Innovation Partnerships NETWORK

Building a New Generation of Performance-Based Research Partnerships between Industry and Universities

Executive Summary

The Critical State Role in Creating Science + Technology Partnerships

Background

- While historically, the federal government has been the country's most significant driver of R&D funding, since the recession of the late 2000s, federal funding for science and technology research has plateaued.
- State governments can't match the sheer scale of federal funding, but they can serve as a catalyst for new models of collaboration between academia and industry by investing their resources in strategic ways.
- In Massachusetts, maximizing the state's competitive advantage has informed economic policy for decades, but it wasn't until the 2002 gubernatorial campaign that the need for an explicit, state-level science and technology strategy bubbled to the surface.
- Over the past decade, Massachusetts has channelled its S+T efforts through three main initiatives: the Mass Tech Collaborative, the Massachusetts Life Sciences Center, and the Massachusetts Clean Energy Center.

Wins and Losses

- Thanks in large part to the coordinated efforts of the last decade, Massachusetts is in a better place for science and technology than it was at the start of this century – and in certain sectors, like life sciences, the state has become a global leader.
- A review of best practices from other states highlights a few key themes that are consistent with our experiences in Massachusetts:
  - Make large-scale infrastructure investments
  - Create matching funds to leverage industry funding capacity
  - Strive for early engagement between the public and private sectors for planning and execution
  - Target tax credits to encourage collaborative research, training, or internships
- However, our review also turned up several "tactics of promise" that we have either not deployed or not yet mastered in the Commonwealth:
  - Long-standing networked communities across private and public sectors (and across states) are critical for innovation and to be competitive for federal funds
  - There needs to be a significant focus on talent and workforce development that is aligned across academia and industry

Future Agenda

- Looking to the future, there is a need for the Commonwealth to focus its S+T policy efforts on initiatives that are larger in scale and cross-disciplinary in nature.
- There are four key criteria that should guide the targeting of S+T initiatives at the state level:
  - Will the initiative benefit the state's innovation ecosystem as a whole?
  - Will the initiative produce results at scale?
  - Will the initiative provide sufficient incentive for academic institutions and companies to cooperate from basic research through commercialization?
  - Does it identify and use objective metrics to track its success?
- States should also focus their policy actions on four main points of leverage:
  - Convene institutional leaders
  - Foster institutional collaboration
  - Provide effective incentives
  - Develop talent at every step

A Solution

- As the state develops its S+T agenda for the next decade, it should consider an approach with a successful track record both here and in other states: Centers of Excellence.
- The approach to Centers of Excellence has evolved considerably since the 1980s, when they first emerged in Massachusetts as Innovation Centers.
- Today's Centers of Excellence are based on explicit ties to a university or universities, involve significant investment in shared infrastructure, and are explicitly focused on developing the next generation of talent alongside translational research.
- Centers of Excellence offer a faster path to scale and cross-sector collaboration than investments in isolated tactics or companies, and generate the following benefits:
  - State-wide economic impact
  - Talent attraction and development
  - Vehicles for institutional change
  - Additional inbound investment

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The Critical State Role in Creating Science + Technology Partnerships

In the spring of 2014, Mass Insight Global Partnerships launched the **Innovation Partnerships Network**, a community of like-minded leaders and practitioners committed to addressing 21st century research challenges through more effective and strategic collaborations between academia and industry.

This first phase of the Network's development is centered on two separate, but interrelated, research efforts: the creation of an S+T Policy Agenda memo highlighting options for the state's S+T strategy that would bolster collaboration between academia and industry; and the development of a more substantive IPN Partnership Roadmap report that incorporates the policy agenda into a larger discussion documenting best practices in university-industry research partnerships.

This Policy Agenda memo is focused on the role that government plays both in actively facilitating collaborations between academia and industry and in creating an environment conducive to those partnerships. Massachusetts has only recently begun to leverage its built-in advantages as a worldwide science and technology leader through new industry and academic collaboration. There remains great potential for the Commonwealth to help catalyze innovation, new company formation, and build on its momentum as a magnet for global talent.

As global competition increases, the need for Massachusetts to devise a targeted strategy that plays to its unique strengths becomes more pressing. To that end, we have developed a working policy memorandum that:

- Reviews the history of Massachusetts' S+T strategies and initiatives over the past 10 years and the impact of those policies on the Commonwealth;
- Explores best practices from other states and countries in supporting and promoting their own innovation economies;
- Presents a series of recommendations for Governor-elect Baker and the Legislature to consider in developing Massachusetts' S+T strategy for the next 10 years.

Historically, Massachusetts has been a more difficult place to establish strategic alliances due to its fragmented marketplace, featuring a smaller public system, a predominance of large, powerful private colleges, and many small- and medium-sized enterprises, as Mass Insight reported in its 2002 report on the role of research universities in regional development, *An Economy at Risk*.

Over the past 10 years, Massachusetts has sharpened its already powerful appeal as an attractive location for industry and talent through a systematic and structured Science and Technology policy that leveraged the state's vibrant research community – both the well-established private institutions and the increasingly active and engaged public university system – and knowledge-driven industry sectors to support a dynamic regional ecosystem. Coordinated efforts in life sciences and technology have built upon the region's strengths to attract significant new research, companies, and jobs to the Commonwealth.

These strategic investments have helped pay dividends and underscore the potential for Massachusetts to continue leveraging collaboration to win in the global marketplace. More than ever, the competition to attract business and talent is global, and forward-looking policies will be critical for Massachusetts to reinforce and build on its leading position in science and technology, research and education. Not doing so puts the state at risk of becoming a hotbed of new ideas that ultimately take root in other regions and countries, to their benefit and not ours.

To meet these challenges, we must embrace the need to collaborate across sectors and disciplines. In light of past successes and current challenges, we believe the best way to create unified communities of interest in a fragmented marketplace is for Massachusetts to establish four to five additional multi-disciplinary technology Centers of Excellence. A significant investment across five areas of focus such as Big Data analytics, cybersecurity, advanced manufacturing, or robotics would allow the state to combine its early competitive advantages in these areas with its research and commercialization capabilities on a regional, national and global scale.

Through a mix of tactics such as requiring a 3:1 match for state dollars from industry partners or federal grants as Mass Tech has done, the state's investment would serve as a catalyst for increased collaboration across academia and industry. This approach would also allow the state to make targeted investments in different regions of the state based on their specific strengths and needs, resulting in more developed local economies and more jobs for all the state's citizens.

