Executive Summary

# Re-Examining Maine's Economic Position, Innovation Ecosystem and Prospects for Growth in Its Technology-Intensive Industry Clusters


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Prepared for:
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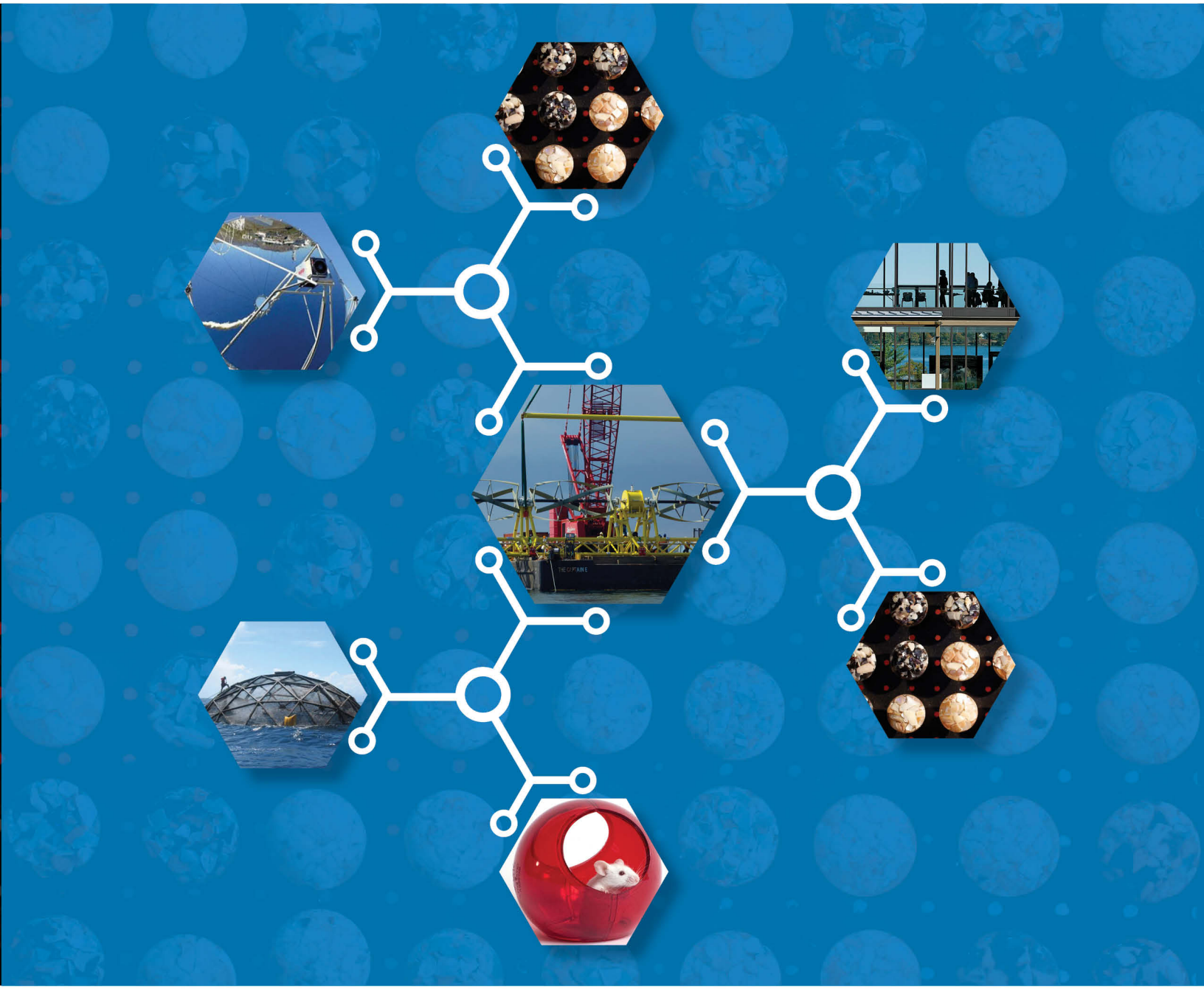

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# EXECUTIVE SUMMARY

Nearly five years after the Great Recession of 2008, the road to economic recovery has been sluggish nationwide – with employment and economic activity still below levels recorded before the severe recession hit. Of particular concern is that the growth in Maine, along with that of the rest of New England, continues to lag behind even the sluggish growth of the overall U.S. recovery. As the Federal Reserve Bank of Boston concluded at the end of 2013, "While New England's economy continued to make moderate advances in 2013, the region experienced smaller gains in economic activity than the nation."[1]

At the same time there is a growing recognition that economic challenges to advancing technology industries are rising. Increasing globalization, the fast pace of technological change, and the growing strength of developing nations in generating highly educated and skilled talent pose a threat to the economic competitiveness of all regions in the U.S.

***This report was undertaken to provide the Maine Technology Institute (MTI) a forward-looking, comprehensive assessment on how Maine's technology industries are evolving and performing as drivers of economic growth. The report also assesses the gaps and weaknesses in Maine's "innovation ecosystem," which supports the ability of innovative firms to succeed in Maine.***

This study had four specific objectives:

- ✓ Assessing the current position and recent trends in Maine's existing and emerging technology clusters based on industry performance and innovation capacity
- ✓ Identifying where Maine is positioned to grow in specific market niches relating to its existing and emerging technology clusters
- ✓ Assessing how the innovation ecosystem in Maine is currently advancing technology clusters in order to identify gaps and provide insights on how better to streamline, revamp, and integrate economic development efforts
- ✓ Developing forward-looking actions for MTI to further advance innovation, commercialization, and the overall strength of the state's existing and emerging technology-based industries.

