall.

In response to the COVID-19 pandemic, Brown established a seed fund, investing a total of \$350,000 in fifteen research teams to fast track research that has the potential for significant and rapid impact on the course of the disease. Projects included digital health technologies, drug discovery, home testing kits, ventilator innovations, and many other approaches to disseminate best practices and address the challenges of the pandemic. Along with the IDeA programs, RI Bio, founded in 2013, plays a critical intermediary role as connector and facilitator for growing the life sciences and public health economy with industry and academia. The organization creates connections across sectors and disciplines to support new insights that generate innovations and provide local to global partnerships for technologies and discoveries by quickly leveraging its small state.

The COVID-19 pandemic required creative, flexible and immediate scientific approaches to diagnostics, therapies and prevention. **URI Professor of Biomedical and Pharmaceutical Sciences, Angela Slitt** and her team quickly recognized the testing mechanism issues. They quickly adapted a similar research mechanism they were using with PFASs in their STEEP lab to develop a new COVID-19 test that addressed and overcame the accuracy challenged by earlier testing. Collaborating with Thermo Fisher Scientific, the research team was able to validate their test and get access to a supply chain for distribution. The saliva-based test is less invasive than many of the traditional nasal swab tests in use, and researchers say it is sensitive, specific, and can deliver results at a lower cost.



Photo courtesy of the University of Rhode Island

ENERGY

Rhode Island is a nationally-recognized leader in energy efficiency and has consistently ranked in the top five most energy efficient states in the country. RI's broad energy expertise spans policy, science, startups (such as TechStyles Materials) and global businesses (such as National Grid), all of which have diverse approaches to meet the global demand for energy and address the urgent challenges of the global climate crisis. RI's aggressive clean energy policy efforts began with the *Least Cost Procurement Law*, a legislation that drove the State's investment in energy efficiency and infrastructure. This pioneering policy piece requires the State to purchase as much energy as possible through the least expensive energy source available, which is actually not about energy production at all; rather it is about infrastructure and technologies that improve *energy efficiency*. With this policy, Rhode Island set the bar for the rest of the country for the following decade. Rhode Island continues to lead the country in energy policy, including with initiatives such as "The Road to 100% Renewable Electricity by 2030 in RI".

Rhode Island also remains a global leader in the energy sector with its investments and innovation in offshore wind, wave and tidal technologies, energy storage, and other clean technologies. Startups and companies continue to grow in renewables and smart grid technologies, both critical parts of the sea-energy supply chain. Ørsted, the global leader in offshore wind development, has opened an Innovation Hub in Providence, Rhode Island to support the development of an offshore wind industry supply chain in the U.S. Advanced building materials and efficient lighting technologies contributed greatly to the increase in energy efficiency employment, and in unique areas like microgrids and smart grid development.

Renewable energy targets and incentives support sustainable businesses growth and attract more clean tech startups and companies to move to Rhode Island. These state efforts and investments have attracted new companies, consultants, international recognition and new ideas/solutions in energy efficiency and smart grid technologies that can be scaled local to global. With new offshore wind projects, like Revolution Wind, the installation, construction and manufacturing will have significant impact on RI job growth and economy. The continued emergence of technologies and innovation in energy will create opportunities and ideas in other S&T domains, such as informing the changing ocean landscape and climate change impacts that inform sustainable strategies, encouraging further undersea innovations, and attracting and reinventing textiles and composites legacy and manufacturing in Rhode Island.

In December 2016, the Block Island Wind Farm came online as the first North American Facility of its kind. RI's south-facing beaches, high wind speeds and densely populated coastlines make it desirable for offshore renewable energy (ORE), which includes wind, waves and tides. The 2020 Rhode Island Clean Energy Industry Report, indicates that there was a 77.3% increase in clean energy employment since 2014, and the energy efficiency technology sector accounted for 66% of the new jobs. The State's clean energy sector employed a total of 16,348 workers as of the end of 2019 in installation, maintenance, repair, engineering, research, trade, transport and manufacturing.

