

Advanced to
Advantageous:
The Case for New
England's Manufacturing
Revolution



Executive Overview

For some, the mere mention of the term “manufacturing” evokes connotations rooted in prior decades – Dirty, Dark, Dangerous, and Declining. However, the advent of advanced manufacturing in the United States has firmly relegated this outdated alliteration regarding America’s backbone industry to the history books. Advanced manufacturing is not performed in a dingy setting, unskilled labor no longer provides the arms and legs for production, and value creation is no longer a pure low-cost input game: small-batching, highly precise components, customization and complex designs are pushing the need for more and better technology and a more highly skilled workforce.

In addition to the skills, innovation and technology elements described, advanced manufacturing relies on information, and this element makes the collaborative network that surrounds the industry of paramount importance. Advanced manufacturing as an industry is regionally advantaged by the depth and diversity of the collaborative network (or “cluster”) that surrounds it. New England’s cluster springs from a rich history dating back to its role as the birthplace of the Industrial Revolution in America; the heyday of the shipbuilding yards and textile mills may have waned, but the highly-skilled, advanced manufacturing networks that evolved from it are poised to have a dramatic impact on the economy in New England.

Emerging economics of production favor a knowledge-driven, networked economy, and as such, New England has carved out a favorable niche in several key sectors including: a) signal processing, navigation, optics and measurement, b) aerospace and defense, c) medical devices and biotechnology, d) semiconductors and complex electronics, and e) precision machining. Region-wide capabilities in software, artificial intelligence, robotics, and advanced materials further strengthen these core industry clusters, preparing New England to trail blaze the new technology frontier brought about by disruptive innovation and “game changer” technologies, including digital design and prototyping, additive manufacturing/3D printing, and the “Internet of Things.”

Despite the strength of the advanced manufacturing network in New England, the cluster is not without its challenges. In addition to the region’s comparatively high cost of doing business, New England faces a shortage of qualified labor to sustain growth, and advanced manufacturing in particular suffers from a lack of brand awareness that keeps talent at arm’s length from meaningful employment opportunities. Coupled with a generation of incumbent workers nearing retirement, the concerns over where to find and how to train the next generation of advanced manufacturing workers is reaching critical levels of need. Additionally, small and medium manufacturers (SMEs) struggle against market failures to scale effectively, innovate, and adopt emerging technologies at the rate demanded by their larger colleagues throughout the supply chain, and a complex and ever-changing business regulatory environment diverts resources from their highest and best use (growth) towards compliance activities. The cumulative effect of these challenges is to restrain overall productivity and growth across the region, keeping it below levels both desirable and attainable. However, within each of these challenges lies a latent opportunity to be harnessed, and across the region, numerous dedicated organizations have taken up the gauntlet and fashioned responsive and innovative programs, “islands of excellence” that can and should be scaled within the New England states and across the region as a whole.

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Based on the findings in this report, one might suggest that the aforementioned four “D’s” of manufacturing should be replaced by the four “A’s” of advanced manufacturing – Advanced, Advantaged, Added-Value, and Accelerating. As demonstrated in the analysis that follows, the implications of this paradigm shift for the New England region are myriad.

Study Objectives

The New England Council (NEC) commissioned a joint study with Deloitte in 2014 to examine industry growth in advanced manufacturing across New England. The objective of the study (which also serves as an update to the 2009 NEC and Deloitte report *Advanced Manufacturing in a Networked World: Prospects for a Resurgence in New England*) was to determine appropriate strategies and solutions to capitalize on and sustain growth in the advanced manufacturing sector by working with NEC members, local, regional and state governments, industry leaders, and other interested stakeholders to assess business capabilities, identify barriers to growth, and develop actionable recommendations to address growth challenges.

More specifically, the study was structured to:

- Provide a fact-based analysis of the New England advanced manufacturing industry cluster using primary and secondary data
- Update and refresh the cluster data analysis presented in the 2009 report
- Examine industry growth patterns and emerging or disruptive innovations within the industry
- Complete an analysis of stakeholder needs and concerns by conducting a series of interviews and workshops with manufacturers, educational institutions, state / local / regional government officials focused on economic development, workforce development and education, nonprofit industry and economy advocacy groups, and other interested parties
- Articulate common challenges to industry growth, along with complementary opportunities to address them
- Formulate actionable recommendations for public and private sector stakeholders to collaborate with one another in efforts to drive growth
- Raise the profile of advanced manufacturing in New England

Approach

Similar to the approach employed for the 2009 study, a detailed analysis of primary and secondary data was conducted to build a comprehensive picture of industry and labor trends in New England’s advanced manufacturing industry. Data from the U.S. Census Bureau, the Bureau of Labor Statistics, and the Bureau of Economic Analysis, as well as publicly available sources from state agencies and industry organizations were analyzed to determine baselines, detect industry trends, and identify advantaged industry subsectors poised for growth. This data analysis was supplemented with findings collected during interviews and workshops with individuals representing private and public sector interests. Together, quantitative analysis and qualitative review were used to develop insights into barriers to success and opportunities for growth in advanced manufacturing. This combined approach facilitated the development of recommended action steps to spur growth and raise the profile of advanced manufacturing across New England.

