Establishing the Richmond Region as a Leader in the Revitalization of Advanced Manufacturing in the United States

Report to Richmond’s Future

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1. Executive Summary

The United States has lost more than six million manufacturing jobs over the past decade [2]. Many of the losses have been in labor-intensive manufacturing fields where the United States cannot compete with labor rates found in other parts of the world. Labor-intensive manufacturing is unlikely to return to the United States in any meaningful way. However, the United States has maintained a leadership position in advanced manufacturing and is capable of growth, including a return of advanced manufacturing jobs from other nations.

Advanced manufacturing makes significant use of automation and information technology to meet the requirements of complex components and systems. The evolution of the advanced manufacturing industry will require continued creation of new technology and the development of more efficient manufacturing systems that take advantage of novel materials and processes to create better, less costly, and increasingly complex products. Automation technology generally results in fewer jobs being needed to produce products, but the resulting jobs require a much higher skill set than does labor-intensive manufacturing. Automation lowers the labor costs as a percentage of the total product cost thus making the labor cost less of a factor in the decision to locate factories. However, automated manufacturing equipment can be placed anywhere in the world, so automation actually increases the global competition for advanced manufacturing jobs.

The growth opportunity in advanced manufacturing is dependent upon important investments being made to attract those jobs. The winners in this global competition will be those regions that can provide: (1) availability of a skilled, productive, and dependable workforce, (2) access to new technological developments and ease of transitioning those developments into commercial practice, (3) easy and cost effective product delivery to customers, (4) easily available and cost effective logistics support for the overall markets being served, (5) access to dependable and cost effective suppliers, and (6) effective governmental policies such as taxation and export control.

The Richmond Region is well positioned to be a leader in the growth of advanced manufacturing in the United States. The Region enjoys what many argue is unequaled geography with easy access to transportation networks of all types and the ability to deliver goods and services quickly to a majority of the United States population. The Region is also home to the Advanced Manufacturing Innovation Zone (AMIZ), including the Commonwealth Center for Advanced Manufacturing (CCAM). CCAM’s vision is to be a global leader in advanced manufacturing applied research and development. AMIZ is an innovative public-private partnership that can be the nexus of the growth in advanced manufacturing throughout the Commonwealth. Also rapidly evolving and important is the Commonwealth Center for Applied Logistics Systems (CCALS).

This report recommends several investments as needed for the Richmond Region to garner a global leadership role in advanced manufacturing and to ensure the success of the Region in this critical area. The recommendations are listed here and are thoroughly explained in this report:

1. Integrate Virginia Commonwealth University (VCU) into CCAM and CCALS.
2. Engage the appropriate Richmond Region’s companies in CCAM and CCALS.
3. Create a jet engine test facility at the AMIZ to spur research and industry growth.
4. Implement the workforce development program presented in this report.
5. Create an advanced manufacturing workforce academy as part of the AMIZ.
6. Create a Governor’s School for advanced manufacturing as part of the AMIZ.
7. Create the Advanced Logistics Innovation Zone (ALIZ) around CCALS.
8. Create a network of CCAM-like centers with each focused on a different industry sector.

These actions will position the Region to become a global leader in advanced manufacturing.
2. Introduction

A simple Internet search on the term “advanced manufacturing” produces more than 24 million results. The popularity of the term has soared in recent years. It has become commonplace to speak of advanced manufacturing as very different from the manufacturing of prior decades and as a more desirable driver in our new world economy, and it is. However, a deeper study finds that there is no single, widely accepted definition of the term “advanced manufacturing”. Paul Fowler of the National Council of Advanced Manufacturing (NACAM) states that “the advanced manufacturing entity makes extensive use of computer, high precision, and information technologies integrated with a high performance workforce in a production system capable of furnishing a heterogeneous mix of products in small or large volumes with both the efficiency of mass production and the flexibility of custom manufacturing in order to respond quickly to customer demands.” This definition has been quoted extensively and most recently used in the “Report to the President on Ensuring American Leadership in Advanced Manufacturing” prepared by the President’s Council of Advisors on Science and Technology (PCAST) [1].