A key intermediary in this space, the Office of Energy Resources (OER), develops policies and programs that respond to the State's evolving energy needs, while advancing environmental sustainability, energy security, and a vibrant clean energy economy. NEEP (Northeast Energy Efficiency Partnerships) and CESA (Clean Energy States Alliance) are regional entities that help government and businesses to collaborate in the energy efficiency and renewable energy spaces respectively.



Arctura Wind (formerly Aquanis) is a South County, RI wind energy solutions company that is transforming the renewable industry by maximizing wind turbine performance -- developing devices that improve the efficiency and resiliency and extend the service life of utility-scale wind turbines. Through statesponsored innovation programs, the company has received two Innovation Vouchers and SBIR matching grants to support product development. Since 2015, the company has grown to include an office in WV. In August of 2019, the company was awarded a \$1-million Phase II SBIR grant from the U.S. Department of Energy to develop a wind turbine blade coating that can reduce the damage caused by lightning. In early 2020, the company was awarded an additional \$0.6 million from ARPA-E to support the development of a floating offshore wind turbine concept. And today, Arctura is working on a novel approach to the industry challenges of wind turbine and wind farm optimization.



Photo courtesy of Arctura Wind



ADVANCED MATERIALS

Via Advanced Materials, Rhode Island is reinventing its legacy economic driver of textiles and composites and leveraging existing manufacturing expertise and infrastructure. Advanced materials shaped the State's economy and its communities from the beginning of the State's history. Technology advances and water access enabled RI to be a global player in established textile manufacturing. From 1789 when Samuel Slater ("Father of the American Industrial Revolution") established Slater's Mill through to the great depression of the 1930s - textile mills have dominated RI's landscape.

Today those 200 textile mills and communities have been converted for other purposes, but a small number of textile operations persisted in innovative ways. In 2016, Rhode Island Textile Innovation Network, a trade group formed by US Senator Sheldon White (D-RI) and the URI Business Engagement Center (BEC) and affiliated with Polaris MEP, was formed with funding from the RI Commerce Corporation. The goal of the Network is to foster growth and collaboration for textile leaders to create fabrics and membranes applied in a wide range of applications in construction, personal protection, military, energy conservation, patient care, sports, recreational boating, and space exploration. Currently, Rhode Island hosts 70 textile manufacturing companies who employ more than 2,500 people and have a combined revenue of between \$2 and \$3 billion dollars annually. The companies serve a broad range of markets. RISD also plays a key role in textile innovation through highly skilled and creative faculty who partner with RI engineers to develop new materials and applications. The Rhode Island textile companies and universities are developing next-generation materials, including new fabrics that adapt to the climate, lifesaving body armor, electronic textiles, conductive fabric and recycle and reduce plastic waste (RITIN.org)

The discovery and application of composites began in Rhode Island with boat building and competitive boat racing. Recently, due to their lightweight, inexpensive and moldable properties, and the recent decrease in boat building, composites are being increasingly adapted for many other uses and industries. The Rhode Island Marine Trade Association (RIMTA) retooled and retrained the workforce to be deployed in many industries including automobiles, aerospace, infrastructure, architecture/construction, marine, military, transportation, and sports and recreation. Several trade schools have modified their curricula to accompany the growing field, including the International Yacht Restoration School (IYRS) School of Technology, the New England Institute of Technology and MTTI (MotoRing Technical Training Institute).

The Composite Alliance of Rhode Island (CARI, also affiliated with Polaris MEP), was established in 2014 to support growth in composites in RI (<http://ricomposites.com>). The Alliance conducted a study in 2018 funded by the RI Commerce Corporation, "The Economic Impact of Rhode Island's Composite Sector" (Sproul and Michaud, 2018). The report states that the RI Composite sector consists of 81 companies generating \$295.74 million in gross sales. It projected the economic output for the State as \$429.21 million (combining direct, indirect and induced effects). Rhode Island companies have successfully applied composites in maritime products, blades for turbines, military applications, string instruments, and embedding sensors for offshore aquaculture and marine sciences projects.

