

PROJECT SUMMARY

BIC MANUFACTURING ACADEMY

LEAD: BERKSHIRE INNOVATION CENTER (BIC)

PARTNERS: MIT INITIATIVE FOR KNOWLEDGE AND INNOVATION IN MANUFACTURING (MIT IKIM), BERKSHIRE COMMUNITY COLLEGE (BCC), GENERAL DYNAMICS (GD)

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SUMMARY PROPOSAL

Policymakers at the state and federal levels have expressed similar goals: to build regional manufacturing ecosystems from the ground up, responding to regional demand and building on the strengths of existing state programs and federal Manufacturing Innovation Institutes. We propose a BIC Manufacturing Academy to serve as the hub of an improved regional manufacturing ecosystem in Western Massachusetts. The Academy will be an industry-led training collaborative among manufacturers in Berkshire County, housed at and managed by the Berkshire Innovation Center (BIC).

The mission of the Academy will be to address persistent challenges facing the manufacturing economy in the Berkshire region by closing the gap between local supply chain capabilities and the needs of larger manufacturers through ongoing education, training, and technology assistance.

MIT research confirms that firms improve their sustainability by acquiring advanced technologies which improve processes and efficiencies, and then training their workers to operate and manage them. Following this model, the Academy will support firms in understanding, acquiring, and integrating new production technologies, and support the regional workforce by developing the foundational and advanced technology skills to meet employers' needs.

The Academy will be shaped by research informing how to build a regional manufacturing ecosystem. Academy programming will include (1) technology bootcamps for manufacturing leaders to identify new opportunities for technology adoption, (2) a regional apprenticeship program among participating companies based on curricula jointly developed with MIT, (3) a shared pool of online training content, and (4) demonstration projects, which will allow participants to engage in applied manufacturing projects that incorporate new technologies.

The Berkshire Innovation Center will host and manage the Academy. MIT's Initiative for Knowledge and Innovation in Manufacturing and the BIC's local academic partners will develop curricula and provide training expertise. General Dynamics will be the lead industry partner.

The objective is to build a sustainable program in the Berkshires to strengthen and solidify the regional manufacturing ecosystem. The Academy could also serve as a model for related efforts elsewhere in Massachusetts and nationally.

CHALLENGES TO ADDRESS

Manufacturers in the Berkshires and across the United States report that they have opportunities for growth, but they have difficulty hiring the talent they need to expand. In more than 30 interviews with U.S. manufacturers of varying sizes, firm executives identified three challenges that a BIC Manufacturing Academy has the potential to address.

First, U.S. manufacturers face a shrinking talent pool of experienced manufacturing technicians. To adapt, many firms report hiring entry-level workers with minimal skill or experience and **providing years of on-the-job training to transform inexperienced workers into skilled machinists, welders, or multipurpose technicians.** The training that firms offer is frequently informal and inefficient. This approach to training forces the most experienced technicians to balance time between doing their jobs and teaching their junior colleagues. Firms are frequently critical of their own training programs; after all, they are not education specialists, and if they invest heavily in training their workers, then they risk losing their investment to firms that poach their most skilled workers.

Second, **gaps between large and small manufacturers in technology and skills hold the whole supply chain back.** On average, small supplier firms in the U.S. are far less productive and less technologically advanced than large OEMs. This creates problems for manufacturing supply chains, particularly those serving defense industries that must source materials domestically. The challenge is frequently that large firms want to improve the technological sophistication of their products, but their domestic suppliers do not have the resources, production experience, or the capacity to keep up. The gap between OEMs and suppliers is particularly wide because production workers have long tenures and do not often transfer knowledge from firm to firm.

Third, manufacturers consistently point out that the work they do is not “their grandfather’s manufacturing.” Factory jobs today are clean, technology-intensive, and more worker-friendly than the dirty and dangerous production work of the past. However, **manufacturing executives lament that young people are largely uninterested in manufacturing careers.** They point to high schools and community colleges in their communities dropping required shop classes and pushing students toward a four-year degree.

REGIONAL PAIN POINTS

Since the decline of U.S. manufacturing employment beginning in 1979, Western Massachusetts – like many regions stretching from Massachusetts to Minnesota - have struggled to generate new economic activity to replace declining legacy sectors. The Berkshires were for decades home to manufacturers with plastics expertise. The region also neighbors the Pioneer Valley, which has been a source of manufacturing innovation dating back to the early 19th Century. However, high-paying job opportunities and manufacturing wages in the region have stagnated for the past several decades.