Perhaps in somewhat simpler terms “advanced manufacturing” is the integration of technology, processes, policies, and people to produce complex products in the most cost-effective, flexible, and efficient way. This captures the essence of the various definitions of advanced manufacturing. Fundamental to advanced manufacturing is the extensive use of automation. Manufacturing automation produces many benefits and side effects, but two fundamental ones are: (1) fewer people are required to produce manufactured products and (2) the skill sets required for the jobs are much higher than in other manufacturing. The reduction in the number of people required means that labor costs are increasingly becoming less relevant in the decisions on where to build advanced manufacturing capacity. More important to the decision making process will be: (1) availability of a skilled, productive, and dependable workforce, (2) access to new technological developments and ease of transitioning those developments into commercial practice, (3) proximity to customers, (4) availability and cost effectiveness of logistics support for the overall markets being served, (5) access to dependable and cost effective suppliers, and (6) governmental policies such as taxation and export control. The result of less dependence on wage rates is that the United States can compete in the new world of advanced manufacturing.

The purpose of this report is to examine how the Richmond Region can become a leader in the revitalization of advanced manufacturing in the United States. The report focuses on the two areas where Richmond can make a difference and be a leader. The first area is the creation of an ecosystem that develops new technology and transitions that technology into commercial practice. We specifically highlight major initiatives in the Commonwealth of Virginia that will drive advanced manufacturing opportunities in the Richmond Region as well as beyond the borders of the Commonwealth. The Advanced Manufacturing Innovation Zone (AMIZ), including the Commonwealth Center for Advanced Manufacturing (CCAM), serves to focus the activities within the Commonwealth of Virginia and provides an excellent opportunity for the Richmond Region to capitalize on the future of advanced manufacturing. Similarly, the Advanced Logistics Innovation Zone (ALIZ) and the Commonwealth Center for Applied Logistics Systems (CCALS) provide opportunities for the Richmond Region to be a leader in the logistics technologies crucial to advanced manufacturing. The second area is workforce development. A proactive and industry-driven approach to workforce development is recommended to ensure that the Richmond Region produces the workers needed to attract advanced manufacturing companies to the region. The Region already enjoys ideal geography. The key to success in the future will be new technology creation and workforce readiness.
3. Trends Driving Industry Investment

A study by the Boston Consulting Group (BCG) [2] states that in the early 1950s the United States produced approximately 40% of the world’s manufactured goods. This was due in part to the innovation of the American economy but also because the United States was one of the few industrialized nations whose infrastructure was not destroyed during World War II. The reconstruction of Europe and Japan following the second world war as well as the emergence of China, Korea, India, and other nations led to massive competition for the United States in manufacturing. In many cases, manufacturing needed low-cost labor, and China and other countries provided an almost limitless supply of low skilled yet dedicated and hard working laborers. Recent data from 2010 shows that China now accounts for 19.8 percent of global manufacturing value while the United States accounts for 19.4 percent [2]. The BCG study further states that between 2000 and 2009 China’s share of the global export market increased from 17.4 percent to 32.1 percent for apparel, increased from 7.5 percent to 25.9 percent for furniture, increased from 4.1 percent to 19.6 percent for ship production, increased from 6.5 percent to 27.8 percent for telecommunications equipment, and increased from 4.9 percent to 32.6 percent for office machines and computer equipment [2]. The BCG study also states that between 2000 and 2009 the United States lost approximately six million manufacturing jobs.

The United States, however, has maintained significant strength in what is commonly called advanced manufacturing, including microprocessors, aerospace, networking equipment, software, and pharmaceuticals [2]. The United States seems well positioned to capitalize on growth in these and other sectors that fit the description of advanced manufacturing.

There appear to be several trends emerging that bode well for the United States if we as a country can take advantage of them. The most recent financial statements for Canon [3] provide a glimpse as to the factors of importance to global manufacturing companies. While it is only one example, it indicates the approach of many companies. Canon states that their strategy is:

“Continuing to pursue the strategies we have implemented to date, such as automated production and in-house production, and exploring cost-reduction methods based on new ideas and innovative technologies. In addition, Canon will work to minimize transportation costs while, at the same time, strive to position manufacturing bases and allocate production in ways that minimize costs and risks from a comprehensive perspective, taking into account all possible factors such as exchange rates, tax policies, labor costs, procurement and logistics.”