CARI and RITIN (Rhode Island Textile Innovation Network) are industry intermediary groups that play a critical role in supporting this domain. They make economic development a priority and look for strategies and opportunities to scale Rhode Island-based industry innovation from local to global. The network also includes faculty from textiles and engineering programs at URI, RISD, Roger Williams University and Brown University. The state government has played an active role to advocate for the sector including supporting the innovation campus of 401 Tech Bridge (mentioned above). During the pandemic, this network leveraged their strengths and collaborative environment to adapt and shift quickly to meet State's demands for COVID-19 tools and products, especially PPE.



Beginning with custom sailboats in 1975, **Goetz Composite** translated its expertise into the new blue economy by making composites—a low cost, durable and flexible material that is accessible in every market—to be used in public infrastructure, buildings, military and theme parks. Goetz operates as Composite Energy Technologies (CET) to reflect its focus now on high performance composite structures and systems integration for commercial and military customers and is planning an expansion of its Bristol facility, doubling its manufacturing space, and growing about 45 employees to more than 100 in the next year. CET received a state Innovation Voucher in 2020, and state matching funds from STAC for SBIR.



Photo courtesy of Composite Energy Technologies

FOOD INNOVATION AND TECHNOLOGY

The story of food in Rhode Island has a long history and draws from a rich diversity of global cultures. Today, Rhode Island's vibrant food scene attracts people from all over the world, enhancing tourism and attracting talent. The RI food and tourism scene benefits from the state's small scale and diverse population, marine resources and the reputation and resource of the globally known Johnston and Wales University. The resulting innovative food ecosystem with high level entrepreneurship presents many opportunities to Rhode Island in the increasingly dynamic foodfocused world.

RI's world class eateries support not only an international profile as one of the top 52 places in the world to visit—according to the New York Times—it also supports more than 60,000 jobs. RI's 3000 restaurants in 2017 generated more than \$2 billion in sales, reflecting a dynamic value-based food buying trends in society. Health and wellness and sustainable food trends have shifted consumer buying and more food and beverage are focused on science to supply data points and enhanced products to meet the demand (eg. plant-based or farm-to-table) Many food and beverage innovation clusters have surfaced in Rhode Island, such as Hope & Main, a successful food incubator in Warren, followed by Foodworks Providence and the Kitchen in Woonsocket in 2017 to take advantage\ of these trends. Breweries and distilleries have increasingly dotted the RI map.

Rhode Island also remains a global leader in the energy sector with its investments and innovation in offshore wind, wave and tidal technologies, energy storage, and other clean technologies. Startups and companies continue to grow in renewables and smart grid technologies, both critical parts of the sea-energy supply chain. Ørsted, the global leader in offshore wind development, has opened an Innovation Hub in Providence, Rhode Island to support the development of an offshore wind industry supply chain in the U.S. Advanced building materials and efficient lighting technologies contributed greatly to the increase in energy efficiency employment, and in unique areas like microgrids and smart grid development.

On the agriculture side, as a small state, RI supports about 1,200 new and historical farms, producing on 67,800 acres. RI tops the rankings in the % of farms owned by beginning farmers and those selling directly to consumers. The African Alliance of RI works with refugee and immigrant communities, leveraging their expertise to enhance agricultural practices in Rhode Island. The State recently invested in the RI Agricultural Innovation and Entrepreneurship Campus, which is a partnership with URI and RI Agricultural Technologies (RI Mushroom Company and American Ag Energy Inc) in West Kingston. Securing the State as the Northeast agricultural technology hub, the campus hosts the advanced facilities for two key partners: Verinomics, a world-renowned genomics and computational biology company, and VoloAgri, a vegetable seed company specialized in breeding for Open Field and Protected crops. The campus will train the cutting-edge agricultural products, processes and jobs of the future food industry.