To assist in this effort, the Battelle Technology Partnership Practice (TPP) was selected through a competitive process to conduct the analysis and offer insights into opportunities and actions needed to strengthen Maine's existing and emerging technology clusters. Battelle TPP is the economic development consulting arm of the world's largest independent non-profit research and development organization. Battelle TPP brings to this project a position as the national leader in advanced, technology-based and cluster-driven economic development practice with an established track record in developing and advising many of the most successful modern development programs in the U.S.

[1] Federal Reserve Bank of Boston, New England Economic Indicators, 4th Quarter 2013.

## Identifying Specific Technology Clusters of Industries Driving Economic Growth in Maine

To effectively compete for innovation and technology development, it is well understood that each state has specific targeted economic drivers for innovation and economic growth. As the National Governor's Association set out in advising states across the nation on best practices for global competitiveness:

> *Each state must exploit the unique advantages it has relative to other states and build on the strengths found in its local "clusters of innovation"—distinct groups of competing and cooperating companies, suppliers, service providers and research institutions."*[2]

This focus on targeted economic drivers has been a hallmark of MTI's efforts and success over the years in investing in companies and technology development opportunities best positioned for commercialization and for new product and process development. In the legislation establishing the Maine Technology Institute, the State of Maine tasked MTI with focusing on seven broad targeted technology areas. These seven targeted technology areas are:

- Biotechnology
- Composites and Advanced Materials
- Environmental Technologies
- Forest Products and Agriculture
- Information Technology
- Marine Technology and Aquaculture
- Precision Manufacturing

While these targeted technology areas reflect where Maine is positioned to generate economic gains from the development and/or deployment of technologies, they are very broad categories that cut across many different industries in the state. For MTI to effectively consider how Maine's economy is recovering from the Great Recession, and as new growth opportunities in technology areas are emerging, it is important to conduct a more detailed examination of Maine's specific technology-related industry drivers found across the seven broad targeted technology areas.

In considering these more specific technology-related industry drivers found in Maine, it is now widely recognized in economic development best practice that individual industries that drive income and economic growth in a state do not stand alone, but are better understood as being part of a broader complex of industries that are inter-related, known as technology clusters. These technology clusters of inter-related industries provide a state with its unique competitive advantages, those most important in growing its economy. The growing importance of technology clusters for economic development is reflected in the emergence of the knowledge-based economy where technological advancements,

[2] National Governor's Association, "A Governor's Guide to Trade and Global Competitiveness," 2002.

innovation, and specialized skills have become pronounced factors for economic growth across both emerging and mature industries.

Of particular importance are those technology clusters that produce goods or services that generate new income flowing into the state – either by being exported outside of the state or by substituting for imports to the state – or what are commonly referred to as "*economic base industries."* These economic base industries generate the regional economic activity that supports "*sheltered*" or "*local serving*" industries that primarily serve the needs of the local population and business community, such as the local grocery or dry cleaners. While sheltered industries can involve the use of advanced knowledge and technologies, as is commonly found in local physician offices or local education providers, they depend upon the economic base industries to drive available incomes to support their services. Sheltered industries circulate the same dollars within the state, while economic base industries bring new dollars into the state and expand the state's economy.

A **technology cluster** is a grouping of industries that typically share common supply chains, markets, and technology competencies.

Battelle – in consultation with MTI and key stakeholders – identified thirteen specific technology clusters composed of the economic base industries that are currently driving the Maine economy across the seven broad technology targeted areas. Each technology cluster involves a grouping of industries that typically share common supply chains, markets, and technology competencies. These thirteen technology clusters are:

- Agriculture, Aquaculture, Fisheries and Food Production
- Alternative Energy and Turbines
- Biopharmaceuticals
- Boatbuilding and Related Industries
- Defense
- Electronics and Semiconductors
- Engineering and Other Scientific/Technical Services
- Environmental Services
- Finance and Business Support Services
- Forestry-related Products
- Information Technology Services
- Materials for Textiles, Apparel, Leather and Footwear
- Medical Devices

The identification of the relevant Maine-specific technology clusters started with an analysis of all economic base industries in Maine that drive new income generation in the state and are aligned with the broad targeted technology areas, with a focus on understanding supply-chain inter-relationships and shared markets. The identification of technology clusters also involved a more detailed analysis of the

core technology competencies that link industries together. Core technology competencies reflect those detailed technology niches in which there is a "critical mass" of industry focus in the state. To understand the core technology competencies of Maine's industry, Battelle analyzed patent applications and awards associated with Maine inventors from 2008 to 2012. Patents represent the intellectual property being generated in Maine, and are a good means of identifying areas of critical mass in technology competencies being advanced specifically by Maine companies, universities, research institutions, and individual inventors. Battelle also considered the presence of emerging innovation companies found in Maine – those receiving Small Business Innovation Research (SBIR) funding and/or venture capital funding – across the patent innovation themes.