The largest manufacturer that remains in the region is General Dynamics, which has a plant in Pittsfield, as well as several other facilities throughout New England. The General Dynamics site

in Pittsfield, MA has more than a decade of guaranteed orders to fill, but the firm and many of its suppliers are struggling with an aging workforce and an inadequate pipeline of new workers to fill needed positions. Despite attempts with local educational institutions to build a local pipeline of talent, the problem persists.

General Dynamics also struggles to find suppliers with the capabilities that they cannot meet in-house. General Dynamics leadership reports that machine shops in Western Massachusetts cannot make parts to the specifications that they need. General Dynamics does not view the materials they use or the precision they need as extraordinary, but nonetheless they have failed to find a reliable supplier base in Massachusetts. There are several potential explanations:

- a. Suppliers do not know how to get their foot in the door. When single-day supplier events have been held, interest and turnout is high, but without sustained follow-up the impact has been limited.
- b. Suppliers are hesitant to risk investing in new equipment to upgrade their capabilities. Local manufacturer Sinicon Plastics reported that they had made big investments in an affiliated machine shop, but they said that this investment was the exception – not the rule.
- c. Suppliers have concerns about the regulations and paperwork required to be a DoD supplier. This concern could affect some cases, but MIT research indicates that approximately 40% of SME manufacturers in Massachusetts have some DoD contract.

The BIC Manufacturing Academy has the potential to address these challenges facing General Dynamics, but it is not an Academy *for* GD. Instead, it is aimed at supporting the growth and flexibility of the regional manufacturing ecosystem as a whole. Since General Dynamics is such an integral part of that ecosystem, the firm's specific challenges will play an appropriate role in the BIC Manufacturing Academy's work.

PROMISING MODELS

MIT research has identified several promising examples of organizations and partnerships that have begun to address these challenges. In simple terms, we think of these examples as models on which future programs can build.

Regional cooperative model. In Northeast Ohio, the Alliance for Working Together (AWT) was established as a cooperative venture between local firms facing similar workforce challenges. Together, a group of firms pooled resources to build an apprenticeship program for incumbent workers. Each participating firm selected promising technicians to become apprentices, attending a weekly class led by a local manufacturing executive with workers from other firms. Firms recognized that their workers might learn from one another in a more structured environment than they could provide as individual organizations.

Prime-led model. One model of distributing knowledge and skills through a supply chain comes from large firms with leverage over a network of firms (e.g. a particular supply chain). A current partnership between Oak Ridge National Laboratory’s Manufacturing Demonstration Facility and MSC Industrial has used the network of metalworking experts at MSC to train factories on how to make the best use of their metalworking equipment with the goal of developing new expertise at manufacturers and improving productivity. This public-private partnership – supported by the Department of Energy – demonstrates the promise of a large firm with a distributed network of partners to diffuse knowledge and training. There is potential to draw on this model for a program where a prime defense contractor like General Dynamics helps create knowledge and training for its own workforce as well as for firms in its supply chain.

Technology commons model. The Fraunhofer Academy in Germany aims to provide expert-level training for leaders within manufacturing firms to update their knowledge and improve their firms’ capabilities. When new machining or robotic technologies are released, a foreman or cell leader might pursue relevant continuing education at a Fraunhofer Academy. For example, the Academy currently offers a cybersecurity training lab that offers background in IT security and its relevance for firms integrating digital manufacturing practices.

State support model. The Commonwealth of Massachusetts through the Massachusetts Technology Collaborative (MassTech) has several programs aimed to address challenges like these. The Massachusetts Manufacturing Innovation Initiative (M2I2) capital grant program makes it easier for firms and educational institutions to acquire new capital equipment through cost-sharing. However, no M2I2 capital grants have been distributed to manufacturers in Berkshire County, and only two M2I2 grants have been distributed to firms in the three westernmost counties of the state. One possibility for this gap is that SME manufacturers in Berkshire County do not fit the profile of typical M2I2 grantees, which might also receive support from SBIR grants and must meet substantial requirements to apply for funds. MassTech has supported the establishment of the Berkshire Innovation Center, which represents an opportunity to build the capacity of manufacturers in Berkshire County and the surrounding region.

THE BIC ACADEMY PROGRAM

Drawing on these examples, we propose a program that combines these models by deploying technology bootcamps for senior manufacturing leaders with the goal of improving their technological capabilities, supporting the development of a regional apprenticeship program, and online curricula developed with input from GD – all under the banner of a BIC Manufacturing Academy. This program will inform industry leaders on new technologies and practical applications for those technologies, demonstrate the returns of technology acquisition, and facilitate training and regional cooperation so that participating organizations might identify ongoing and worthwhile investments in workforce development.