Matunuck Oyster Bar will work with URI's experts in fisheries on design and validation of a hatchery facility for existing and new aquaculture products. The primary goal of this project is to establish the aquaculture practices that will lead to the development of a hatchery that is able to produce oysters, bay scallops and various seaweeds. State funding has supported this marine and food sciences collaboration with Innovation vouchers.



Photo courtesy of Matunuck Oyster Bar

Fisheries and aquaculture contribute significantly to RI's overall food economy. In 2018, aquaculture grew with a total of 76 small and/or family-owned farms producing on 319.3 acres (CRMC 2019). Products for consumption and seed sales was \$6.09 million (CRMC 2019), despite heavy state regulations and permitting. In 2015, 100 million pounds of seafood was landed in Rhode Island – with an export value over \$1 billion. In 2017, the RI fisheries sector (including direct fishing, processors/ wholesalers and recreational) included 428 companies supporting 3,147 jobs with combined gross sales of \$538.3M (Sproul and Michaud 2018b).

Beyond food science and production, this sector is strong in supply chain management, distribution and business services. During COVID-19, restaurants were dependent on online ordering and delivering. It was an unprecedented challenge that demanded overnight changes. RI startups, like Upserve (Swipely in 2009), a restaurant management cloud-software company, became integral to restaurant survival and success during the pandemic. This RI startup's innovative approach was recognized and purchased by globally known Lightspeed (cloud-based commerce platform) for \$430M in 2020.

The role of food as a prescription tool to promote health is becoming more common, with many diets (plant-based) and brands competing to capture this market also supporting consumer value-

based buying trends. Food Innovation Nexus (the Fix), for example, is a product and venture development enterprise that established itself in RI to innovate at the intersection for healthy food, design, and medicine.

The State invested in a Director of Food Strategy position in Commerce RI as an intermediary to harness the food industry growth area as a key cluster for the State's economic development growth. It is a unique state-level position, one that provides connections for collaborations and shared resources among agri/aquaculture, academia, restaurateurs and food clusters and producers. The position also oversees Relish Rhody, which presented its Rhode Island Food Strategy in 2017 before the pandemic. At that time, Relish Rhody envisioned a sustainable, equitable food system that taps Rhode Island's food production assets to support a growing economy. Rhode Islander's experience of food insecurity during the COVID-19 pandemic emphasizes the need to attain food security. Since less than 10% of food that RI eats is produced in RI, the Relish Rhody report recommended a regional goal of 50% of the food eaten in New England be produced in the region by 2060. As RI saw with energy and state targets and incentives, this regional goal will inspire science and technology innovation.

Figure 3. The integrated innovation ecosystem of the five S&T domains; including examples of intersections.

	Life Sciences & Public Health	Marine Sciences	Advanced Materials	Energy	Food Innovation & Technology
Financial Performance	Population health; Neurologic diseases; med-devices, therapies and diagnostics		Smart textiles, graphene research, medical devices, pharma, Sensors	Energy efficiency in health care, clean energy	Sustainable Health, Health inequity; Food security, Public health, Food Prescriptions, CTR
Marine Sciences	Ocean meds, Sustainable health, Climate Change, INBRE, Superfund	Climate change & adaptation, ocean contaminants, marine technologies and sensors (Smart Bay), blue economy		Wave, tide or offshore wind energy; electric boats	Food waste; STEEP, Marine Debris/Pollutants, EPSCoR
Advanced Materials		Defense; sensors in materials, blue tech initiatives; boat building; ocean engineering, Sailing industry	Textiles & composites (smart textiles, alternative materials, plastics, energy, defense)		Packaging, processing, food waste, aquaculture modeling
Energy			Manufacturing, composite materials, innovation in energy, building/architecture, wind turbines, sensors	Energy efficiency, alternative energies, utilidata, smartgrids,	
Food Innovation				Hydroponic energy efficiency, supply chain, regenerative ag, sustainable aquaculture, Energy efficiencies, solar farms, electric vehicles, biofuels	Food science, packaging and processing, innovative aqua/agriculture, food digital platforms

CROSS-CUTTING COMPETENCIES IN RHODE ISLAND'S S&T DOMAINS

All of the identified S&T domains are complemented by five key cross-cutting competencies: design, digital technologies, translation of scientific discoveries to market, science communication, and workforce development. These strengths give each of the RI S&T domains depth, dimension and character. They take into consideration that S&T solutions should be in service to society and therefore must be accessible, relevant to and inclusive of a diverse and dynamic world of humans. They are the key strengths that, if integrated, can make this small state a big player.