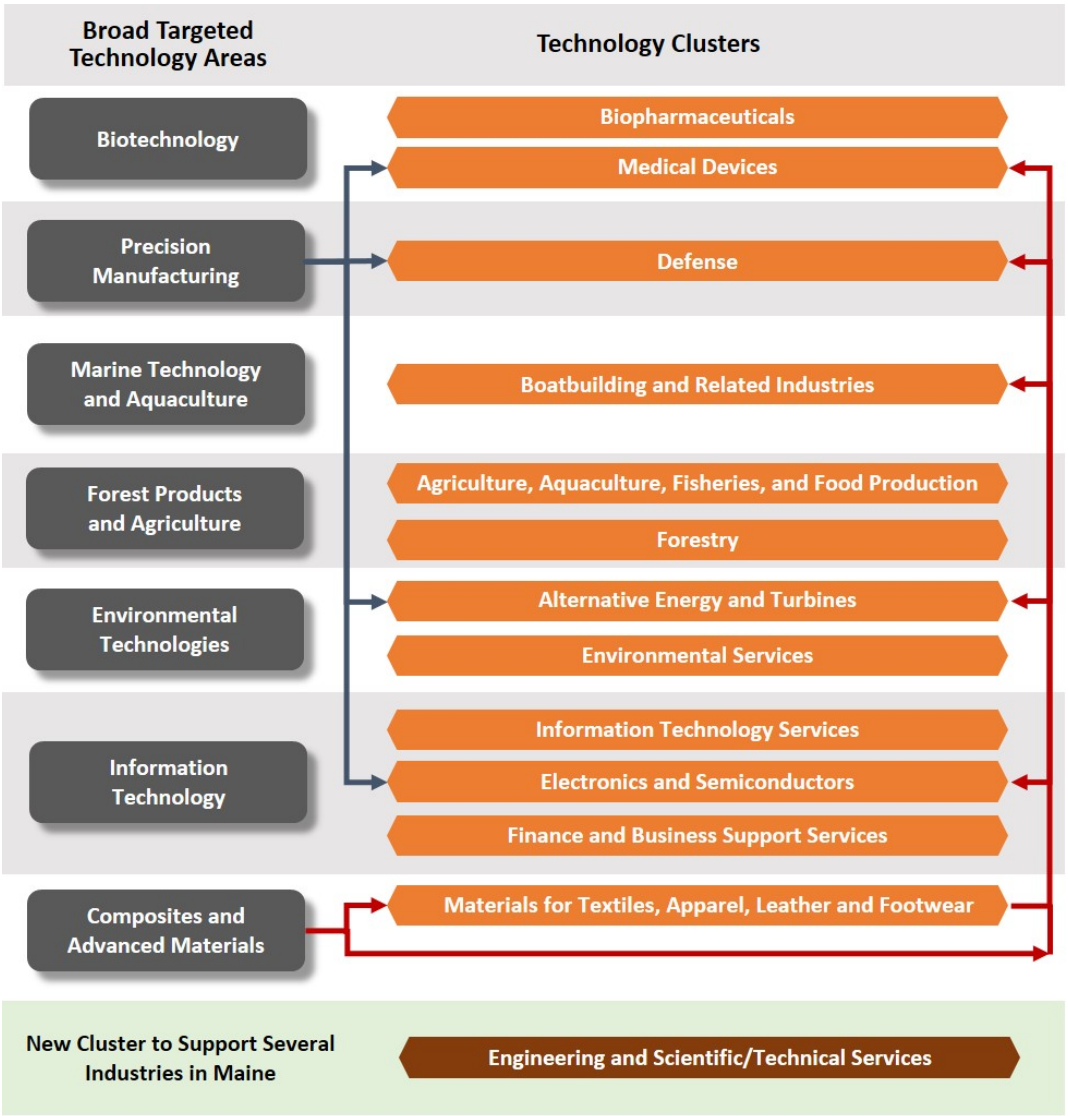
Three broad observations can be made in comparing the thirteen technology clusters identified as leading economic drivers for Maine to the broad targeted technology areas that define the technology focus of MTI's activities:

1. For the most part, the refreshed and more detailed technology clusters that were identified reflect a more distinct understanding of how the broad targeted technology areas in Maine are organized across industries from a market, supply chain, or technology driver perspective. Overall, eleven of the thirteen specific technology clusters that were identified map closely to one of the broad targeted technology areas.

2. Two specific technology clusters are characterized as more cross-cutting, and draw upon the technology know-how and/or markets found across a number of broad targeted technology areas. The Defense Technology cluster draws upon Maine's traditional technology strengths in precision manufacturing and in composites and advanced materials to serve our nation's military needs. The Engineering and Scientific/Technical Services technology cluster is an emerging set of industries that taps many of Maine's broad targeted technology areas and reflects a strong technology strength across the New England region.

3. Two of the broad targeted technology areas today are better understood as underlying technology strengths of Maine that support a number of specific technology clusters. In the case of the broad technology areas of both Composites and Advanced Materials as well as Precision Manufacturing, the pure-play industries typically found in those broad technology areas now have diminished. Still, the technology know-how and innovations present in those broad technology areas remain an important factor in Maine's competitiveness in many of the specific technology clusters, such as Boatbuilding and Related Industries, Defense, Alternative Energy and Turbines, and Electronics and Semiconductors.

**Figure A. Mapping the Refined Technology Clusters for Maine across the State's Seven Broad Targeted Technology Areas**




***Note: Crosscutting targeted technology areas that impact several technology clusters include Precision Manufacturing and Composites and Advanced Materials.***

## Performance of Maine's Technology Clusters

The thirteen technology clusters shown in Figure A represent key drivers of economic activity and employment in the state of Maine. Thirteen of Maine's top fifty businesses, based on employment size, are found within these technology clusters, including Bath Iron Works, New Balance, and Anthem Health. As the core components of Maine's economic base industries, these thirteen technology clusters bring new income into the state and support economic activity across the state's economy. Battelle analyzed the economic impact of the thirteen technology clusters on the overall Maine economy and

found that the 84,305 jobs found in the thirteen technology clusters generate almost 100,000 additional total jobs in the state and generate over $15 billion in labor income.[3]

Given the major impact of these technology clusters on Maine's economy, a comprehensive assessment of the performance of these clusters is critical. While the generation of jobs is an important measure of success, there are many other measures of economic performance to be considered. Battelle analyzed the performance of Maine's technology clusters using eight performance criteria, including:

- Concentration of the technology cluster relative to the nation
- Job generation for the technology cluster
- Growth of the technology cluster relative to the nation
- Productivity
- Average wages
- Economic multiplier
- Projected national growth
- Position in the New England regional economy.

The definitions and importance of these measures is provided in the text box on the facing page.