All companies look at these and more issues when determining where to locate manufacturing facilities. Increasingly the issues include [2]:

- Automation – increased automation has reduced the number of employees needed to operate manufacturing facilities. The increased use of automation will reduce the labor contribution to the total cost of a manufactured product. The same automation machines can be purchased and placed anywhere in the world, so automation by itself will not drive the location of capital investments. However, as automation increases and the labor cost per unit decreases the importance of the labor cost in determining factory location will diminish. This is especially true in advanced manufacturing where the automation is required to meet the precision and quality needed in the final product and is not simply a substitute for human labor. In other words, the requirements found in advanced manufacturing products will drive the need for automation, which in turns reduces the percentage of labor costs in the final products. This levels the playing field across the world and results in facility locations being decided primarily by other factors.
• Logistics – the term “logistics” was used originally to describe the science of the movement, supply, and maintenance of military forces as they operated in the field. In more general terms, logistics is the management of the flow of goods and services between a point of origin and a point of consumption to meet the requirements of customers. The requirements include, for example, the time, location, volume, reliability, security, sustainability, and cost of the logistics solutions. A logistics system is an integrated set of resources that provides a customer an end-to-end solution. Multiple issues affect logistics costs including fuel prices, transportation costs, transportation delays, international trade laws, security measures, warehousing costs, proximity to ports, railroads, airports, and highways, and delivery times. The costs of moving goods and services from one point to another in a manufacturing supply chain including the end consumer will ultimately increase the importance and cost effectiveness of manufacturing capacity being located in close proximity to major customers and suppliers.

• Workforce – the increased use of automation will reduce the number of people required to operate a factory, but the remaining jobs will require an increased skill level. The good news is that the more advanced jobs have higher pay levels and better job security since fewer people can handle the increased requirements. The bad news is that the educational systems in many regions are ill equipped to prepare students for these new careers. Countries and regions that can consistently and rapidly provide well-qualified workers and provide capabilities to regularly upgrade skills will win the battle for manufacturing locations. This is perhaps the most important factor in decisions to locate facilities.

• Currency exchange rates – a company that sells its product in dollars and creates its expenses in other currencies is especially subject to currency fluctuations. Since the United States is a very large market for all types of goods and services many products are sold in United States dollars. It is increasingly advantageous for expenses to occur in a dollar environment in alignment with the revenue produced by sale of the product. This also argues for the use of supply chains that operate within the United States as well. China has mitigated this issue to some extent by centrally controlling the value of its currency. This strategy is not likely to continue to be completely successful in the future.

• Governmental policies – taxes, tariffs, and governmental regulations are major factors in the location of businesses including particularly the stability and predictability of such policies. Manufacturing facilities represent very large investments often totaling billions of dollars. Companies must be able to predict over long terms and with high confidence the future costs associated with governmental policies as they decide where to build their factories. What happens in Washington, DC and Richmond will have a tremendous impact on the ability of the Richmond Region to be competitive in attracting new advanced manufacturing companies.

• Technology creation and commercialization – in addition to excellent people, companies need access to novel ideas. However, they also need a seamless way to transition those ideas to commercial production in minimum time and at minimum cost. Advanced manufacturers need relationships with universities and other research capacities to stay ahead of the curve in the development and adoption of new ideas and new technologies. They also need ways to share the costs of expensive research and development as well as commercialization and to rapidly demonstrate the industrial relevance of a new technology before making the large investments needed to bring the ideas to market.
The net result of the above trends in the advanced manufacturing industry is that geography, new technology, and skilled workers are becoming increasingly important in the decision making process on where to build advanced manufacturing facilities. The past couple of decades have been defined by globalization where companies have expanded worldwide. This will undoubtedly continue as companies strive to have a global footprint and serve the world’s markets. However, a significant component of that strategy will be defined by regionalization where companies seek to locate factories near the markets being served to minimize the logistics costs and the impact of currency exchange rates. They will also locate in regions where a technical and workforce ecosystem exists to drive the creation and commercialization of new technologies. This seems to provide very clear insight into what a region must do to be competitive in the global advanced manufacturing environment.

The Richmond Region already enjoys outstanding geography in support of serving the markets in a vast majority of the United States as well as lowering the total cost of logistics. The Richmond Region has excellent access to an outstanding deep-water port along with excellent roadways, rail systems, and airports. The ongoing enhancements to the Panama Canal will only amplify the attractiveness of the Richmond Region as being easily and cost effectively connected to logistics solutions that cover the spectrum from supply chains to the end customers.