DESIGN

Design is a critical approach when tackling complex societal issues because it can provide a framework to begin to answer complex questions and deliver long-lasting solutions. The Rhode Island School of Design (RISD), the first independent college of art and design school in the US, has prioritized a new research agenda that re-invests in RI research partnerships. Boasting the most designers per capita, Rhode Island's S&T community frequently collaborates with expert faculty from RISD and Brown in arts, design, and culture to advance solutions with arts and design insights. The design process seeks to understand the multiple dimensions and multiple possible solutions to a challenge. Often, the human dimension is prioritized, expanding the empathy within S&T applications to produce more nuanced, effective, sustainable, and even beautiful solutions. As a result, solutions are more meaningful and more easily adopted.

RISD's Center for Complexity serves as a resource for statewide and global challenges in public health, food security, and nuclear security. The Edna W. Lawrence Nature Lab at RISD connects arts and design to natural sciences and works locally and internationally to further research in biomaterials, science visualization, biomimicry and biodesign research.

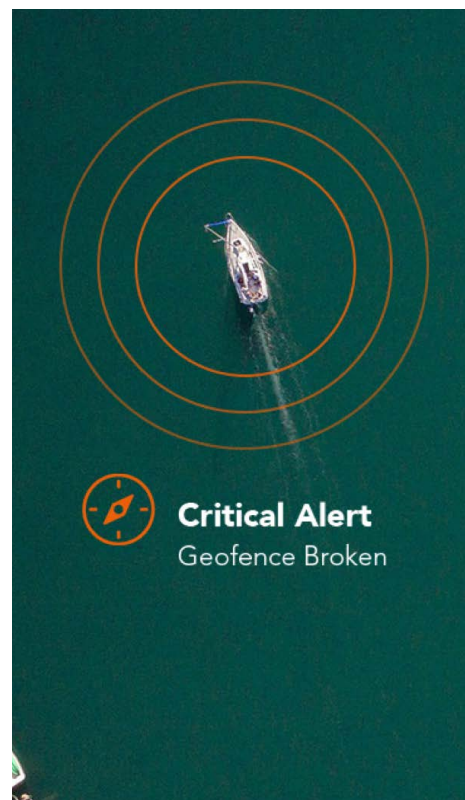
Brown and RISD have developed a joint masters program in design and engineering called MADE (Master of Arts in Design Engineering). An 11-month residential program led by faculty from both institutions, students learn best practices from design approaches and engineering methodologies to address real-world needs.

DIGITAL TECHNOLOGIES

A major silver lining from the pandemic is that digital technologies are now integrated into our daily lives at an unprecedented extent. The innovations are scalable and provide access across the globe, in the schoolrooms and in every household. These technologies helped business transition rapidly to online platforms, and kept the world going. Digital tools augment our work environment and decrease isolation. Artificial Intelligence (AI), Machine Learning (ML), Augmented Reality (AR), Virtual Reality (VR), Internet of Things (IoT), and other new acronyms became household tools and names. Use of digital technology grew exponentially during the pandemic; as a result, every innovation going forward is likely to be made possible through digital technology.



Siren Marine, a Newport, RI-based marine technology company, launched in 2011, brings the Internet of Things (IoT) to the marine industry through its innovative "Connected Boat" technology. The technology provides state-of-the-art boat monitoring, tracking, controlling and security system providing boat owners with remote access to critical and timely information about their boats. Siren Marine is a globally recognized company with more than 70 employees a list of global customers.