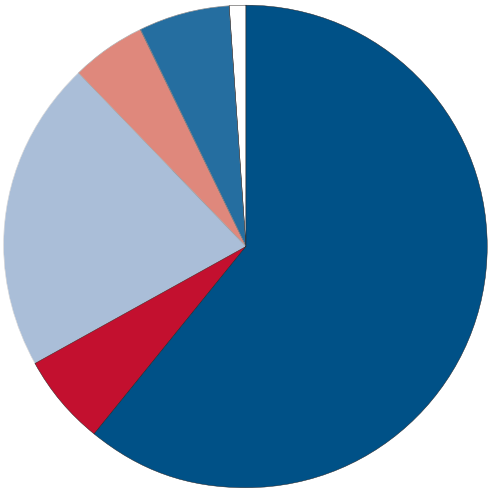
BIG PICTURE

In the post-WWII years and through the 1980s and 1990s, the federal government was the country's most significant driver of R&D funding. However, since the recession of the late 2000s, federal funding for science and technology research has plateaued.

This levelling off of federal investments increases the pressure on states, universities, and industry – who are now competing for a smaller pool of federal funds – to fill the gap. Universities still rely on the federal government for more than 60 percent of their research funding while industry sources account for approximately 5 percent. Conversely, nearly 90 percent of industry R&D funding is spent internally while just 0.4 percent flows to universities. (NSF 2012)

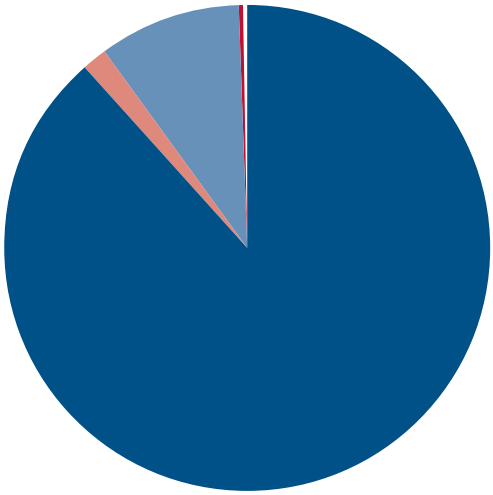
Companies and Universities should cooperate in addressing changes in federal spending.

University R&D Funding by Source



Federal Government	61%
State/Local Government	6%
Institution Funds	21%
Business	5%
Nonprofits	6%
Other Sources	1%

Industry R&D Funding with Partner



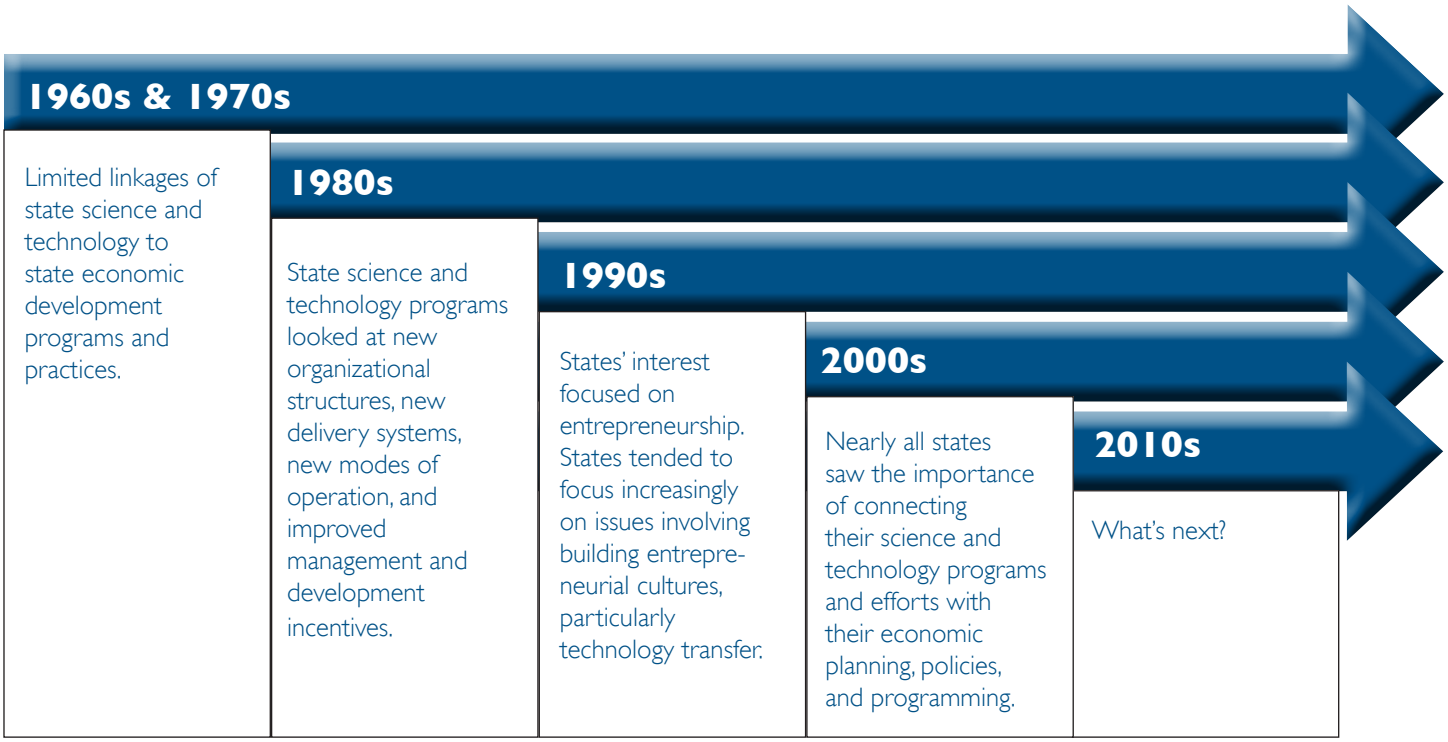
Internal Business	88.4%
Joint Government	0.1%
Business Alliances	9.4%
Universities	0.4%
Other Partners	1.6%

Source: NSF 2012

Academic institutions and companies will, out of necessity, adapt to this new federal funding climate, but state governments have a critical role to play. States can't hope to match the sheer scale of federal funding. However, by investing their resources in strategic ways, states can serve as a catalyst for new models of collaboration between the research community and industry, thus maximizing the effect of limited resources and funding. Sophisticated states are well-suited to drive these interactions: The knowledge they have of their local communities allows them to fine-tune specific funding initiatives to meet local needs.