The two most important areas of focus for the Richmond Region should be workforce development in support of advanced manufacturing and the creation of the next “city of knowledge” in advanced manufacturing [4]. The concept of the “cities of knowledge” [4] is that successful regions such as Silicon Valley, Boston’s Route 128, Austin, Texas, Research Triangle Park, and others occur because of the convergence of excellent universities with industrial and government partnerships that result in the attraction and creation of new companies and the enhancement of existing companies. The Richmond Region is poised to capitalize on the emergence of advanced manufacturing and logistics as two focus areas within the region. Either advanced manufacturing or logistics would be significant by itself, but the opportunity for excellent capabilities in both provides a unique combination that does not appear to be equaled in any other region in the United States. The Richmond Region, with focused investments, is well positioned to lead the emergence of advanced manufacturing in the United States.

4. Technology Creation and Commercialization

It is critical that advanced manufacturing companies have easy access to new technologies in order to compete in a global landscape. The process of innovation is not simple nor is it easy. The advanced manufacturing industry has many problems that need to be solved. The creators of technological ideas have many new concepts that can potentially solve those problems. The challenge is to align the problems with the solutions and to demonstrate that the new ideas are industrially relevant and are scalable to the levels needed by industry. What is needed is an environment in which industry defines the problems to be solved and universities provide new ideas and technical solutions to those problems. University solutions and technology cannot be developed in a vacuum but instead must be created in an environment in which there is alignment between problem and solution. This will also allow for a faster and more effective commercialization of the solution. Such an approach is defined in the following sections.

4.1 Technology Readiness Levels

The technology creation and commercialization process, as well as one of its fundamental problems, is illustrated graphically in Figure 1. New ideas move through multiple Technology Readiness Levels (TRLs) [8] on their way to becoming new products and services introduced
into the marketplace. TRLs 1-3 are basic research and technology creation that often result in laboratory scale demonstrations and proof of concept. TRLs 1-3 involve very high risk in that many more ideas are tried and fail than actually make it to later steps in the technology evolution process. TRLs 4-6 include the application development and proof that the concept can be scaled appropriately and cost effectively to complete industry deployment of the new product or service. One of the most difficult challenges is oftentimes aligning the technology solution with a legitimate need for a new application or product and then demonstrating conclusively that the solution works. In other words, there is very often a mismatch between the new ideas and the desired new products and services. TRLs 7-9 include the product commercialization and delivery phases where solutions are finalized and delivered to the marketplace. This includes not only the technical aspects of the new product or service but the business elements as well.

Universities excel at TRLs 1-3, and companies excel at TRLs 7-9. The so-called “Valley of Death” exists at TRLs 4-6 where it is difficult to transition a technology from the laboratory to the market. This is true in part because the research function is often separated from the commercialization function and is too far removed from the realities of the marketplace. Universities are often consumed by the creation of new technology and disconnected from the realities of what it takes to actually get the product into the hands of the customers. Companies are often consumed by the practicalities of delivering current products and services and often lack exposure to the new ideas being created in research organizations. There is certainly much good in the freedom of that independent focus by industry and universities, but there is also a need to better align them. Industry’s market requirements must be better aligned with universities’ idea generation capabilities, and that alignment occurs at TRLs 4-6.

4.2 Applied Research Centers

A new type of research center and relationship between universities, industry, and government is needed to solve the problems illustrated in Figure 1. These new centers are designed to better bridge the gap between basic research and product commercialization, thus solving the “Valley of Death”. This is accomplished in part by placing members from all stages of the product creation and development pipeline into the same facility to work collaboratively. Universities, including their students, will work together with industry and government to bridge the gap

![Figure 1: The Technology Development Pipeline](image-url)
between basic research and commercialization and bring new ideas to fruition in the marketplace. This allows each partner to focus on what they do best but integrates seamlessly the partners into a pipeline of new ideas flowing from concept to implementation. This new applied research center model creates a flow of new ideas and people trained to implement those ideas from the laboratories of the universities through applied research centers to the commercial product lines of companies.

This concept is not really new. It has been known and practiced for years in quality control engineering where designers, factory floor workers, financial officers, sales and marketing, maintenance, and others are integrated into a single team to provide the best overall product and result. In essence, a systems approach is taken to the development to ensure that all elements of the system work well together. What is new here is the application of this concept to a research enterprise integrating universities and companies into a single unit. One example of such a center is the Advanced Manufacturing Research Center (AMRC) created jointly by Boeing and the University of Sheffield in the United Kingdom [5]. Many of the concepts embodied in the AMRC are now being borrowed to develop new centers in the United Kingdom and elsewhere. The objective is to get universities and companies working together collaboratively.