APPLIED/TRANSLATIONAL SCIENCE

The number of collaborative efforts dedicated to the translation of scientific discoveries into commercial products and services has grown due to the large-scale networks and commercialization resources built by EPSCoR, INBRE, Advance CTR and Superfund grants. The goal of these grants is to build and translate solutions from science to address society's most complex challenges and make the US more competitive. STAC's collaborative grants ensure that translation is part of S&T projects, and through the application process, can provide connections to collaborators with relevant expertise. To increase the chances of success, this process could connect entrepreneurs to designers to support productive testing to begin the translation from concept to product or service. The critical components for translating a good idea into market-ready products or services include: shared and accessible social and physical infrastructure; early-stage venture investment (incubators and accelerators); effective communications; and trust across S&T domains, institutions and networks.

SCIENCE COMMUNICATION

Compelling stories make S&T accessible and translatable to broad audiences. Stories engage society and enable them with the critical information needed to make decisions that protect our environment and support healthy and high-quality lives. Telling the RI stories of innovation not only inspires, it raises the profile of the State's S&T efforts to raise funds and ignite national and global partnerships. Several RI institutions provide unique, rigorous approaches to communications training, such as the Metcalf Institute, URI's Science & Story Lab, the Ocean Agency and the RISD Nature Lab. These organizations help current and future scientists and science communicators develop compelling yet accurate stories, employing a variety of modern-day communication mediums. Branding the State's S&T domains and sharing the narrative in a strategic and meaningful communication platform could build the State's profile and grow awareness around S&T to retain and attract talent, partners and funding.



An RI EPSCoR program, **Vis-a-Thon**, is an arts-based program designed to reimagine visualization as an evolving process of inquiry, indivisible from research itself. Produced in collaboration with the Edna Lawrence Nature Lab at RISD, Vis-A-Thon is an annual event where communication/visualization faculty and students work with science-focused students to provide opportunities for participants to collaboratively experiment with new and innovative ways to create and use visual imagery and language. They also critique traditional models of scientific communication and gain insight on individual research concerning visualization processes and outcomes.



FERN HEADS, WILDFLOWERS, SWALLOWTAIL BUTTERFLY
Renee Monteiro-Bernard
00 ID + RISD ID CE Instructor

WORKFORCE DEVELOPMENT

The economy is not just about industry, knowledge or technology—it is about people and communities. A thriving economy will emerge when individuals from diverse backgrounds, cultures, perspectives and interests connect with each other to share a vision, work together in inspiring ways and contribute to growth as a collective. Across domains, from workforce development and training to mentoring and incentive programs for new startups, RI academic institutions, government, industry and non-profit agencies are testing and sharing models to build a more richly diverse workforce. More importantly, these institutions are focused on creating appropriate resources for individuals and communities who have historically been marginalized in many S&T sectors. Such resources include S&T career training and development, support for minority-owned startups and companies, and other business networking and services to promote equity and excellence in the Rhode Island S&T eco-system.

Several other resources across the state are dedicated to STEM education and training for a diverse and inclusive workforce; such as: Summer Undergraduate Research Fellowship (SURF) program, the State's Wavemaker Fellowship, Real Jobs Rhode Island, RI Promise incentives, Skills for RI's Future and Building Futures. Many organizations representing different communities could be partners in approaches to promote inclusive excellence, such as the Center for Women & Enterprise, Social Enterprise Greenhouse (SEG), the RI Black Business Association, the RI Hispanic Chamber of Commerce, Center for Southeast Asians and the Multicultural Innovation Center. With STAC's support Rhode Island can continue to play a role that connects the STEM education/training/workforce development efforts and incentives to the S&T environment and industry partners. Not only would these resources help meet a rising demand for STEM-trained high-tech workers, they would contribute to a stronger and more diverse S&T community and identity and a much more competitive, collaborative, innovative and productive workforce.