Different individual technology clusters stand out because of a strong showing across the performance measures:

- Two technology clusters have no weak ratings across the eight performance measures
  - Biopharmaceuticals
  - Finance and Business Support Services
- Two technology clusters have only one weak rating across the eight performance measures
  - Agriculture, Aquaculture, Fisheries and Food Production
  - Alternative Energy and Turbines
- Four technology clusters have only two weak ratings across the eight performance measures
  - Boatbuilding and Related Industries
  - Engineering and Scientific/Technical Services
  - Environmental Services
  - Forestry.

[3] Battelle analyzed the economic impact of the 84,305 jobs in Maine's thirteen technology clusters using the IMPLAN model. Multiplier effects include the "induced" effects created by the in-state purchases of the industries analyzed and the "induced" effects of the resident incomes supported by these industries themselves and impacted industries.

### Defining the Key Measures of Technology Cluster Performance for Maine

**Relative concentration of the technology cluster** – a measure of how specialized a technology cluster is in Maine relative to the nation, and so gauges "competitive advantage" for the technology cluster in Maine relative to the nation. The specific measurement of relative concentration is known as a location quotient. A location quotient is the share of Maine's employment found in a particular technology cluster divided by the share of total industry employment in that technology cluster for the nation. A location quotient greater than 1.0 indicates a higher relative concentration, whereas a location quotient of less than 1.0 signifies a relative underrepresentation. A location quotient greater than 1.20 denotes employment concentration significantly above the national average, and is considered "specialized".

**Job generation for the technology cluster** – a more straightforward measure of whether a technology cluster has been gaining or losing jobs in Maine.

**Relative growth of the technology cluster** – a measure of whether a local technology cluster is gaining or losing competitive share compared to the nation. It is measured as the difference between the percentage change in employment in a technology cluster in Maine minus the percentage change in employment in that same technology cluster for the nation.

**Productivity** – a measure of the economic output generated by each job. Comparing the level of productivity of Maine's technology cluster to its national level provides insights into whether the state's technology cluster is more or less productive, and therefore more or less competitive. Higher levels of productivity in Maine compared to national levels mean that, for each job, more economic output is generated; this suggests that the Maine technology cluster is better able to make use of advances in technology to produce goods and services and is able to produce more complex, higher value products.

**Average wages of the technology cluster** – a reflection of the overall quality of jobs found within a technology cluster. It is a measure that relates the contribution of the cluster to Maine's per capita income and ultimately to the economic well-being of the state. By comparing average wage levels across technology clusters, it is possible to learn which industries offer high-quality jobs. Average wage levels are measured by taking the total payroll reported by employers and dividing by the number of jobs. These data are reported by employers to federal and state agencies.

**Economic multiplier of the technology cluster** – a way to consider the broader economic impact of the cluster's economic activity on a local economy. Of particular importance for economic development is how inter-connected a technology cluster is to the broader regional (in this case New England) economy. These broader economic linkages consist of two types. The first type of local impacts consists of the presence of a local supply chain for that industry, often referred to as "indirect" impacts. Also important is the local income generated by an economic activity. Businesses pay wages and salaries to their workers, which are translated into local purchases of products ranging from housing, to medical care to groceries. These local income effects are termed "induced" impacts. Both the indirect and induced multipliers for each cluster were estimated using the IMPLAN input-output model of the inter-industry purchasing and income effects that occur on the national level. The model then considers the Maine industry structure in considering the opportunity for such inter-industry and personal consumption related purchases to happen in Maine. IMPLAN is one of the most widely used input-output models in the nation, and provides for each county in the nation its own customized input-output model based on national inter-industry purchases and the structure of the local industry base.

**Projected national growth of the technology cluster –** although past performance of technology clusters matters, it is critical also to have a view towards the expected future development of technology clusters. Of particular importance is whether technology clusters are expected to grow or decline in the next five to ten years. The long-term industry employment projection of national average annual employment growth developed by the U.S. Bureau of Labor Statistics (BLS) was used as the measure of national performance. The ten-year, long-term industry employment forecast generated by BLS has been a widely utilized tool for career guidance, educational and training program planning, and studying long-range employment trends. It is prepared every two years by BLS. The most recent period for which projections are available is for 2012 to 2022.

**Position in the New England Regional Economy** – since Maine is part of New England's dynamic regional economy, there are considerable economic linkages across these states. Understanding how Maine is positioned relative to other states in New England offers an important insight into the growth and development of its technology clusters. This measure considers Maine's position concerning the size of the cluster, level of cluster specialization, and the cluster's job generation, compared to the other New England states, for each of the thirteen technology clusters.

However, given the breadth of the performance measures in reflecting each technology cluster's strengths and weaknesses in the state, even those technology clusters doing well have a mixed economic performance profile within the cluster itself. The performance profile for each technology cluster – even those that generally are lagging across most of the performance measures – suggests how Maine might consider advancing the development of that cluster in the years ahead.

Battelle's insights into the development implications based on the technology cluster performance is set out below grouped into those well-performing technology clusters and those mixed-performing technology clusters.