MASSACHUSETTS S+T POLICY PAST AND PRESENT

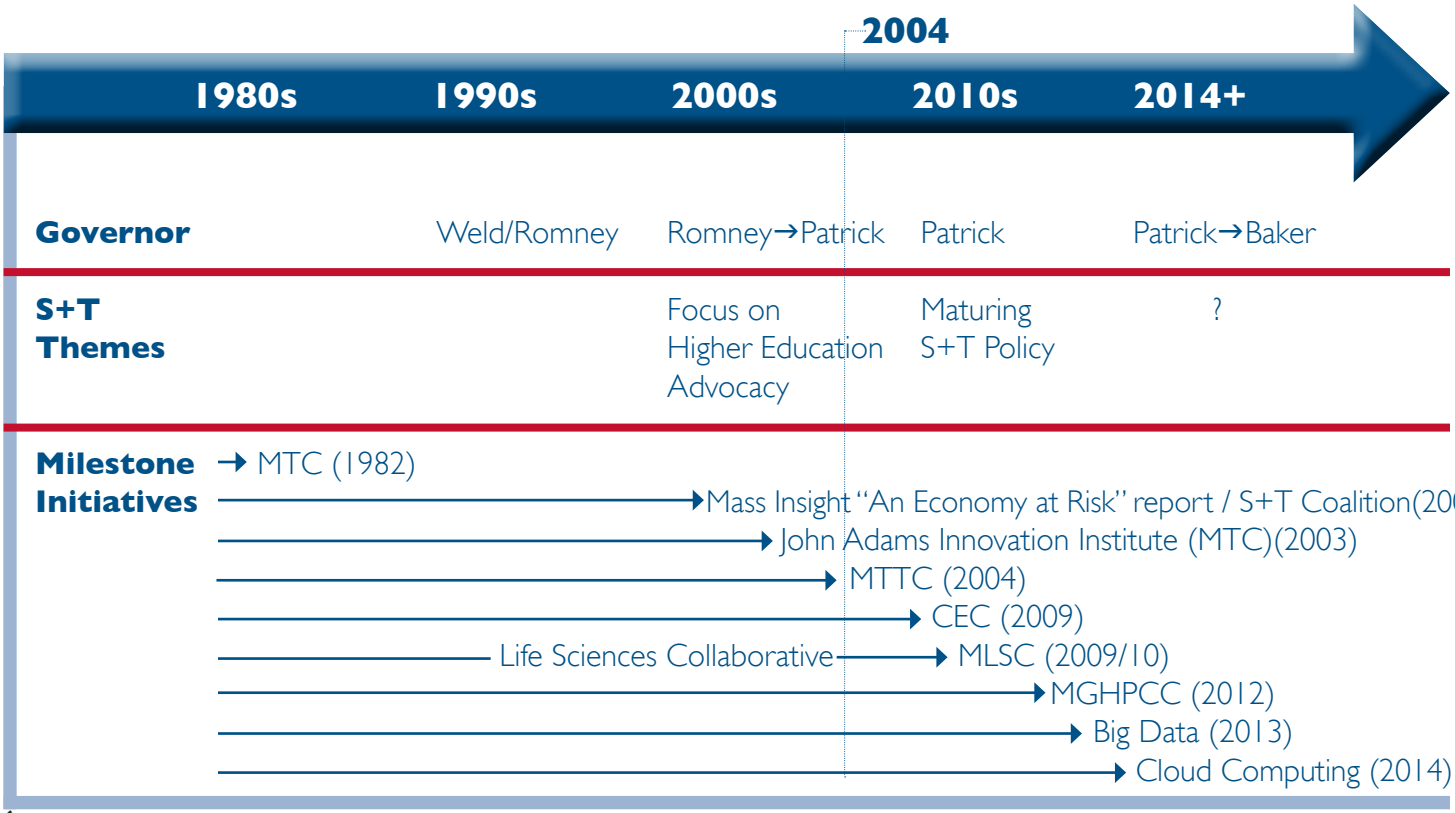
Evolution of state's role in science and technology policy



Source: Plosila,Walter H. "State Science and Technology-Based Economic Development Policy: History, Trends and Development and Future Directions." Economic Development Quarterly 2004 18:113

States are certainly not new actors in the funding of science and technology efforts. Starting in the 1990s, many states ramped up their efforts through the development of large-scale, multi-year, coordinated technology policies. This process accelerated through the 2000s and continues to do so today. Several states, including Massachusetts, have been leaders in coordinating and implementing these policies.

Massachusetts Timeline



Wins and Losses

Preserving the state's competitive advantage both nationally and globally in the race to attract business and talent has informed Massachusetts state economic policy for decades. In the 1990s, under Gov. William Weld, the state took on an ambitious program of tax and regulatory reform in an attempt to shed the "Taxachusetts" label and rebrand itself as a business-friendly environment.

As the state moved into the new century, it awoke to the potential of its higher education institutions, both public and private, to drive economic development efforts. **But it wasn't until the 2002 gubernatorial campaign that the need for an explicit, state-level science and technology strategy bubbled to the surface.** Mass Insight's 2002 report, ***An Economy at Risk***, argued that the state needed to remake its economic development strategy by framing it around science and technology, with higher education as the central lever.

The report, along with the formation of the Science + Technology Coalition, helped **kick off a decade focused on developing and implementing a robust roadmap guiding the state's S+T policy actions**. Highlights include the appropriation in 2003 of $35 million to form the John Adams Innovation Institute, now simply the Innovation Institute, under the Mass Tech Collaborative (MTC), and the commitment in 2008 of $1 billion over 10 years for the Massachusetts Life Sciences Center (MLSC). The MTC and the MLSC were later complemented by the establishment of the Massachusetts Clean Energy Center (MassCEC).

These three initiatives have been the primary focus of Massachusetts's science and technology efforts, as outlined in the state's economic development plan, *Choosing to Compete in the 21st Century (2013)*. More specifically, the state has channelled funding through these three centers across a range of investments and grants.

A significant portion of state funding flows to capital projects and tax incentives, and relatively little to academic research grants.