To gain a clear understanding of the competitive business environment across the region, the study examined each state’s economy. From a macroeconomic level, location quotients — the percentage of jobs provided by a particular industry in a selected region as compared to the nationwide percentage of jobs in that same sector — were used to identify the advanced manufacturing subsectors that were particularly well-represented in the region. These calculations were combined with an analysis of productivity data to pinpoint subsectors with the potential for economic growth. The team also conducted a microeconomic review of industry clusters that exist to support growing subsectors in the region, as well as capability clusters that overlay all industry sub-sectors and enhance the region’s competitiveness. In addition to identifying industry and capability clusters, the team identified emerging disruptive technologies, or “game changers,” that are poised to radically alter the way in which advanced manufacturing firms operate.

After industry subsectors were analyzed and disruptive technologies identified, the team assessed both the core drivers and barriers to advanced manufacturing growth in the region. These issues included education, workforce development,

economic development, business regulation, cross-sector collaboration and industry branding. To validate initial findings and enhance analysis, the study team held interactive workshops and 1-on-1 interviews with policymakers, economists, educators, business advocacy groups, and industry leaders. Through these discussions, the diverse group of stakeholders discussed the region's manufacturing environment and identified key issues that the manufacturers were facing, as well as initiatives that had sprung up to address them.

The final phase of the study focused on developing recommendations for the region to create an actionable economic development strategy to improve New England's competitiveness in advanced manufacturing, increasing the region's ability to grow, retain, and attract firms within the region. These findings and recommendations were based on both the quantitative analysis of available data, qualitative review of information provided by industry stakeholders, and analysis of leading practices nationwide.

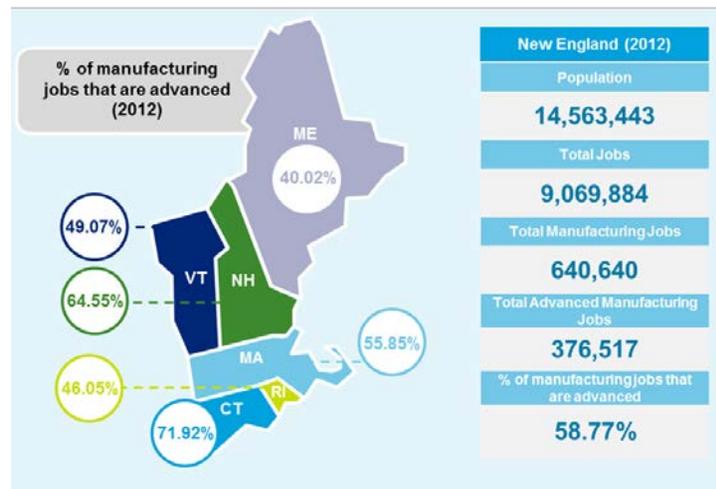
Key Findings

1. Where We Are Now: Manufacturing in the New England Region

- New England as a region enjoys a competitively advantaged position with respect to advanced manufacturing, stemming from an intricate network of cross-sector relationships (industry, government, and education) that have evolved over time.
- Advanced manufacturing operates in a complex network of suppliers, skill sets, and innovators. Within the region there exists a high concentration of both industry clusters and capabilities clusters that support the various industries.

- Despite the difficulties of the recession, advanced manufacturing has proven to be resilient sector of the economy. The industry has been able to return to, and in some cases surpass, pre-recession levels for shipment value, GDP, and employment while traditional manufacturing has struggled to rebound.

- The emerging economics of advanced manufacturing further favor New England in that the industry has shifted to that one operates on networks of innovative firms interacting to advance design and production methods and tools while creating quantum leaps in productivity. In this manner, New England's industry is able to ameliorate the high cost of business within the region with the value added by leading research institutions, a sought-after talent pool, and a supportive community of innovators co-located with operations.