We envision the program rolling out in three phases: coalition-building, development, and implementation.

1. **Coalition-building:** We have already begun convening and directing a coalition of regional manufacturers and supporting institutions. We know that thriving ecosystems depend on coalitions of actors, which typically include non-profits, educational institutions, and large and small firms across sectors (e.g. manufacturers, R&D firms, banks). MIT’s ongoing research on developing a “regional playbook” offers examples of thriving ecosystems that can serve as models for what Berkshire County might build. MIT research would suggest a process for coalition-building based on the success that other regions have experienced.

The coalition-building process will continue to identify shared priorities, such as technology acquisition and workforce training. Concrete goals for critical next steps include: helping firms – or consortia of firms – develop applications for M2I2 capital grants to share the costs of new equipment purchases; building R&D partnerships relevant to regional strengths that might qualify for state support; mapping skills and developing curricula that meet the needs of regional firms. This process will also identify particular technologies or sectors where coalition members aim to invest and built capabilities.

BIC will convene this process, with support from GD. MIT will work with firms on skill mapping and developing training curricula. MassTech will monitor and advise the process to identify opportunities to scale coalition activities with available funding. Examples from other cases can inform how exactly to approach coalition-building, which might include holding workshops where firms share their capabilities and challenges or bootcamps, where Berkshire actors learn about how other regions have dealt with similar challenges.

2. **Development:** As the coalition-building process among local manufacturers and educational institutions unfolds, we will begin the workforce development programs. We will engage a select number of small and medium manufacturers in the region that have recently acquired new technologies – along with General Dynamics – to jointly develop a shared apprenticeship curriculum that addresses overlapping needs between regional employers. The apprenticeship exercise would require ongoing communication with employers to understand the successes and missteps of the program – as well as the tangible impact that they see from their apprentices on the factory floor. This data collection will inform how the program evolves with subsequent cohorts. It will also be useful evidence for attracting future partners to scale the program and make it sustainable. During the course of the initial apprenticeship exercise, which will last approximately one academic year, our aim is to train one cohort of approximately 20 production workers.

BIC will manage the apprenticeship program in partnership with local educational institutions. MIT IKIM will work with the local coalition on curriculum design and development, as well as assist in distilling the lessons from the one-year experiment.

3. **Implementation** Building on lessons from our technology-focused coalition-building activities, as well as our workforce-focused experimentation, the fully integrated BIC

Manufacturing Academy will support regional manufacturers in acquiring and integrating new technologies, *and* train production workers and those manufacturers to make the most use of those technologies. The program will feature technology workshops at the BIC facility, as well as a larger cohort of manufacturing apprentices in the region who are trained to understand new manufacturing technologies in general, as well as the needs of regional manufacturers more specifically.

BIC will lead and host the technology workshops and continue to work with local educational institutions to manage the shared apprenticeship program. MIT IKIM will advise on the subject matter of the technology workshops, as well as on the scale-up of the regional manufacturing program.

ROLES FOR PROGRAM PARTNERS

The project will require an ongoing collaboration between the BIC, MIT IKIM, regional organizations including General Dynamics, BCC, and MassTech. The contributions of major partners in the program will include:

THE BIC

- Manage the budget and reporting requirements of the program
- Operations team to lead coalition-building phase
 - Identify potential coalition members in partnership with General Dynamics and MassTech
 - Convene regional leaders to discuss assessment and develop plan for building a regional manufacturing ecosystem
 - Maintain ongoing communication with coalition members about priorities and potential programming
 - Publish strategy for manufacturing ecosystem that lays out coalition commitments and benchmarks for coalition programming
- Operations and community team to partner with MIT on training programming
 - Host in-person training
 - Recruit companies and individuals to participate in programming, such as classes and workshops
 - Work with companies to apply for and use M2I2 funds, as well as other sources of funding for new equipment and product development (e.g. SBIR)
 - Work with MIT researchers and coalition partners to share data and perform evaluations of the pilot program's progress
 - Maintain ongoing communication with partners through meetings and surveys to assess whether programming is on the right track

MIT IKIM

- Provide research insights from Regional Manufacturing Playbook project
- Develop agendas for “coalition-building” convenings and advise BIC personnel on best practices

- MIT training lead works with BIC and coalition partners to identify shared training interests, including:
 - Developing curricula and training materials in response to coalition priorities
 - Advising on firm-led training modules and curriculum development
 - Designing in-person and online training modules that meet the needs of regional coalition members
 - Training in-person teachers and coaches to conduct workforce education programming at BIC