2013 $ millions

	MLSC	*MTC*	*MassCEC*
2013 Revenue	**65 (15 discretionary)**	**60.7**	**27.3**
2013 Investments and Grants	**93.3**	**41.2**	**29.57**
Capital Projects	53.9	35.5	4.83
Grants & Loans	6	3.56	2
Academic Research Grants	2 (+2m matched industry funding)		.64
Tax Incentives	23		
Internships & Workforce Development	3.2	.6	2
Education Funding	3.2	.02	
Other Grants	2.25	1.53	20.1

Thanks in large part to the coordinated efforts of the last decade, Massachusetts is in a better place for science and technology than it was at the start of this century. In certain sectors such as life sciences, Massachusetts has become a global leader, thanks to significant state investment and a coordinated effort across academia, industry and government.

At the same time, we have also experienced some failures during this period. Also addressed in Appendix I, review of cases where we have not succeeded can be of use.

Massachusetts Report Card

Doing well	*Could do better*
• Emerging models to use state funds	• Large-scale, ongoing, multi-party collaborations across sectors
• Early engagement between the public and private sectors	• Investing at scale
• Establishment of shared infrastructure	• Leveraging increased industry and federal funding

WINS

MGHPCC (2012)

Massachusetts Green High Performance Computing Center - The Northeast's first high performance computing center. Funded through public-private partnership with emphasis on utilization of shared infrastructure.

- Set precedent for cooperation across multiple research institutions and sectors
- Early private sector engagement as active partners
- Shared infrastructure and co-location focus
- Regional play not focused on metro-Boston area

Massachusetts Open Cloud (MOC) (2014)

Funded by $3M Commonwealth of Massachusetts MassTech Collaborative Matching Grant Award, with more than $16M of matching grants from key industry participants. New public cloud, designed and implemented in Massachusetts as the first "Open Cloud eXchange."

- Built upon MGHPCC structure and process that reduced political and bureaucratic red tape
- Funded by range of private and public sector partners, including MTC and MLSC
- Shared infrastructure for partners and start-up community
- Linking to a National Laboratory, Oak Ridge (TN)

Neuroscience Consortium (2012)

The Commonwealth's initial structured initiative under the MLSC, funded with $1.75M of private money to be invested across academic-sponsored research and proof-of-concept funding. Attracting significant government and industry funding.

- Power of the state to convene as host and coordinator
- Investment by large pharmaceutical and biotech companies both inside and outside of Massachusetts
- Formation of multidisciplinary strategic advisory board that identified areas of opportunity
- No public funding required; leveraged member investments; open to additional funding from federal government and industry

LOSSES

Biofuels (2007)

10 year, $500M competition by BP to develop a biofuels Center of Excellence that Massachusetts failed to secure due to its fragmented community network and insufficient state support.

- Main competitors were Massachusetts and California universities
- In 2007, Massachusetts's biofuels interests were fragmented across the community: While MIT looked to partner with Purdue for the BP funding, Harvard was pursuing a complex industry partnership for two $125M Department of Energy projects.
- From the state perspective, California was willing to invest $40M compared to Massachusetts' match of $25M.
- UC Berkeley ultimately won the Center by submitting a bid that included multiple state partners (university and industry) and out-of-state partners in Illinois and National Laboratories.

Advanced Manufacturing Center (2011/12)

$500M federal initiative developed to revitalize and secure the nation's manufacturing leadership by fostering partnerships between university-industry-government through Centers of Excellence.

- Objective was to build a network of AMCs around strong regional communities.
- Massachusetts had strong research and business activity, but lacked a comprehensive understanding of who was active and in what areas, and a community vision or cohesion.
- For the bid, Massachusetts partnered with universities (including UMass, MIT and WPI) and companies to submit a strong bid based on a commissioned industry mapping exercise and proposal.
- However, the Massachusetts consortia was new and didn't have the same track record of engagement and impact as the winning bid.

BEST PRACTICES

As we look forward to the next decade and beyond, we should complement our self-assessment with consideration of the S+T efforts in other states and countries. Adapting or adopting some of these approaches, including possibly partnering with other states, may help attract investment at various levels, including federal. Appendix II to this memorandum contains a detailed review of some of the most relevant efforts in selected states and countries, but here we have chosen to focus on three specific regions: California, Ohio, and Germany.

CALIFORNIA: *Keeping pace with the future*

Over the past 60 years, California has built a global reputation for innovation and entrepreneurship through a productive mix of private investment supported by state funding in the education system (community college and university) and key 'market gap' initiatives. While the 'tech' community dominates California's economy, the state is at the forefront of many sectors, including biotechnology, life science diagnostics, technology hardware, agriculture, clean energy and robotics.

Tactics Employed

- Established Centers of Excellence (Davis Institutes) within UC system focused on future technologies and the industries surrounding their development
- Leveraged private funding at 3:1 ratio for Institutes
- Ensured curriculum developed in partnership with industry
- Spread benefits of the innovation economy across the state
- Big plays:
  - Davis Institutes - $400 million state investment
  - CIRM - $3 billion bond issue to fund stem cell research for 10 years

Tactics of Promise to Massachusetts

- Structure initiatives that span a number of established and growing sectors and industries
- Require matched grants or leverage private funding for state-sponsored translational research initiatives
- Attract additional funding (federal and industrial) by making significant seed investments (e.g., 'seed big to play big')
- Ensure a reliable funding stream so leadership can focus on objectives

OHIO: *Retooling for success*

In the 1990s and 2000s, Ohio's core manufacturing industries fell victim to economic globalization, leaving behind a skilled workforce with limited options for re-employment. Through a mix of public-private partnerships and strong leadership, the state identified areas in which core capabilities could be refocused and the workforce re-tooled. By focusing on healthcare devices and technologies, polymer science, clean energy and additive manufacturing, Ohio has leveraged its direct investments at a 9:1 ratio and secured 100,000 jobs.

Tactics Employed

- Founded the Edison Centers in the 1980-90s to drive university-industry collaborations on applied research
- Improved talent pipeline by directing $54 million into training centers for workforce development
- Leveraged a third-party manufacturing advocacy group (MAGNET) to help secure AMP by engaging in public-private partnerships

Tactics of Promise to Massachusetts

- Understand the strengths of the overall community and the specifics for each region
- Map and connect needs with skills and opportunities
- Introduce state involvement where gaps or market failure are occurring
- Utilize third-party entities to convene and support ecosystem development engagement

GERMANY: *Reaping the rewards of a strong educational infrastructure*

Germany's sustained success in the innovation economy has benefited from strategic investments in its educational structure and system, from K-12 through to technology colleges and universities. Additionally, an extensive and well-developed apprenticeship program feeds the country's major and mid-size corporations. Fraunhofer Centers are an excellent model for aligning applied academic research with the requirements of mid-size corporations in order to scale translational research for commercialization.