## Performance Profiles for Well-Performing Technology Clusters in Maine:

- ***Agriculture, Aquaculture, Fisheries and Food Production*** – This is a highly integrated technology cluster in Maine with strong supply-chain linkages and a sizable employment base of 10,352 jobs. This industry has shown promise in Maine with moderate job growth of 1.8% from 2007 to 2012, which slightly exceeds the average of 1.1% for the cluster nationally. Still, as an integrated technology cluster which runs from harvesting/fishing to processing, Maine is still not yet at national levels of employment concentration. By comparison, Maine still lags well behind the high specialization and strong growth found in Vermont, the leader in New England in this technology cluster. One particular sign of concern for Maine is its lower levels of productivity in this cluster relative to the nation, suggesting the need for more deployment of process technologies and for raising the value-added of its processing activities.
- ***Alternative Energy and Turbines*** – Although this is the smallest technology cluster in Maine, with just 948 jobs in 2012, it is one of the fastest growing with job gains of 11.9% from 2007 to 2012, and it is the most specialized with an impressive five times the national level of employment concentration. It also is one of the highest paying technology clusters in the state, with average annual wages of $74,091. The national growth prospects for this industry are strong and Maine appears to be well-positioned for growth. Both national and state policies and incentives are critical for the growth of this industry in Maine.
- ***Biopharmaceuticals*** – This technology cluster is performing particularly well in its recent employment growth compared to both the nation and the New England region, and also stands out in its future growth prospects. This future growth is particularly important for Maine given the cluster's high economic multiplier impacts in the state, reflecting both its high wages and good supply chain linkages. Still, it is only a moderately sized technology cluster in Maine, with just 3,950 workers, and lacks resources such as a strong academic medical center to help advance more translational and clinical research. Therefore, it is important to pursue efforts to connect Maine's biopharmaceuticals industry to the broader complex of academic resources found across New England.
- ***Boatbuilding and Related Industries*** – This is a specialized cluster in Maine, though it is one of the smaller clusters in the state, with1,003 jobs in 2012, and has undergone significant employment declines both in Maine and nationally from 2007 to 2012. Still, Maine's technology cluster appears to be competitive, with both lower declines in employment and higher productivity levels than those seen nationally. Looking to the future, national employment projections suggest only modest declines of 1% annually in the years ahead. This suggests this technology cluster, with its more competitive positioning, can perhaps hold its own and remain

a niche industry for Maine, though it is not expected to be a strong economic driver for the state.

- ***Engineering and Other Scientific/Technical Services*** – This is one of the moderately sized clusters in the state, with 3,928 jobs in 2012. Maine is gaining jobs in this technology cluster at a fast pace, with gains of 10.4% from 2007 to 2012 that more than doubled this cluster's national gains of 4.7%. This is most promising since future national projections suggest this will continue to be a high-growth industry, with expected annual average growth of 2.2% through 2022. Still, Maine is a follower in this technology cluster to Massachusetts, a national leader that appears to be driving the growth of this technology cluster for all of New England. This suggests that Maine needs to maintain close connections to this technology cluster at the regional level and find ways to competitively position itself to benefit from growth opportunities being driven by Massachusetts.
- ***Environmental Services*** – This is a smaller technology cluster, with 1,660 jobs in 2012, that is not yet specialized in Maine, but recording strong growth of 3.4% from 2007 to 2012 that outpaced the national growth of 1.7%. It is forecasted to continue to grow strongly at the national level with expected average annual growth of 2.6% through 2022. At the regional level, there appears to be a shift in this industry within New England, with Rhode Island and New Hampshire having gained employment, along with Maine, while the larger and more specialized states of Massachusetts and Connecticut lost employment from 2007 to 2012. This suggests that Maine needs to maintain close connections to this technology cluster at the regional level and find ways to competitively position itself to benefit from growth opportunities being driven by Massachusetts. One important competitive issue will be both national and state policies and incentives, according to industry stakeholders.
- ***Finance and Business Support Services*** – This is one of the largest technology clusters in Maine, with employment nearing 30,000. Maine also has significant momentum in this technology cluster, growing through the recession and economic recovery years of 2007 to 2012 even while the technology cluster's employment at the national and New England regional level declined and still remain below its 2007 levels. To continue to gain market share, Maine needs to be focused on growing talent, particularly for the more technical Information Technology jobs associated with this technology cluster.
- ***Forestry*** – This sizable technology cluster remains an anchor within Maine's economy, with 15,157 jobs in 2012, an industrial specialization that is three times the national level, and a high economic multiplier reflecting the most well-developed supply chain linkages among Maine's technology clusters. While employment declined from 2007 to 2012 in Maine and the U.S., the state appears highly competitive. Most outstanding is that Maine's productivity level for this technology cluster is 56% higher than the national average, suggesting that this industry is deploying technology and finding higher value-added at a level far greater than the industry across the nation. In addition, Maine's employment declines stood below that of the national average, and looking to the future national projections suggest small employment declines of less than 1% annually. So, while not a direct employment driver for the future, this competitive technology cluster remains important for Maine, and the continued output growth from the high productivity in this cluster adds significant value to Maine's economy through its supply chain linkages.

## Performance Profiles for Mixed-Performing Technology Clusters in Maine:

- ***Defense*** – This is a sizable and specialized technology cluster in Maine, with 7,397 jobs in 2012, but a declining one. Even as employment in this industry grew from 2007 to 2012 nationally, it declined in Maine. Future prospects at the national level are not strong, with expected small annual employment declines of less than one percent through 2022. More importantly for Maine, this industry is driven by just a few major employers – including Pratt & Whitney and Electric Boat (General Dynamics) – and so the attention needs to be on ensuring their continued successful operations in the state.

  Despite the limited near-term growth prospects for this technology cluster, it is a viable target for state technology development efforts, because it is comprised of several of Maine's leading employers, it operates with strong linkages to the rest of the state's economy, and it generally pays high wages. As a result, efforts to stabilize the performance of this technology cluster even in the context of national declines represents an opportunity to protect and retain high wage employment opportunities both in this technology cluster itself and in its local supplier community.

- ***Electronics and Semiconductors*** – This is a smaller technology cluster, with 2,055 jobs in 2012, that is not specialized in the state and lost jobs faster in Maine than nationally from 2007 to 2012. Future employment prospects at the national level are weakly negative with expected annual average declines of 1.3% through 2022.

  Still, this technology cluster is led by major companies with operations in Maine, particularly Fairchild Semiconductor Corporation and Texas Instruments. Similar to the Defense technology cluster, the attention needs to be on ensuring that these major employers have continued successful operations in the state.