GENERAL DYNAMICS

- Identify the characteristics of companies and other organizations that would be productive members of a regional coalition focused on training and technology development
- Send senior representatives to coalition-building meetings to help lead discussions on training and technology standards in regional manufacturing
- Provide input on training curricula and subject matter experts for technology bootcamps
- Enlist senior General Dynamics personnel to help lead trainings and share expertise with coalition members

THE MASSACHUSETTS TECHNOLOGY COLLABORATIVE

- Identify potential coalition members in Western Massachusetts manufacturing community
- Provide input on Assessment of challenges facing Massachusetts manufacturers
- Advise coalition members on opportunities for state funding (e.g. M2I2, R&D funds) to improve their technological and workforce capabilities
- Consider coalition member proposals for capital equipment cost-share with the understanding that the BIC Manufacturing Academy will support firms in training workers to operate and integrate the technology on the shop floor.
- Monitor programming content to ensure regional coalition goals align with Commonwealth's overall manufacturing priorities
- Use lessons and best practices to apply to other regions of the Commonwealth

PROGRAMMING

Detailed programming will reflect the coalition's interests, as well as the best practices from other regions. Several areas will be explored:

Regional apprenticeship program. The BIC Academy will develop and manage a regional apprenticeship program for incumbent workers from non-competitive manufacturers in Central and Western Massachusetts. The program will recruit cohorts of 20-30 apprentices from firms involved in the BIC to complete one year of coursework. Firms will be asked to identify junior technicians with an Associate's degree or below and less than 3 years' experience on the job to join the apprenticeship program. The goal will be to provide these technicians with the skills to become fully self-sufficient on the job, as well as to develop the capabilities to move into more senior roles within their firm.

Based on the apprenticeship model developed at AWT in Ohio, BIC Academy apprentices will attend evening classes with instructors that the Academy will recruit from participating firms. Ideal instructors will be leaders of local manufacturing firms with an interest in workforce development and an understanding of the most advanced manufacturing practices. BIC Academy will work with these instructors, as well as participating firms and Berkshire Community College, to establish a standard curriculum for apprentices.

The curriculum will include in-person training with instructors reviewing new production technologies and techniques, as well as online course materials that the BIC Academy has assembled in coordination from MIT IKIM. The online course materials will draw from original course material for technicians (discussed below), as well as from the growing library of online courses associated with MIT's EdX platform.

In addition to following a pre-arranged curriculum, apprentices will also have opportunities to discuss problems they have encountered on the job with their peers from other firms, as well as with instructors who have decades of experience with similar challenges. A monthly workshop for apprentices will allow instructors to walk through how to solve real-world problems that the apprentices have encountered as part of their work. The Academy will also arrange small groups of apprentices with career coaches who talk through their desired career path and what steps will be necessary for achieving it.

The apprenticeship program will also facilitate factory tours for apprentices to see the workspaces of their peers. One of the challenges facing SME manufacturers and their employees is that there is limited information sharing among firms. If firms have different equipment or an alternative way of organizing production, there are rarely channels for firms to learn from one another and innovate. To facilitate open dialogue among apprentices and information sharing between firms – such as invited factory tours – we will recruit apprentice cohorts from SMEs that are not competitive with one another.

In partnership with MIT IKIM, BIC Academy will study the outcomes of the apprenticeship program through surveys and data-sharing. The Academy will measure the productivity of apprentices before and after their instruction. We will also survey apprentices and managers to understand the core lessons that apprentices gained from the program, as well as what managers saw as the benefits and drawbacks of apprentices participating.

The BIC Academy will support two cohorts of regional apprentices between September 2022 and December 2023. Our goal through these first two cohorts is to establish a sustainable model whereby regional companies see the value in the program and help subsidize the cost of future apprentices to join the program. As the program grows, it will be designed so tuition costs for incumbent workers could be subsidized by the Massachusetts Workforce Development Fund.

Online curriculum development. The BIC Academy will partner with MIT IKIM to develop online training materials targeted at technicians at manufacturing firms associated with the BIC. The Academy will solicit ideas for online training modules from firms associated with the BIC,

as well as regional community colleges and vocational high schools. It will identify which modules to develop based on the breadth of regional interest, as well as the ability of existing online training content to meet that need. The Academy will focus on creating original content where there is a strong regional need without existing online training material available. The Academy will share original content with partner firms and community colleges. Where applicable, the Academy will plan to publish original content on an Open EdX platform, making it publicly available.