Tactics Employed

- Developed a comprehensive network of applied research centers (67) focused on supporting the development and acceleration of mid-size corporations
- Provided perpetual operational funding to Fraunhofer Centers, but required them to secure additional research grants and fee-for-service
- Developed academic curriculum in collaboration with industry to ensure employment opportunities for population
- Encouraged universities and industry to work together to ensure commercialization and exploitation of innovation

Tactics of Promise to Massachusetts

- Develop a long-term vision
- Provide education at all levels
- Connect educational and research institutions with industry
- Focus on company growth and anchoring start-ups to community to maximize economic impact

In each of these cases, there are some consistent themes that resonate with our experiences here in the Commonwealth:

- Large-scale shared infrastructure investments
- Matching funds to leverage industry funding capacity
- Early engagement between private and public sectors for planning and execution
- Targeted tax credits to encourage collaborative research, training, or internships

However, across the regions studied, we also saw several "tactics of promise" that we have either not deployed or not yet mastered here in the Commonwealth:

- Long-standing networked communities across private and public sectors (not just ad hoc syndicates for proposals) as a key strength in driving long-standing innovation and better competing for federal funds (Example: OH/PA AMC)

- Multi-state partnerships with a similar goal of capturing innovation and scale in order to better compete for federal funding (Example: OH/PA AMC, and NC)

- Significant focus on talent/workforce development in tune with industry needs through collaboration between private and public sectors including community colleges (Example: California Gray Davis Institutes, Germany Fraunhofer)

MASSACHUSETTS MOVING FORWARD

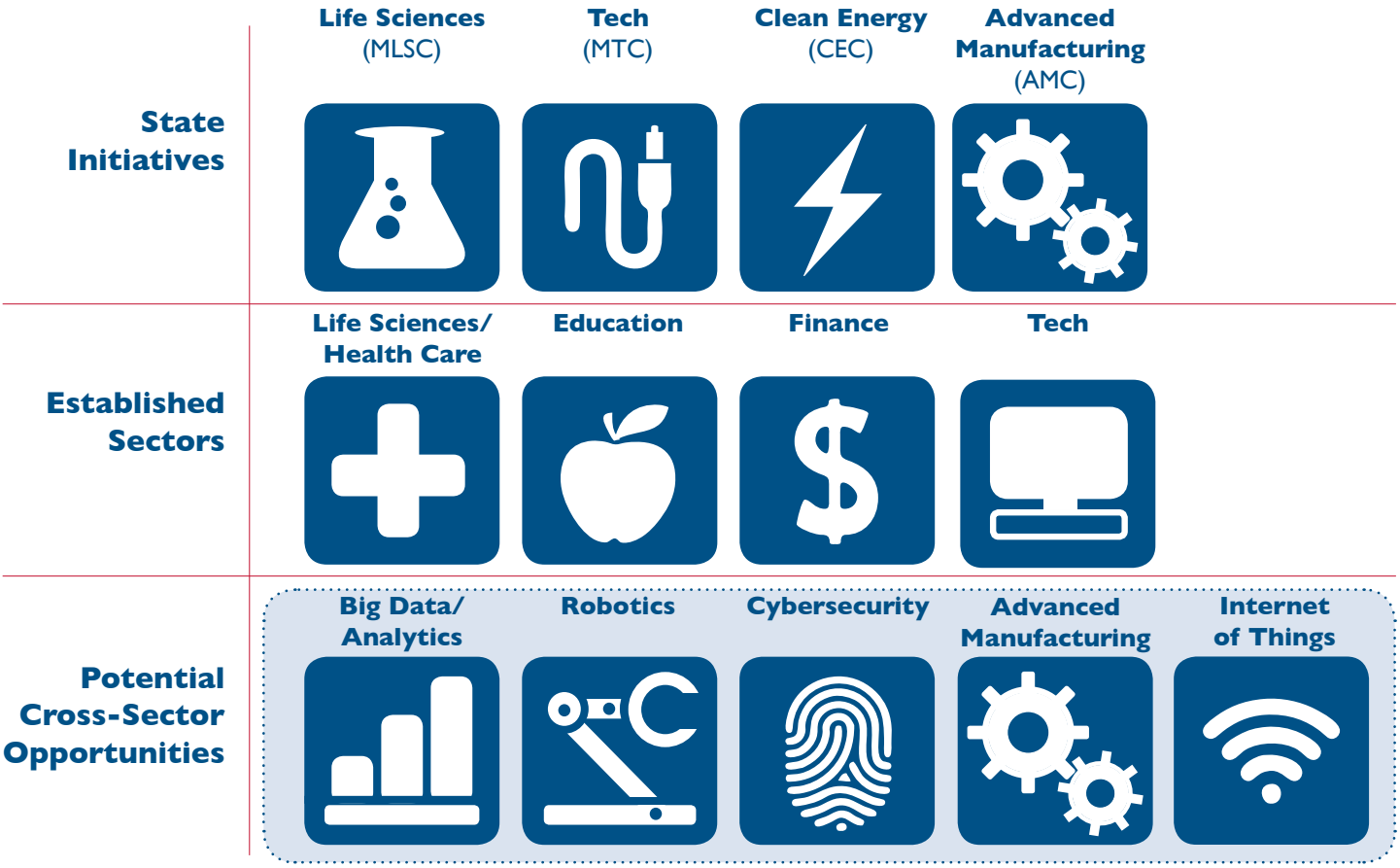
Massachusetts has achieved a tremendous amount over the last decade. But ensuring that the Commonwealth remains at the forefront of the national and global innovation economies requires identifying potential areas of focus based on the state's existing competitive advantages and aligning those areas with global opportunities. Efforts against these areas must be carefully assessed and structured.

Areas of focus

The Commonwealth's existing initiatives - MLSC, MTC, MassCEC- have shown immense promise and have delivered significant advancement in a number of ways to position Massachusetts as a national and global leader in the innovation economy. However, we firmly believe there is a need for the Commonwealth to focus its science and technology policy efforts on initiatives that are larger in scale and cross-disciplinary in nature. A compartmentalized approach has served us well in certain industries, but capturing competitive advantage in the technological landscape of the 21st century will require strength in cross-cutting sectors. Similarly, to successfully contend for federal grants under the new funding model, the state must nurture deep-seated collaborative relationships across the three points of the Innovation Triangle: academia, industry and government.