Source: Bureau of Economic Analysis (2012); U.S. Census Bureau; Deloitte Analysis

- Further, location quotient analysis identified several competitively advantaged industry sub-sectors of advanced manufacturing in the New England region. These "industry clusters" have a high concentration of firms and employees relative to the general economy, and include:
 - **Signal processing, navigation, optics, measurement**
 - **Aerospace and defense**
 - **Medical devices and biotechnology**
 - **Semiconductors and complex electronics**
 - **Precision machining**
- In addition to specific industry clusters, New England possesses an umbrella of industry-agnostic "capability clusters" in software and artificial intelligence, sensors and automation, and advanced materials. These differentiate

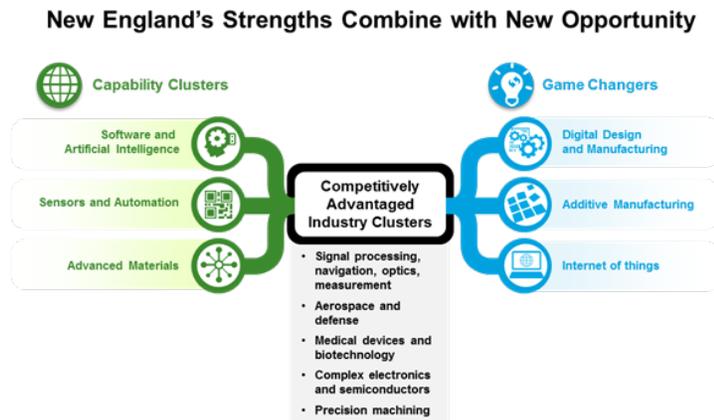
the region in terms of competitiveness and also bolster the firms within industry clusters to further innovate and advance their product.

- Taken together, there is a significant advantage for New England's industry; however, the future is not without its challenges. The region still maintains a sizeable advantage in advanced manufacturing GDP per capita compared to the rest of the country, but the gap is not quite as big as it used to be. Employment and GDP have both rebounded following the recession but recently have begun to stagnate. The obstacles are far from insurmountable; they are, however, very real.

2. Where We Are Going: Game Changers – ‘faster, better, smarter’

The rapidly accelerating rate of technological innovation is changing the environment in which advanced manufacturing exists today. Three disruptive technologies have emerged that break traditional economic tradeoffs within the manufacturing economy. These “game changers” include: a) digital design and prototyping, b) additive manufacturing, and c) the “Internet of Things” (IoT).

- **Digital design and prototyping** employs advanced software and collaboration tools to allow global manufacturing teams to collaborate remotely on a virtual product before a prototype even exists, significantly reducing time to market, as well as the cost of iterative failure and refinement of product prototyping and development.
- **Additive manufacturing** (also known as 3D printing) liberates production from a traditional mold, model, or dye, and provides seemingly infinite combinations of complexity and variability of product design and construction for an array of commercial applications.
- **The Internet of Things (IoT)**, a disruptive concept with applications well beyond advanced manufacturing, will likely alter the relationship that manufacturers and consumers have with their products and machines. More than just data connections between machines, IoT is about the ability to have cheap and tiny sensors that collect information, share that information with other machines and turn information into action, gathering data along the way that can be used to improve product performance.



Game changers represent a new frontier of productivity and possibility for New England's advanced manufacturers. They are both enabled by the region's industry and capability clusters while strengthening them and opening up new markets for the region. The primary challenge for advanced manufacturers will be how they prepare to seize the opportunities that disruptive technologies represent.

3. How We Get There: Seizing the Opportunity

Through the course of our research and discussions we have identified five categories of challenge that are inhibiting advanced manufacturing as an industry from achieving anticipated growth, and at the extreme end, may be costing the region in terms of competitiveness.

- **Education and the skills gap:** There exists today both a dearth of skilled workers qualified to work in manufacturing, as well as an under-skilled labor pool to fill available job vacancies within advanced manufacturing. The aging of the incumbent workforce has brought the need for skilled talent to crisis levels within the industry.