There are two concrete examples of these new types of centers emerging in the Commonwealth of Virginia and focused on filling the gap of TRLs 4-6. These include the Commonwealth Center for Advanced Manufacturing (CCAM) and the Commonwealth Center for Applied Logistics Systems (CCALS).

4.3 Commonwealth Center for Advanced Manufacturing (CCAM)

The Commonwealth Center for Advanced Manufacturing (CCAM) is an innovative public-private partnership founded by Canon Virginia, Chromalloy Gas Turbines, Newport News Shipbuilding, Rolls-Royce, Sandvik Coromant, Siemens, Sulzer Metco, University of Virginia, Virginia Tech, Virginia State University, and the Commonwealth of Virginia. The CCAM mission is to bridge the gap between basic research and commercialization and to accelerate the introduction of new technologies into the marketplace. The CCAM goal is to greatly improve manufacturing capabilities and provide lower cost, higher quality, and shorter time to market for new products.

CCAM achieves its mission via applied research collaborations between multiple universities and a diverse set of industrial members. CCAM conducts Directed Research on problems of interest and benefit to individual CCAM member companies. CCAM also conducts Generic Research on problems of interest and benefit to all CCAM member companies. Generic Research provides foundational solutions that support multiple applications, while Directed Research tailors the solutions to the market applications of specific companies. The CCAM vision is to be a global Center of Excellence in advanced manufacturing applied research with an initial focus on surface engineering, manufacturing systems, and the related supporting technologies.

CCAM partners with its University Members to also conduct fundamental research that feeds the pipeline of new technologies flowing into the application development and proof of concept phase. In addition to the Directed Research and Generic Research CCAM works with its University and Industrial Partners to perform Collaborative Research. Collaborative Research is typically funded by the federal government and focused at TRLs 1-3. The difference with CCAM is that the basic research and technology creation can be guided by the ultimate vision of the new products and services that are needed or the problems that need to be solved. This puts the research into the context of the ultimate solution desired or problem to be solved.
CCAM is currently constructing its initial research center in Prince George, Virginia. The 60,000 square foot facility will open in September 2012 and provide space to accommodate 60 full-time employees and 70 graduate and undergraduate students conducting research projects with more than 30 industry members. The facility has 16,000 square feet of high-bay space with production scale equipment that allows new concepts to be proven in an industrial environment so as to substantially reduce the risk and the challenges encountered during the move to the factory floor. The CCAM campus occupies 20 acres with a master plan designed for expansion to accommodate two additional applied research buildings and a workforce center or academy.

4.4 Commonwealth Center for Applied Logistics Systems (CCALS)

The Commonwealth Center for Applied Logistics Systems (CCALS) is modeled after CCAM and will provide industry and government with transformational improvements in the design and analysis of logistics systems for military, commercial, consumer, and emergency applications. The term “logistics” was used originally to describe the science of the movement, supply, and maintenance of military forces as they operated in the field. In more general terms, logistics is the management of the flow of goods and services between a point of origin and a point of consumption to meet the requirements of customers. The requirements include the time, location, volume, reliability, security, sustainability, and cost of the logistics solutions. A logistics system is an integrated set of resources that provides a customer with an end-to-end solution. The applications of logistics include, as examples, military, government, business, and emergency systems with each area having similar problems but often focusing on varying priorities in their requirements. Complex logistics systems involve global processes, policies, technologies, and human factors. The unique research focus of the CCALS will be on integrating solutions in these diverse areas to form logistics systems that meet customer requirements and are cost effective and dependable. The focus on the integrated logistics system is unique compared to others.

Advanced manufacturing depends on logistics to provide dependable supply chains as well as the delivery of goods and services to customers. A unique feature of the CCALS is the collaborative research environment designed to accelerate the transition of technologies from creation to product implementation. CCALS members will include government, manufacturers, transportation companies, and suppliers as well as service providers and users from military, commercial, consumer, and emergency applications. The CCALS research staff will work closely with its members on industry and government research projects that address critical challenges in the development of advanced logistics systems. Close communication between sponsors and research staff will ensure timely delivery of results that can be transitioned quickly to commercialization. Integration of CCALS staff with its academic partners, including Longwood University, University of Virginia and Virginia State University, will ensure that projects leverage the resources of the universities for the benefit of members.