SECTOR STRENGTHS IN MASSACHUSETTS

Building on our current strength and focus, the Massachusetts ecosystem affords opportunities in a number of areas. In addition, each of the cross-sector opportunities identified represent areas in which the Commonwealth or the New England region has deep-seated, early advantages that could be developed through targeted efforts into centers of gravity that define our region on a national and global scale similar to our worldwide leadership in Life Sciences.



CRITERIA FOR EVALUATION

Within selected areas of focus, we have identified four key criteria that should guide the targeting of S&T initiatives at the state level:

1. **Will the initiative benefit the state's innovation ecosystem as a whole?** The state has neither the expertise nor the available funding to pick "winners and losers." Investing funding and resources in efforts such as workforce development programs that develop the talent pipeline as a whole or in cross-sector plays that benefit multiple industries and companies are better options than targeted equity investments within specific companies.

2. **Will the initiative produce results at scale?** No matter how effective a particular initiative, if it cannot replicate results at scale, it will not build the state's innovation economy. The state should focus its agenda on efforts that will allow initiatives to scale quickly and to benefit a wider range of people and companies.

3. **Will the initiative provide sufficient incentive for academic institutions and companies to cooperate from basic research through commercialization?** The state's academic institutions and its companies need to identify new models for collaboration that drive innovation and fill the technology and talent pipelines. The state can play a key role in developing policies that incentivize and reward universities and companies for engaging in strategic partnerships.

4. **Does it identify and use objective metrics to track its success?** All initiatives should have a clear definition of success and an identified set of metrics, developed in partnership with the business and academic communities, that track progress toward that end goal. Importantly, these metrics and goals should be spread across various time horizons (e.g., 1, 3, and 5+ years) to ensure all stakeholders that progress is being achieved.

LEVERS AND TACTICS

States have many policy levers at their disposal. To help bring these options into focus, we can group them into four main points of leverage: **Convening Leaders, Institutionalizing Collaboration, Developing Talent,** and **Providing Incentives.** Within these areas, states can allocate limited resources and money to a selected set of tactics proven to be effective within the Commonwealth and/or within other regions. The following table groups these effective tactics by major lever.

MAJOR LEVER	SELECTED TACTICS
Convene institutional leaders	• Establish public-private working groups that focus on specific challenges, sectors, or opportunities; these become networked communities • Foster cross-community engagement in pursuit of federal funding (include as appropriate community colleges and regional partners) • Develop a unified voice to work with and influence federal initiatives and policies
Institutionalize collaboration	• Award academic research grants with requirements to work with commercial partners for development or production • Support standing working groups (similar to MLSC SAB's) meeting with public/private innovation partners • Build mentorship programs working with private sector to provide start-ups with a range of mentors • Shared Infrastructure – develop facilities and technologies across public and private sectors to co-locate partners and start-ups
Provide effective incentives	• Create matching fund programs requiring private sector commitments • Targeted tax credits for R&D and employee training • R&D vouchers – SME to work with research institutes - $5-10k per start-up to be used with research institutions • Academic research grants awarded in areas/sectors of focus • Tax incentives to start-ups and employees • Workforce Attraction Credits – minimum employment period with claw back
Develop talent at every step	• Develop internship and co-op programs for students at community colleges and universities • Connect community colleges with industry and research institutions in development of curricula • Workforce Development Credits – tax credits for staff training • Early Career Program – support academics in spending one year in industry before beginning academic career path

A SUGGESTED APPROACH: 'CENTERS OF EXCELLENCE'

As the state seeks to establish direction and to build momentum on S+T policy, it should consider an approach with a successful track record both here and in other states: Centers of Excellence. The approach to Centers of Excellence has evolved considerably since the 1980s, when the concept first emerged in Massachusetts. Those fledgling efforts (e.g., Dukakis-era Innovation Centers) were disconnected from the state's institutions of higher education – the engine of Massachusetts' innovation economy.

Today's Centers of Excellence are founded with **explicit ties to a university or universities**. They involve **significant investment in shared infrastructure** that brings together faculty from multiple universities and industry researchers. The close **involvement of industry** ensures that the Centers will be **market-led** in their research and commercialization efforts. Centers of Excellence are explicitly focused on developing a **robust talent pipeline**. And, finally, they can serve as **incubators for the next generation of innovative start-ups**. Some examples of these "new" Centers of Excellence include the Gray Davis Institutes in California and the Advanced Manufacturing Center in Ohio.

In this iteration, Centers of Excellence can be a very effective means of marshalling critical mass in financing, research, and talent in important sectors, and cross-disciplinary Centers of Excellence provide a unique opportunity to develop a highly influential innovation community across the Commonwealth.

A five-year, $50 million annual capital budget could create a network of five centers capable of exploiting the state's applied research and commercialization capabilities in areas such as big data, robotics, or cybersecurity. This approach offers a faster path to scale and cross-sector collaboration than investments in isolated tactics or companies. It also addresses directly the state's legacy of excessive fragmentation and closed silos.

Established as independent, not-for-profit entities and overseen by multi-disciplinary governance boards, each Center of Excellence would be required to match the state investment with additional funding from commercial partners and should be expected to undertake fee-for-service activities. Once established, the Centers of Excellence will provide an excellent foundation to pursue additional funds from federal research grants and initiatives. These requirements will ensure that initial seed funding by the state is significantly leveraged and will also help each Center identify an ongoing, sustainable source of revenue.

'Centers of Excellence' Benefits

State-wide economic impact

Locating Centers across the Commonwealth, especially in Gateway cities, will boost local innovation economies and will have beneficial spillover effects through development of supplier networks and community support services.

Talent attraction and development

The Centers will develop a robust and effective talent continuum by connecting the K-12 STEM initiative to the state's two- and four-year colleges and then aligning those educational efforts with the workforce needs of industry.

Vehicles for institutional change

Centered at the intersection of university, industry, government, the Centers help to establish multi-disciplinary communities of practice with more closely aligned interests, operating approach, and sense of the possible.

Additional inbound investment

By establishing strong foundations in key sectors or multi-disciplinary areas, the Centers will attract additional investment and attention from major corporations and will position the state to be more competitive for federal grants.