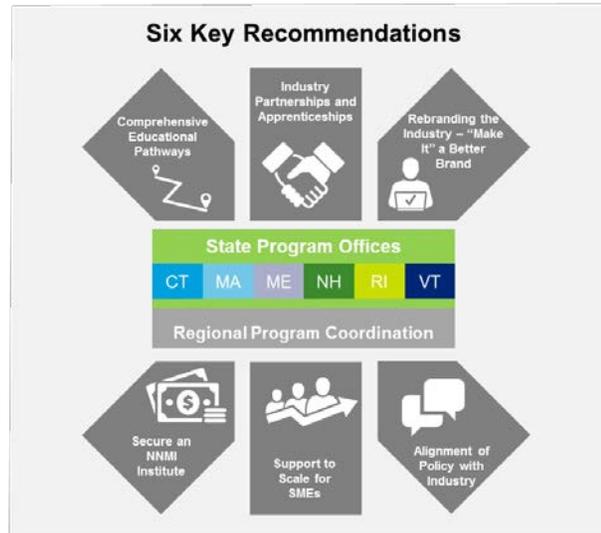
- **SME challenges to scale:** Small and medium-sized enterprises (SMEs) suffer challenges to technology transfer, talent recruitment, and access to innovation tools given their size and constrained bandwidth. These challenges exert a negative influence on the overall industry given SMEs' role in the advanced manufacturing supply chain.
- **Alignment of policy to industry:** Existing programs (most federally funded) may not have the flexibility to meet the needs of advanced manufacturers in a manner that is timely or user-friendly. Many "islands of excellence" exist to meet targeted training and technical assistance needs, but they alone can't scale to meet the demand for services that is present within the manufacturing ecosystem. R&D tax credits and training funds, although beneficial to larger, established companies, are less applicable to smaller, startup advanced manufacturers.
- **Complex regulatory environment:** More than tax incentives or direct investment by the government, companies expressed a desire to make business regulatory environment more clear, reliable, and predictable during our interviews. Most companies understand the need for government regulation of business, but the complexity of regs and timing for compliance force many to employ separate staff to analyze and process regulatory documentation.
- **High cost of doing business:** High-priced inputs (energy) as well as aging infrastructure (roads, bridges, ports) and tax policies across New England drive up the cost of doing business, and many companies within the region are persistently approached by "lower cost" states with comprehensive business attraction and relocation packages.

Embedded in each of these challenges are a number of related opportunities. The further success of the advanced manufacturing sector will likely depend on a focused and collaborative approach between the private, public, and education stakeholders within the new regional innovation framework.

4. An Action Plan for New England

Through the course of our research and discussions, we have identified six areas of opportunity that, if fully shared and applied across the region, could differentiate New England and serve as accelerators for advanced manufacturing growth:

- **Creating comprehensive educational pathways:** A fully connected system for students beginning in high school through a variety of higher educational institutions, technical education, vocational education, training and even internships and work experience. Credit is fully integrated and connected through all levels on the pathway.
- **Increasing industry partnerships and apprenticeships:** Creating connections implemented and strongly reinforced between industry and educational institutions so that students are not only workforce ready, but new ideas from students permeate the industry, spurring innovation. Reinforce career progression and employee retention through paid internships and apprentice models which earn pay and college credit, leveraging funds available from state and federal grants.
- **Rebranding the industry – "Make It" a better brand:** Moving away from the old view of manufacturing by changing the language we use for it – by calling it the "Maker Revolution" we change the brand of "advanced manufacturing" to reflect the high pay, critical thinking, advanced technologies and designs that define it. Support intake of interested students by helping them enroll in the programs that will support their success in advanced manufacturing.
- **Secure a National Network for Manufacturing Innovation (NNMI) Institute:** Successfully pursuing a future round of Revitalize American Manufacturing and Innovation (RAMI) Act funding to make New England one of the 45 NNMI advanced manufacturing centers in the U.S.



- **Support to scale for SMEs:** Vital to the growth of the maker generation are new ideas and the ability of those small enterprises to come to scale. Entrepreneurs and SMEs require programs/support to allow them to develop and scale, as well as R&D incentives that are accessible small and medium-sized startup businesses as well as IP protection and technical assistance to protect their entrepreneurial investment.
- **Alignment of policy to the needs of industry:** Through collaborative dialogue between industry and government, align existing programs to the areas of greatest industry need and examine ways to improve flexibility of use, ease of access, and increased utility to businesses who utilize them. Using industry's input and requirements, steer emerging policy development towards creative and flexible programs and funding that reduce the cost of doing business, streamline regulatory complexity, and support growth in advanced manufacturing for manufacturers of all sizes.

To achieve maximum effectiveness for the New England region, these recommendations must be implemented in a thoughtful, coordinated manner that minimizes duplication of effort, reflects a regional approach, and leverages the leading implementation practices from each state to the benefit of all. Through the creation of a governance structure such as a regional council of state program management offices (PMO) for advanced manufacturing, the six New England states can work collectively to achieve greater outcomes than each state could acting in parallel.

Conclusion

A coordinated effort across a broad range of stakeholders – industry, government, educational institutions, and others – is necessary to take full advantage of the opportunity to grow. This coordinated approach, has helped stimulate growth in other regions across the country and it can work for New England.

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