4.5 University and Industry Collaboration

The importance of developing these types of relationships between Universities and industry is illustrated in part by Figure 2 showing the level of research and development funding by industry, government, and other sources. All sources of funding have declined in recent years due to the recession. However, funding from industry historically has been more than twice that of government and other sources. Most government sources are ideally suited to fund basic research at TRLs 1-3, while most industry funding is targeted at TRLs 4-6 and even into TRLs 7-9. The model adopted by CCAM and CCALS and illustrated in Figure 1 seeks to optimize the relationship between industry and government funding by getting companies engaged with universities and focused on achieving the pipeline illustrated in Figure 1. There will always be a
need for basic research that is driven by pure inquiry, but CCAM and CCALS provide the opportunity to align industrial problems with basic and applied research in a way that maximizes the benefits to all parties. This new model represents tremendous opportunity for all partners.

Important to the creation of the public-private partnerships in CCAM and CCALS has been an innovative intellectual property policy designed to optimize the relationship illustrated in Figure 1. The research centers CCAM and CCALS perform three types of research projects as mentioned earlier—Generic Research, Directed Research, and Collaborative Research. Directed Research and Generic Research are both funded by member fees paid by the Industry Members. Directed Research is performed for one member, or potentially for several members who decide to partner on a project. The member (or members) owns any intellectual property that results from Directed Research. Generic Research is performed for all of the members. The relevant center owns any intellectual property that results from Generic Research, and all members have a non-exclusive, royalty-free license to commercialize the results of any Generic Research.

The premise is that Generic Research solves problems that are of interest and importance to all of the members and is shared across all members. Directed Research solves problems that are of interest and importance to one member or a subset of the members. It could be one member or multiple members that decide to team on a project and provide a collaborative solution.

CCAM, for example, has in place a master research agreement with the three Organizing University Members that allows CCAM to fund research at the Universities if CCAM chooses to do so. The universities agreed in the Master Research Agreement to transfer ownership of intellectual property resulting from Generic projects to CCAM and in the case of Directed

![U.S. R&D expenditures, by source of funds: 1990–2009](image)

**Figure 2: Sources of Research and Development Funding**

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projects to the member company (or companies). This allows the member companies to have the same intellectual property agreement independent of whether the research is performed at CCAM or at one of the universities. This allows the research to be performed seamlessly and performed where it makes the most sense to perform it – either at the CCAM facility or at one or more of the universities. This novel approach requires a strong commitment by all partners.

Collaborative Research is typically funded by the federal government or other entities but is specifically not funded by the member fees. In the case of Collaborative Research the creator of the intellectual property owns it. So, if CCAM received a federal grant and awarded a subcontract from that grant to one of the Universities then the university would own any intellectual property created by that university's employees on that grant. Similarly, CCAM would own any intellectual property created by CCAM employees on that grant. This allows the universities to work with CCAM on federally funded research in the same manner that universities always work on federally funded research. Collaborative Research is thus handled identically to the way intellectual property is normally handled at the universities.

4.6 Technology Pipeline

This approach allows the creation of a pipeline of new technologies from the universities and into commercialization by the member companies. Federal funding can be used to perform fundamental research as Collaborative Research at the universities, and the universities will own what they create. Applied Research is funded by the member fees in the form of Generic and Directed Research and is owned by the center and the companies. This allows all to participate and benefit and do what they do best. Universities perform the basic research. CCAM and CCALS perform the applied research. Companies perform the commercialization.

The universities have a clear path for ideas to become commercial practice. The universities also have close relationships with the member companies so that they better understand their problems and needs. Also, students are provided direct access to companies for internships and future employment. The public-private partnership created by CCAM and CCALS allows all to benefit and also allows each entity to focus on what they do best. This approach is very novel and is fundamental to creating the pipeline described in Figure 1. Effectively bridging the “Valley of Death” requires an integration of people, process, technology, and policies and essentially provides a novel “logistics system” for delivering new ideas from creation to use.

5. Advanced Manufacturing Innovation Zone

The growth of the advanced manufacturing industry in the Richmond Region will require momentum. Success will attract success and will build the momentum needed to sustain the growth of the advanced manufacturing industry well into the future for the Region. Critical to the attainment of the needed momentum is the creation of an Advanced Manufacturing Innovation Zone (AMIZ). The start of the AMIZ has been created just south of Richmond in the Crosspointe Industrial Park. The impact of such innovation zones is easy to see if one looks at Research Triangle Park in North Carolina, the BMW complex in Greenville, South Carolina, the new Boeing Manufacturing Facility in Charleston, South Carolina, Silicon Valley in Northern California, Route 128 near Boston, and others. We will use the BMW complex as an example.