SUMMARY & CONCLUSIONS

Over the last decade, Massachusetts has made significant progress in strengthening its already powerful appeal as an attractive location for industry and talent through a systematic and structured Science + Technology policy. By channelling its efforts through three main initiatives – MTC, MLSC, and MassCEC – the state was able to leverage its vibrant research community and knowledge-driven industry sectors to support a dynamic regional ecosystem. In certain sectors, such as life sciences, Massachusetts has become a global leader, thanks to significant state investment and a coordinated approach across academia, industry and government.

Now more than ever, the competition for business and talent is global, and in order to maintain and improve its leading position in S+T, Massachusetts must adopt forward-looking policies that embrace the need to collaborate across sectors and disciplines and are larger in scale than previous efforts. To maximize the impact of its policy efforts, the state should concentrate on four main points of leverage: convening leaders, institutionalizing collaboration, developing talent, and providing incentives.

We believe the state can best achieve these results by making a significant investment in Centers of Excellence. A multi-year investment in key areas of focus would allow the state to combine its early competitive advantage in critical research fields with its research and commercialization capabilities on a regional, national and global scale. Centers of Excellence would generate significant benefits for the Commonwealth in four key areas: state-wide economic impact, talent attraction and development, vehicles for institutional change, and additional inbound investment.

We see three primary next steps for the Governor's consideration. First, we suggest that he convene the leaders of the major cross-sector areas of interest with an eye toward agreeing on the next generation of the Commonwealth's S+T strategy and supporting initiatives. Second, we suggest the creation of an R&D advisory board to steer the process and advise the Governor in its implementation. Last, we believe the Governor-elect should seek to establish himself as a national voice on economic development and cross-sector collaboration.

Appendix I

Initiative (year founded)	Aspects	Positive Takeaways
Broad Institute (2003/4)	• Ground-breaking partnership between Harvard, MIT, and philanthropic endowment • Objective to realize potential opportunities from human genome project • World-leading engineers and life science researchers cohabit space to sequence and analyze complex genomic data with increasing speed, complexity and accuracy	• Individual research institutions pooling resources for greater impact • Cross-disciplinary focus across life science, engineering, and data science • Focus on being a world-leading player • Shared infrastructure and co-location
MGHPCC (2012)	• Objective to address research institutions' common need for increased computing power. At the time each institution was looking at developing their own initiative • Addressed significant challenge of operating costs (e.g., electricity); Holyoke utility offered a competitive rate to make program possible • Governor Patrick's direct intervention to find common ground between universities, industry, and government was critical; Two previous attempts without this leadership had failed to progress	• Set precedent for multi-research institution cooperation • Early private sector engagement as active partner • Shared infrastructure and eco-friendly play • Effort extended to community engagement • Regional effort not focused on metro-Boston
Neuroscience Consortium – MLSC (2012)	• MLSC Strategic Advisory Board identified to engage in growing area of neuroscience (dementia) in 2009 • MLSC confronted challenge of engaging in complex area with limited discretionary resources by acting as convenor, host, and coordinator for industry-led research program • Partners worked through complex legal framework and launched initiative in 2011 with $1.75M of funding for translational research and start up investment funds • Noted by federal government as best practice and OSTP looking to replicate nationally	• Power of the state to convene especially in mandating early engagement of private sector • MA center of international partnership • No public funding required; Leveraged funding $250K from each member with opportunity to seek additional funding from federal government and industry • Engaged start-up community with 5 investments to date • Framework established is replicable in other areas such as diabetes and infectious diseases
Cloud Computing (2014)	• Objective to develop cross-sector opportunity leveraging existing capabilities in big data and life sciences • Built upon MGHPCC structure and process; significant amount of politics and red-tape eliminated • Funding from a range of public and private partners, including more than one state center (MTC & MLSC)	• Built upon prior experience in developing multi-center partnerships • Cross-sector opportunity leveraging developed strength in life sciences • Shared infrastructure for the ecosystem; not limited to research universities but also start up community
Advanced Manufacturing Center (2011/12)	**Aspects** • Federal agencies seeking initial centers as part of Advanced Manufacturing Partnership Network across the country • Bid requirements were to be regional, inclusive and established across applied research, industry (start-ups, mid size, & corporations), and government • Necessity for job creation across a range of sectors	**Lessons Learned** • Federal funding increasingly cross-sector and multi-disciplinary • Emphasis on application and identified industrial customers / partners • Regional partnerships (multiple states) • Partnerships need to be established and engaged before bid process

Appendix II

New York

Context
- Historically recognized as manufacturing state, outside of NYC
- Demise of heavier industrial base in 1980s required state intervention and refocus of regional expertise
- State engagement focus on expertise in:
  - Precision manufacturing
  - Glass
- Refocused emphasis on
  - Nanotech and semiconductors
  - Glass technology to use in the technology sector

Major Initiatives
- Centers of Excellence in Semiconductors and Nanotechnology

Tactics of Promise for Massachusetts
- Took long-term strategic position and vision, 20+ years
- Established public-private partnerships through Centers of Excellence approach
- Encouraging academic research grants to consider 'the customer/user' when submitting applications
- Building programs that contribute to the broader development of the ecosystem/ community play

Tactics and Levers
- Capital investments
  - Albany – Center of Excellence ($85M)
  - Center of Semiconductors ($100M)
  - Center for Hyper-Integration ($35M)
- Centers of Excellence required at least one 'significant' leading commercial partner
- Strong tax support (e.g., 0% tax rates) for tech start-ups – companies and staff

Differences from Massachusetts
- Very regional (NYC, Hudson Valley, Up-State – Albany & Buffalo)
- Complex public education system (CUNY & SUNY)

North Carolina

Context
- Traditional agriculture (cotton, tobacco, fruit) & manufacturing (textiles) focus
- Built initiatives around three major research universities (NC State, Duke, & UNC Chapel Hill) beginning in 1950s
- Supported the development of numerous research hospitals by recognizing opportunities in clinical trials
- Structured and promoted region as a 'business friendly' environment

Major Initiatives
- Research Triangle
- Centennial Park

Tactics of Promise for Massachusetts
- Strong interplay in initiatives that encourage public and private universities to work together with industry partners
- Utilize the opportunities provided by philanthropy and foundations.
- Structure "business friendly" approaches to ensuring start-ups remain in Massachusetts