- ***Information Technology Services*** – This is a moderately sized technology cluster in Maine, with 4,065 jobs in 2012, but is surprisingly a declining one, with job losses of 11.1% from 2007 to 2012, despite strong national growth of 16.4% and growing employment levels for all of the other New England states during that same period.

  Still, this industry's national growth projections are outstanding at over 3% average annual growth through 2022 and it is a high wage technology cluster in Maine, with average annual wages of $73,168 in 2012. So this technology cluster is hard to ignore, but clearly struggling in Maine. Perhaps this cluster is best viewed for Maine as a critical enabler to the state's Finance and Business Support Services technology cluster. They share a need for specialized talent and many of the growth opportunities are in related markets.

- ***Materials for Textiles, Apparel, Leather and Footwear*** – This is a moderately sized technology cluster in Maine, with 4,194 jobs in 2012, and is highly specialized with over two times the national average concentration in the state.

  While a declining technology cluster in Maine and nationally, it is a competitive cluster in Maine with productivity standing 3% higher in the state than in the nation, and job losses at a much lower level from 2007 to 2012 than nationally. Still, the national projections are for continued major employment declines of more than 3% annually through 2022. So, while a clear niche for Maine, this technology cluster will not be a strong economic driver.

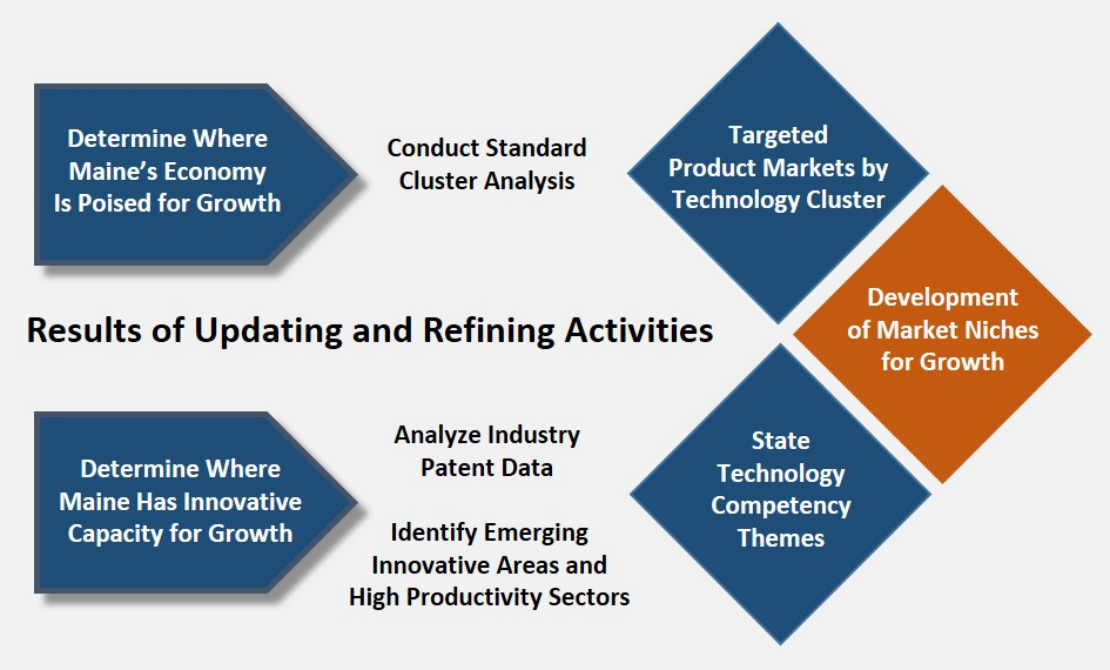
- ***Medical Devices*** – This is a small technology cluster, with total employment of 1,036 in 2012, and a much lower level of industry concentration found in Maine than in the nation (unlike the Biopharmaceuticals cluster, which is specialized in Maine).

  While Maine has enjoyed job gains mirroring the national average of 1.5% from 2007 to 2022, this cluster in Maine has a low level of productivity and low average salary of $44,602. Future national employment projections are forecasted to be relatively flat with average annual declines of less than 0.5% through 2022. So this technology cluster is not expected to be a major economic driver for the state. Still, across New England Medical Devices are an industry specialization, led by large and highly specialized technology clusters in Massachusetts and Connecticut. From an economic development perspective, it appears that Maine needs to maintain close connections to this technology cluster at the regional level – especially to fill in a lack of translational and clinical research drivers in the state – and continue to look for ways to competitively position itself within the region.

## More Targeted Focus on Line of Sight to Growth Opportunities

This report also examines where Maine is positioned for targeted growth opportunities over the next three to five years by applying a "line of sight" analysis to market opportunities. This line of sight analysis examines the focus areas of strength in Maine today based on the detailed industry strengths found within each technology cluster, together with a forward-looking assessment of core technology competencies based on the patent cluster analysis developed for this study (see Figure B).

**Figure B. Identification of Growth Opportunities based on Target Product/Service Markets and Presence of Core Technology Competencies**



While the thirteen technology clusters in Maine are economic drivers for the state, they vary considerably in how they are positioned for economic and employment growth. More importantly, even in technology clusters that were hard hit by the recession, key component industries or sub-sectors may offer important growth opportunities, even when the overall technology cluster has limited overall growth potential based on national or international economic trends. As a result, it is important to analyze Maine's technology clusters in more depth to examine how they are positioned.

Battelle reviewed each of the thirteen technology clusters using three key steps to identify likely growth opportunities:

- **Step One:** Identified, for each of the 13 technology clusters, those detailed product/service markets in which Maine has a strong or growing presence and are economic drivers. In this context, a detailed product/service market is defined very narrowly in order to be able to specifically identify the high-performing detailed industries within a cluster.
- **Step Two:** Assessed how these detailed product/service market drivers align with technology competencies or specific assets found in Maine.
- **Step Three:** Surveyed market research studies at the detailed industry and project level to identify, for the most attractive product/service market opportunities, the market growth potential and critical technology and market advances required.