The BMW facility illustrates best what can happen in the Richmond Region and beyond if care is taken to invest and focus resources and attention appropriately. BMW announced its initial facility in South Carolina in 1992. At the time of the BMW investment South Carolina had little if any experience in the automotive industry. The attractiveness of the state was its easy access to
transportation including major airports, modern rail and roadway systems, and a major port. Geography also played a significant role in that South Carolina is within easy distance of the majority of the eastern coast of the United States and a large percentage of the United States’ population. The location was also within one hour of Clemson University with a strong and growing engineering program. Clemson University further agreed to create the International Automotive Research Center (ICAR) to grow talent in the areas critical to BMW.

The South Carolina location also included significant land (over 1,100 acres) that allowed for future growth of the BMW facility as well as the attraction of suppliers. The result is that BMW has now invested over $5.0 billion in the manufacturing complex to create a 4 million square foot campus that employs over 7,000 people. BMW now uses 170 North American suppliers with 40 of those based in South Carolina. Estimates are that more than 20,000 jobs have been created in South Carolina as a result of the BMW factory with more likely to come.

There are many parallels between BMW in South Carolina and what is happening in the Richmond Region with the decision of Rolls-Royce to locate at Crosspointe. Rolls-Royce has more than 1,000 acres of land on which to grow at Crosspointe. The Commonwealth of Virginia, University of Virginia, Virginia Tech, and Virginia State University have created the research linkage to Rolls-Royce and other companies through the Commonwealth Center for Advanced Manufacturing (CCAM). In addition to Rolls-Royce, CCAM, as mentioned previously, has attracted Canon, Chromalloy, Newport News Shipbuilding, Sandvik Coromant, Siemens, Sulzer Metco, and Aerojet as industrial members. CCAM can be the hub to not only grow the Rolls-Royce facilities but to also attract others to nearby locations. The logistics infrastructure of the region is outstanding with ports, highways, railways, and airports all in close proximity providing excellent and cost effective transportation capabilities. If it is properly nurtured
 Virginia can achieve at Crosspointe what South Carolina has achieved with BMW in Greenville/Spartanburg, South Carolina. The Richmond Region can be one of several regions within the Commonwealth of Virginia to benefit substantially from these accomplishments.

An additional potential key to success for the Crosspointe complex is the decision by Boeing to build a 787 aircraft assembly facility in Charleston, South Carolina. Hopefully, this will make it a natural decision for Rolls-Royce to build an assembly and test facility at Crosspointe to provide the jet engines used on the Boeing 787 aircraft. Those engines are currently assembled in Derby, United Kingdom and Singapore among other places outside the United States. However, logistics costs and global currency issues should make Crosspointe an excellent location for supplying the large engines needed by Boeing in South Carolina. This all forms the basis for an emerging Advanced Manufacturing Innovation Zone to be created around the Crosspointe complex.

The concept of the AMIZ is illustrated in Figure 3. The AMIZ is designed to be to the Richmond Region what the BMW manufacturing complex has been to the Greenville/Spartanburg, South Carolina area and in fact to the entire state of South Carolina. The key to success for AMIZ is the integration of university led applied research, university led basic research, community college led workforce development, and industry led advanced manufacturing as shown in Figure 3.

The basic components for AMIZ are in place. The Commonwealth Center for Advanced Manufacturing (CCAM) has been created and will open the doors of its new research facility in September 2012. The Commonwealth Center for Applied Logistics Systems will be created in 2012 and will supplement the capabilities provided by CCAM. The Commonwealth Center for Aerospace Propulsion Systems (CCAPS) has been created at the campuses of the University of Virginia and Virginia Tech and has been performing basic research for more than two years. Initial workforce training programs have been initiated with the John Tyler Community College, and new manufacturing laboratories exist at the University of Virginia. Finally, the first Rolls-Royce factory is up and running with the second factory announced for start of construction in 2012. The ultimate success of the AMIZ will be dependent upon the ability to attract the test cell capabilities and the assembly facility as well as attraction of supply chain companies. In addition, the workforce components need to be strengthened and increased in magnitude.