In addition to original course content, the Academy – with input from MIT – will also help firms and local community colleges identify existing online training content for firms associated with the BIC depending on their training needs. The purpose of identifying and sharing online training content is to complement – not replace – in-person instruction. Indeed, the Academy would aim to development local trainers to help ensure students are properly supported to ensure the effectiveness of the online train

There are three key workforce education challenges that the addition of online training content can address:

1. **Protecting senior technicians' time:** one issue for SME manufacturers is that teaching a junior technician new skills requires a significant investment of time from a senior team member. Online modules – developed with input from the senior team member, who might record their tutorial on a particular machine or process – can save the senior team member time and deliver the same information to a junior technician learning the ropes.
2. **Refreshing forgotten skills:** learning requires repetition, but in many SME factories with a high mix of products, a technician might encounter one problem or task only once per month or less. If a junior (or even a more seasoned) technician needs to revisit how to perform this task, an online module that they can watch on their phone could help ensure that there is minimal downtime on the factory floor.
3. **Learning new techniques:** when technicians are open to learning from online course materials, which they can consume at work or at home, they have access to knowledge about production technologies and techniques that their firms might not already employ. Accessing online content that the Academy will highlight could enable technicians and others to bring new ideas into their firms.

The Academy envisions original online content in several areas, including online course modules to complement in-person apprenticeship instruction; online “best practice” modules that GD would like to share with current and prospective suppliers; and online “standards” modules that the Academy develops in partnership with DoD and MassTech to identify the evolving regulatory standards facing manufacturers, as well as the resources that firms have available to comply.

Technology bootcamps and demonstration projects. Regional cooperation around workforce development will be most effective if regional firms are aware of the same “best practices,” which lead them to invest in similar technological capabilities and recruit for similar skills. The

Academy will promote best practices through technology bootcamps and demonstration projects. Technology bootcamps will illustrate for regional firms the potential of new production technologies and how they might be applied in reality.

The Academy's bootcamps will be half-day sessions targeted at employees across the firm – managers, engineers, and technicians. Participants in the bootcamp will learn about a particular technology through a technical review from an industry expert as well as case studies of firms that have deployed the technology successfully. For example, a bootcamp focused on robotics would begin with a review of the variety of industrial robot applications, as well as new developments in robotic technologies. It would continue with case studies of regional firms that have adopted robotic technologies, including the challenges they faced in deploying them and the benefits that they have seen.

The purpose of a bootcamp is to show firms what the technology can do, as well as how firms like the ones that are represented at the workshop can use the technology in practice to help their business. The bootcamps are intended to be a hands-on trade show for regional firms. In addition to introducing regional firms to new technologies, the bootcamps can highlight success stories from within the region, allowing firms to highlight the effectiveness of the technological investments that they have made.

Demonstration projects will involve mini-deployments of a particular technology to illustrate how it can be used. The Academy will partner with a company – typically the supplier of a particular technology – to set up a sample cell within the BIC over a period of time to demonstrate the use of a particular piece of equipment or software system. In the industrial robot example, there would be a collaborative robot at the BIC that could be reconfigured to perform various small tasks of relevance to regional firms.

The demonstration project at the BIC complements the time-limited technology bootcamp because it allows employees at regional firms to see the technology in action at their convenience. These demonstration projects have been used elsewhere to demonstrate the potential of particular manufacturing technologies. The manufacturing innovation institute MxD in Chicago has featured production technology from Siemens in the past in their facility.

Demonstration projects can also contribute to the Academy's workforce education programming. As apprentices learn about new equipment and software systems, they can also interact with technology suppliers and see demonstration projects that introduce them to the cutting edge of manufacturing technology.

SUSTAINABILITY PLAN

The objective of the pilot will be to begin programs that can continue sustainably in the years after the initial programs are completed. There will be three keys to sustainability:

1. Engaging community training partners: MIT IKIM will provide training expertise and support the development of online curriculum for firms in the region during the course of the launch of the program. Once the program is fully launched, the online material will

be in the hands of educators in the region at places like Berkshire Community College and McCann Technical High School. For the programs to be sustainable, these partners will need to be trained and engaged during the first two years.

2. Cost effective for coalition members: the pilot is an opportunity to convince GD and SMEs in the region that technology upgrading and joint training is worth it. If the pilot proves that the programs can pay off for firms by saving them money on training or making them money on productivity gains, then partners will have the incentive to continue investing in joint programs through the BIC.
3. Continued monitoring from BIC and MassTech: even if the pilot builds a coalition and demonstrates advantages to technology and training, we cannot expect the programming to continue on auto-pilot. BIC and MassTech have an ongoing role in gathering data on program effectiveness and holding coalition members accountable to their commitments to the group's shared goals.