From this three-step process, Battelle identified a promising set of growth opportunities that take advantage of Maine's position over a range of detailed product/service markets over the next several years. These growth opportunities range from those that draw upon technology competencies in Maine, such as turbine-powered energy and molecular-based diagnostics, to those that build upon assets found in Maine that have fueled traditional industries, such as aquaculture and functional foods.

These identified **detailed product/service market growth opportunities** across Maine's thirteen technology clusters include:

- Aquaculture
- Electronic components
- Engineering services
- Enterprise and data hosting services
- Financial transaction processing and telemarketing
- Functional foods
- Molecular-based diagnostics and genomics
- Remediation and environmental consulting
- Turbines for energy production
- Wireless sensor networks.

## Assessment of Maine's Innovation Ecosystem

Economic development is not easy to achieve in general, while technology-based economic development is an even greater challenge. For economic development to occur an entire inter-connected sequence of positive factors has to be in place. For development of technology-based business sectors the chain of factors is particularly complex and challenging to develop and manage. If any link in the chain in missing, a sustainable technology cluster is unlikely to develop.

For this assessment of Maine, Battelle considered three broad areas that encompass the key functional areas involved in technology development, including:

- Research and Development – including basic and applied research through the process of technology transfer
- Commercialization/Market Entry – focusing on product development, new business formation, and access to capital
- Growth/Scalability – involving the range of issues for growing, retaining, and attracting technology companies to Maine and advancing overall technology clusters.

This assessment relied on several sources, including the following:

- Analysis of available databases on Maine's activities in R&D, venture funding, SBIR awards, STEM (science, technology, engineering and math) occupations, entrepreneurial activities, business tax climate, and broadband technology infrastructure
- Detailed interviews conducted with over 20 Maine stakeholder groups and individuals representing a cross-section of the broad targeted technology areas
- Results from a Maine Department of Economic and Community Development survey of companies receiving assistance from MTI.

The analysis of available databases on Maine's key factors shaping technology development suggests the following:

- The state's university and industry levels of research and development are still well behind the national average per capita, but are growing. In particular, growth in Maine's university research expenditures has significantly outpaced the nation's since 2001, growing by 90 percent, compared to 73 percent nationally.[4]
- New business start-up levels in Maine are higher than those in other New England states but lag the national average. Where Maine appears to fall short compared to other New England states is in high-growth small businesses.
- Formal venture capital funding in Maine has increased since 2007, while it has declined nationally, but its level remains well behind other New England states and the national average.
- Maine is also lagging in federal SBIR awards to innovative small business.

[4] Battelle analysis of National Science Foundation data.

- While high-skilled talent specializations are limited, Maine has been recording strong growth in high-skilled occupations.
- Maine's general business tax climate falls in the middle range of states across the U.S., and within New England it is neither the lowest nor the highest.
- Broadband technology infrastructure, involving the adoption and download speeds of broadband, is at about the national average for Maine, but lags other New England states.

From the more qualitative information garnered through the stakeholder interviews and company survey results, a number of gaps were identified across the innovation ecosystem in Maine. These gaps, which point to possible areas for future program efforts by MTI, include the following:

- Lack of a connection between Maine's base of industry and university based research capabilities
- Maine has successfully increased the level of support for entrepreneurial activity in urban areas, but there exists unmet needs in rural areas
- Technology based development in Maine is hampered by a lack of access to capital and a shortage of skilled labor.

In order for the state to achieve success in its technology-based development efforts, there is general consensus among the key stakeholders interviewed that:

- Efforts to link the industry-driven research base in the state to the targeted technology clusters are critical
- Continued investments in entrepreneurial development remain important
- Cluster-based initiatives to enhance access to capital and promote talent generation will be vitally important.

## Implications for the Future

This refined analysis of technology industries, together with the assessment of Maine's innovation ecosystem, points to some important implications for MTI going forward. The analysis points to five major implications for MTI to consider as it moves forward in the years to come relating to either supporting technology cluster development in Maine or to strengthening the broader innovation ecosystem in Maine, as summarized below.

### Implications Focused on Supporting Technology Cluster Development in Maine

#### *Implication #1: The use of specific technology clusters offers insights into industries driving Maine's economy and growth opportunities.*

Efforts in the past have focused on the seven broad targeted technology areas, but this analysis shows that a more precise examination of technology clusters focused on industries that typically share common supply chains, markets, and technology competencies can offer more helpful insights into how Maine's technology-related economy is performing and a more refined line of sight to growth opportunities. For example, within the Agriculture, Aquaculture, Fisheries and Food Production cluster further engagement on aquaculture is indicated, but MTI may also consider advancing functional foods, linking its wild blueberry production with its traditional frozen food industry. Furthermore, even within struggling technology clusters in Maine, such as Information Technology Services, there are promising opportunities. In this case the continued rapid adoption of IT into the Finance and Business Support Services cluster provides a more effective driver for Maine to take advantage of the high projected national growth in areas such as financial transaction processing.

#### *Implication #2: Raising productivity is a crosscutting challenge for nearly all of Maine's technology clusters and can lead to higher wages, helping to address the lower average wages found in Maine's technology clusters compared to the nation and the New England region.*

Maine's level of productivity – a key measure of technology deployment and activities in higher value-added products – stands generally well below the U.S. average. Only three of the thirteen technology clusters outpace the U.S. average in productivity, most notably Forestry-related Products, with productivity which is 56 percent higher in Maine than the U.S. average. Not surprisingly, Maine's average wages are below the U.S. average for twelve of the thirteen technology clusters, and only exceed the U.S. average for the Forestry-related Products. This partially reflects the lower cost of living in Maine, but also reflects the generally lower productivity of Maine's technology clusters. Increased productivity increases the wealth and value of the companies in a cluster, and usually results in increased wages, as some of the increased wealth is passed on to employees. While increased productivity does not guarantee increased wage levels, it is a necessary component.