The **Westerly Education Center (WEC)**, managed by Office of the Postsecondary Commissioner, is a novel statewide, industry model that could be replicated and grown. WEC is a public-private collaboration to meet projected workforce growth in the region. The Center helps people get the education, training, certification and licenses needed to get Rhode Islanders to work and build the economy. It adapts to the needs of the market by working with industry and academia as training partners. During COVID-19, WEC worked to modify programming to support manufacturing companies that were newly producing masks and to support a demand from RI DoH for water treatment skills.



RHODE ISLAND S&T RESOURCES

Working with Commerce, STAC has cultivated and grown a strong S&T statewide network that is enriched with deep institutional knowledge and decades of experience in the S&T sector. The State was able to support the community throughout the pandemic, and quickly make connections that led to innovation. Rhode Island has increased investments in building an economy based on advanced industries and launched new policies and programs intended to grow S&T industries, encompassing tax and regulatory reform, workforce development and talent attraction, quality of place, innovation and R&D, and supplier and industry cluster networks. Despite substantial progress, a new round of policy and practice innovation is needed to continue the trajectory—expanding programs that are succeeding, responding to new threats and embracing new opportunities. To help the S&T domains deliver on the State’s economic goals and outcomes, the State must continue to build a strong foundation of accessible, appropriate S&T resources, including the following.

INFRASTRUCTURE

The most important infrastructure need identified in the surveys was space and facilities to explore, prototype and test research ideas. There are limited accelerator spaces, shared labs, (wet and dry) green facilities across the State. However, there is great potential for new infrastructure to support S&T endeavors. In the space made available after the re-routing of I-195, the State invested in the Innovation and Design District, a key to future S&T activity. With strategic investments from CommerceRI and partners like Brown University, the CIC, URI and local food entrepreneurs, the area has become an inviting environment for inventors and new companies. The area hosts clusters of innovation centers (i.e. Brown’s Center for Science and Innovation), state-of-the-art urban living (i.e. Chestnut Commons), convenient working spaces (i.e. the redevelopment of the Dynamo building and Garrahy Garage), and hotels near RI’s celebrated eateries. For example, the CIC Providence and its flexible workspaces and community space have provided a connected innovation ecosystem and cost-effective space. While the Innovation Campuses did incentivize and accommodate some new space and infrastructure, it was limited, and targeted to specific projects. Even with these additions, still more tech space for R&D is needed to enable growth in the S&T sector.

A statewide digital platform for shared data would advance countless S&T research efforts, along with updated IT platforms for processing efficiency and speed. Cores RI provides access to

shared infrastructure at Rhode Island R&D institutions, but needs better buy-in from the state agencies, and improved marketing and coordination to promote access.

There are several key incubators, accelerators and other business support organizations that can help entrepreneurs, startups and other companies advance an idea to market: RI Bio, Polaris MEP, 401 Tech Bridge, RITIN, CARI, RI Commerce, INBRE, EPSCoR, RI Hub, Mass Challenge, IDeA programs, RI Hub, Slater Fund, Cherrystone Angel Group, NEMIC, Magpie X, Get Started RI, Social Enterprise Greenhouse and more.

PEOPLE

Key to the success of any S&T endeavor is connection to the people with expertise about each S&T domain and the companies and entrepreneurs within them. Such intermediaries can make connections for capacity building, navigate state systems and infrastructure requests and needs, gather teams for training or collaborative grants, identify intersections with other domains and advocate and build awareness of RI on behalf of their domain. STAC, in the overarching liaison role, can leverage these intermediary supports to move more flexibly and quickly. The intermediaries usually include a non-profit entity and state-wide collaborative grant mechanisms. RIBio has worked to assess the life sciences strengths and advocate for its needs. RIBio is aligned with statewide collaborative grants IDeA programs/grants in building capacity and competencies. Polaris and the State innovation campus, 401 Tech Bridge, play a pivotal role building capacity and accelerating innovation in advanced materials and manufacturing. RI EPSCoR plays a key role in accelerating marine sciences, as does URI’s Coastal Resources Center who aligns scholars and stakeholders to apply science and empower communities through collaboration and capacity building. Commerce RI’s Director of Food Strategy (one of two positions in the US) is supporting the food innovation and technology innovation ecosystem. As mentioned above, the Office of Energy Resources (OER) plays a key role in connecting the different public, private and community agencies in the energy sector.