Tactics and Levers
- Capital investments at scale and reflective of sector needs
- Investment in public and private universities
- Relaxed regulatory and tax environment for business

Differences from Massachusetts
- Volume of clinical trials
- Business-friendly regulatory and tax structures
- Manufacturing capacity and capabilities
- Pursued outreach and engagement with other states

Ohio

Context
- Heavy industrial ecosystem directly or indirectly focused around the auto industry
- Mid 1970s-1980s began to focus on additional engineering capabilities
- Repurposed industry sectors for new needs and opportunities
  - Engineering to Medical Technologies
  - Engineering to Clean Energy
  - Rubber to Material science / polymers
- 2007/8 recession and near collapse of auto industry severely impacted region and efforts
- Worked with other states (e.g., PA & MI) through third-party organizations - MAGNET

Major Initiatives
- The Third Frontier – broad movement of initiatives that provides vehicle for sector-specific areas of effort

Tactics and Levers
- Network of Applied Research Centers and Incubators to support scale up of start-ups and medium-size companies.
- Workforce Development Innovation Center to support range of applied research industries
- Matching grant funding for companies that have secured federal SBIR/STTR
- Strategically funded program ($50+ million) to invest in start-ups and entrepreneur programs

Tactics of Promise for Massachusetts
- Strategic engagement with other states
- Repurposing industry sectors, rather than trying to replace
- Workforce development initiatives to re-tool established workforce

Differences from Massachusetts
- Industrial legacy challenges still remain
- Significant state financial investments needed to attract direct industrial investment

California

Context
- Stimulus for CA innovation economy similar to MA developed out of DoD research and funding in 1950s and in 1960s from NASA 'moon race'
- Home of initial active semiconductor industry (1970s): Fairchild to Intel
- Little direct state activity outside of UC system
- Federal government has maintained a number of federal labs
- 1980-90s state started to work with universities (public and private) to build on market and technology needs,
  - Hardware
  - Digital network
  - Internet based companies
  - Life sciences/start of biotechnology
- State play actively began with Centers of Excellence within UC system
- Risk Capital self-cultivated around initial internet success (e.g., Silicon Valley Bank)

Major Initiatives
- Gray Davis Institutes
- California Institute for Regenerative Medicine (CIRM)

Tactics and Levers
- Significant investments of $400M in 4 centers (QB3, Calit2, CNSI, CITRIS – all within UC system)
- $3B bond – voted for in 2004
- Targeted workforce development across 10 areas (e.g., agriculture, construction, hi-tech, etc.)

Tactics of Promise for Massachusetts
- Community college play
  - Active engagement with industry to supply technically ready labor force
  - Transparency of ability to enter four-year undergraduate programs
- Networked communities – environment for sectors to meet and engage on issues, challenges, and opportunities
- Public University system – active engagement with industry in sponsoring research and engagement with awardees to realize commercialization of product/services

Differences from Massachusetts
- Dynamic supply chain networks that feed the existing community and provide stimulus for start-ups
- Number of federal labs
- Ability to scale companies
  - Robust local risk capital infrastructure
  - CA has a good balance of suppliers and customers to support start ups.
  - Established networked communities
- Attitude and culture (e.g., open, focus on work/life balance, etc.)

Germany

Context
- Need to revitalize manufacturing base
- Establishment of Centers of Excellence
- Core funding – perpetual from government to ensure consistency
- Focused towards supporting mid size companies
- Partner with universities
- Testing and standards
- Evolved to a broad range of areas
- Expansion of Fraunhofer model to US with two centers in Boston: clean energy and advanced manufacturing

Major Initiatives
- Fraunhofers are the foundation for a number of innovation incubators and Centers of Excellence

Tactics of Promise for Massachusetts
- Education continuum from K-12 through to university and into the workplace
- Partnership of industry with education structure
- Focused efforts to support mid size companies with development and growth strategies

Tactics and Levers
- Leverage government funding and engagement with private sector
- Mandated to secure third-party funding to support centers' growth
- Fee-for-service work
- Shared infrastructure
- Testing and regulatory services
- Speciality knowledge
- Workforce development

Differences from Massachusetts
The resources a national government has at its disposal both in regards to levers and tactics are considerably more complex than at a state level and therefore it's difficult to draw direct comparisons. However, the principles and objectives of economic development are the same and should be the foundation for understanding best practices.

United Kingdom

Context
- Government's role is to support innovation development through a suite of services
- Established a network of Catapult centers to focus on emerging enabling technology areas. Role of centers is to bridge gap between research and industry.
  - Minimum of 5-10 year core funding for Catapult centers
  - Requires matched industry funding and participation
  - Focus on world leading research and commercial opportunities
  - An independent non-for-profit entity
  - Bottom-up approach
- Areas of focus derived from active consultation with industry and academia

Major Initiatives
- Comprehensive range of services to support the development of applied and translational research partnerships

Tactics of Promise for Massachusetts
- KTN & KTP
- Catapult centers – Network of 8 enabling Centers of Excellence
- Innovation Vouchers – use by start-ups with research institutions
- R&D Tax Credit – increased tax break .
- Entrepreneur Visa – attracting and retaining talent within the innovation ecosystem
- Community engagement to understand the needs and wants of the overall innovation economy
- Independence of centers to address market needs

Tactics and Levers
- Development of Knowledge Transfer Networks & Partnerships (KTN's & KTP's) to foster and facilitate university-industry cooperation
- Catapult centers – Eight Centers of Excellence focused on enabling technologies within sectors. Fostering university-industry research and commercialization
- Innovation Vouchers – nominal $4-5,000 credits for start-ups to use with research institutions for services and shared infrastructure
- R&D Tax Credit including 'patent box' – 10% corporation tax rate.
- Entrepreneur Visa – a focused entrepreneur visa to attract international talent

Differences from Massachusetts
The resources a national government has at its disposal both in regards to levers and tactics are considerably more complex than at a state level and therefore it's difficult to draw direct comparisons. However, the principles and objectives of economic development are the same and should be the foundation for understanding best practices.

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IPN
Innovation Partnerships
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Innovation Partnerships Network is a New England-based, cross-sector network of industry and university leaders and practitioners committed to improving their organizations' strategic research partnerships and the region's innovation leadership. It was established with the goal of identifying and developing new roadmaps to guide next-generation, strategic university-industry research partnerships. IPN is an initiative of Mass Insight Global Partnerships.

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