What will be critical for raising productivity levels is addressing the deployment of technology as well as raising the value-added to the goods and services being produced in Maine across its technology clusters.

### *Implication #3: Technology cluster development in Maine needs to continue to find the right balance between defined measurable projects to realize growth opportunities and broader outreach, increased innovation, and networking to create a more closely knit and collaborative business environment.*

Often there is a common tension in technology cluster development on whether to support projects involving a group of companies within a technology cluster or to support the industry or trade organizations that help to bring the cluster together through networking and broader outreach. This tension is clearly articulated in a case study of Arizona's cluster activities in the 1990s by Mary Jo Waits, currently Division Director of Economic, Human Services and Workforce at the National Governors Association: "During the early years of strategy implementation, the focus was on keeping the cluster organizations together, connected to each other, and visible to economic development organizations and the broader community … Arizona economic development leaders soon learned, however, that such intelligence might be moot without the ability to modify services accordingly, provide them in a timely holistic manner, and reach enough firms to make an impact. In other words, the full formula to help firms compete in global markets is the identification of their needs *plus* development of an effective system for meeting their needs." [5]

From the stakeholder discussions, it is clear that there is an uneven pattern to the organizational engagement across the broad targeted technology areas in Maine. In some cases, too few resources and too little attention have been paid to particular technology clusters. In other cases, Maine might actually have too many industry groups, none of which has sufficient resources to support the needed networking services for the industry. This uneven infrastructure can inhibit the ability of MTI to advance needed collaborative efforts.

As MTI seeks to be more pro-active in pursuing growth opportunities in the state, rather than expending resources addressing a multitude of different industry groups' requests and needs, some of which may duplicate others, MTI may find it useful to offer a more centralized "shared" service. The mission of this shared service would be to offer a suite of resources – such as web site development, mailing capacity, company directories, and production of materials – that can support multiple industry networking efforts. The users of this service could come and go as MTI probes the opportunities to realize the potential for growth opportunities set out in this report and others that it identifies over time. These industry networking efforts would typically need a facilitator that could be jointly supported through MTI and industry organizations. This can allow MTI to be agile in its industry consortium work, while acknowledging that while industry

[5] Mary Jo Waits, The Added Value of the Industry Cluster Approach to Economic Analysis, Strategy Development, and Service Delivery, *Economic Development Quarterly*, February 2000, page 47

organizations need to identify the efforts needed to move forward, they cannot always self-organize.

## Implications Focused on Strengthening Maine's Broader Innovation Ecosystem

### *Implication #4: Regional context matters.*

Many of the refined technology clusters within Maine's broad targeted technology areas are not strong in Maine and need to be connected to regional efforts for development. Where Maine is not a regional leader but is rather either a regional player or regional follower, simply trying to grow these technology clusters outside of the regional context will be difficult. Efforts to advance improved supply chains, talent development, and technology advancements outside of the broader New England states will not be as successful as looking to work on a multi-state basis. This does not necessarily mean having to create government-to-government collaborations. Instead, it is more about how to work across the industrial base found in New England. Regional approaches are also needed to address some of Maine's most difficult ecosystem challenges:

- Financing challenges, particularly for emerging biopharmaceutical and Information Technology services firms, where Maine is a regional player and regional follower, respectively, requires leveraging the private financial institutions that are more prevalent in other New England states . A more regional approach to engaging existing regional financial institutions to support the later stages of financing needs in Maine would greatly compliment MTI's efforts in early stage development and commercialization and is more realistic than Maine establishing its own private financial institutions.
- Entrepreneurial/C-level management talent is another opportunity area for Maine to tap the expertise found across New England. Interestingly, technology organizations in other states that are focused on growing start-up ventures have hit upon a strategy of rooting an emerging company's operations locally but bringing in experienced management talent from outside of the state to see the company through its later stages of development. This is now being done by the Louisiana Fund and the Virtual Incubator Company in Arkansas.
- Talent development may also offer opportunities. Many other New England states that are regional leaders or regional players in specific technology clusters have developed more advanced university programs and research capabilities. There is no reason not to seek ways to collaborate. This is already being done in Maine through its collaborations with the University of Massachusetts, Lowell's advanced materials programs. Universities, even public ones, do not see state boundaries as they advance industry partnerships. Creating collaborations through multi-institutional research institutes might be a way to also establish greater strengths in Maine's universities in areas that are lacking today.

### *Implication #5: The lack of emerging companies' ability to scale is a critical gap across Maine's innovation ecosystem which must be addressed.*

MTI has done an excellent job in its technology development efforts in generating "more shots on goal" through its early-stage investment and commercialization assistance efforts. This is critical to having an effective innovation ecosystem and must diligently be pursued.

Still, MTI may need to consider how to address, on its own or in partnership with other development organizations in the state, the critical factors holding back the ability of companies to scale. Noted from the stakeholder interviews and DECD survey of MTI-assisted companies were the following key factors holding back the ability of emerging technology companies to scale:

- Access to capital, particularly later stage venture capital ($750,000 to $5 million) and expansion capital for equipment
- Finding the right workers, which combines needs for both specific skills and experience
- Reaching markets.

Some of these issues can be addressed through regional New England approaches, but state efforts targeting incentives and programs to grow the talent base and focusing more on opening markets for targeted product markets are crucial. Together these implications can help guide the next generation of activities of MTI by reflecting the new economic realities facing the state, the line of sight to new growth opportunities, and the situation confronting its overall innovation ecosystem.