FUNDING

Lack of public financial resources is a common issue across all S&T growth domains. The State currently invests in S&T through innovation vouchers, grants to support the S&T ecosystem, Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants, and the Innovation Campuses. While the survey respondents appreciated these resources and the private resources, such as Slater Fund, Magpie X and Cherrystone Angel Group, each mechanism would benefit from larger, more strategic and multi-year investments. For example, Rhode Island businesses have received limited SBIR and STTR funding from the Department of Health and Human Services. Massachusetts was awarded \$352.7 million between 2016 and 2018, whereas Rhode Island was awarded \$6.4 million during the same period. Innovation Vouchers at \$50,000 contribute a relatively small amount to innovative biomedical solutions, especially when considering the substantial costs of clinical trials.

Many of those surveyed felt the RI startup ecosystem still had not matured, and there are still significant gaps in private and public funding at the early stages of the startup lifecycle. Too often, Rhode Island startups move north to the Boston area or to the west coast because they cannot attract investors to Rhode Island. Research innovation needs assistance to facilitate large-scale public collaborative grant proposals that require significant industry support, such as an NSF Engineering Research Center, industry-academic grants, or NIH-funded research center. Support from national legislators has been helpful in raising awareness and support in the US Congress, but RI needs more support to identify new funding opportunities and marshal successful proposals.

CONCLUSION & NEXT STEPS

This update is a progress report for the 2009 strategic plan and a vision to begin a more comprehensive, inclusive strategic planning effort for the next decade. This report assessed and identified: five S&T domains that leverage assets of place, leadership, community and collaboration; statewide resources to share and lift the S&T domains; cross-cutting competencies to make Rhode Island's S&T profile more known and competitive; and in this conclusion the next steps to complete the goals and final phase of the 2009 plan. Despite the State's limited financial resources, since the 2009 update, STAC and its partners across S&T domains continue to connect, collaborate and share resources; however, according to the survey, the State needs to communicate and promote awareness of the S&T assets. Enhancing communication and public awareness is the final goal and last phase of the 2009 implementation plan.

Specifically, the State could:

1. Create a statewide shared resources (financial, physical and social) platform. An integrated innovation system targeted to advance these five S&T domains would lead to more efficient use of resources and accelerated R&D. The platform could leverage the partnerships of S&T networks in development. Perhaps investing in a more robust portal or a partnership with Cores RI to develop a consistent, easy to navigate and market-oriented resource of services, programs and facilities that are available across the State, but also highlight the key intermediaries in each growth area to also support seamless access; and,
2. Build a statewide S&T integrated innovation ecosystem identity and campaign. RI's identity as a small innovation state with its place-based assets and unique character of connection and resilience will position the State's S&T domains for success. As identified in the 2014 progress report, the STAC website plays a critical role in enhancing communication and public awareness of S&T activities. With support from the tourism and arts/cultural sector, the State needs to build a statewide S&T integrated innovation ecosystem identity that leverages its place-based assets with a wellthought and creative communications campaign to build awareness of and confidence in its historical and future role in the national and global S&T environment. This should be disseminated through the STAC website in collaboration with others.

These two State recommendations could help promote STAC as the guide, connector and coordinator of S&T resources with a strong online presence and platform. The integrated innovation system presented here would be the versatile and flexible framework that allows RI to succeed in a dynamic world. This document provides an update that informs progress to date (from 2009 plan), while setting the foundation for a vision for the strategic planning process to be embarked upon in the coming year for the next RI Science & Technology Plan that will guide the state in the next decade.