6. Workforce Development

The availability of a strong, reliable, and well-trained workforce will be one of the critical factors determining where advanced manufacturing companies choose to locate in the future. We propose that the Richmond Region take a proactive approach to workforce development and become engaged in a process being jointly developed by the Commonwealth Center for Advanced Manufacturing (CCAM), the Virginia Industry Foundation (VIF), and the Virginia Manufacturers Association (VMA) [7]. What follows is an overview of the proposed program that we believe is essential to positioning the Richmond Region to be a leader in the revitalization of advanced manufacturing in the United States.

6.1 Introduction

The proposed advanced manufacturing workforce development program builds upon the existing educational and training resources of the Commonwealth of Virginia. The goal of the program is to develop a workforce pipeline capable of meeting the requirements of existing and emerging employers in advanced technology industries. This proposed program and approach ensures that limited resources are aligned to a single vision and mission for addressing the workforce needs.
of all of Virginia’s manufacturers, including those currently in the Richmond Region as well as future employers in that region, as well as other parts of the Commonwealth of Virginia.

The strength and uniqueness of the partnership and program is that it provides the advanced manufacturing sector within the Commonwealth of Virginia a single point of access for workforce needs and industry image building. This enables the companies to: (1) increase the awareness of career opportunities in advanced manufacturing, (2) provide input on the workforce skills currently needed by the manufacturing industry, (3) provide input on the types of jobs that will be emerging in manufacturing in the future, (4) access potential employees with the education and skills needed by manufacturing, and (5) provide feedback on the quality and preparation of the potential employees, specifically work readiness and industry/occupational credentials, as well as government and private sector educational pathway resources.

The result of the partnership is an industry-directed workforce program that provides companies with the educated and trained workers needed to support their businesses. The program will be an asset in the retention of existing companies within the Commonwealth and the recruitment of new companies to the Commonwealth. The program will enhance existing workforce development efforts in Virginia. A central role for the collaborative will be coordinating the many capabilities of the existing resources in the Commonwealth along with ensuring a strong and direct connection with industry. This will ensure the efficiency and effectiveness of the advanced manufacturing workforce programs and that they are easily accessible by the advanced manufacturing industry throughout the Commonwealth.

The program builds upon efforts currently supported by the Virginia Tobacco Indemnification and Community Revitalization Commission (TICRC) and expands those efforts beyond the Tobacco Region and throughout Virginia. The program is also a replicable model that can be expanded to other industry sectors including, for example, logistics, energy, healthcare, defense, and information technology. The result will position the Commonwealth of Virginia as a national and world leader in specialized work-readiness and manufacturing skills while creating a robust and sustainable industry-guided and industry-responsive workforce development system.

6.2 Background

As described previously, the Commonwealth Center for Advanced Manufacturing (CCAM) is a Virginia non-stock corporation that has been granted tax-exempt status by the Internal Revenue Service as a 501(c)(3) organization. CCAM has as its goal to greatly improve manufacturing capabilities and provide lower cost, higher quality, and shorter time to market for new products. CCAM is an innovative public-private partnership founded by Canon Virginia, Chromalloy Gas Turbines, Newport News Shipbuilding, Rolls-Royce, Sandvik Coromant, Siemens, Sulzer Metco, University of Virginia, Virginia Tech, Virginia State University, and the Commonwealth of Virginia. The CCAM mission is to bridge the gap between basic research and commercialization and to accelerate the introduction of new technologies into the marketplace.

Technology transfer works best when people are properly trained with the appropriate skills and then transition into the workforce to support commercialization of the new technology. A major advantage for CCAM’s industry members is to work side-by-side with students who are engaged in the company’s research projects and then employ those students in full-time positions as the people and technology transition from CCAM into commercial practice. The students benefit tremendously by being exposed to industry and having an opportunity for internships and other forms of practical industrial experience in the advanced manufacturing sector.

The Virginia Industry Foundation (VIF) is similarly a 501(c)(3) organization structured for charitable, educational and scientific purposes. In 2009, the VIF and the National Association of
Manufacturers (NAM)/Manufacturing Institute launched Dream it Do it Virginia\(^1\) (DIDIVA) to increase awareness of career opportunities in advanced technology industries. The goal of the DIDIVA network is to connect talent to opportunities in advanced technology sectors and promote an accurate image of the 21\(^{st}\) century advanced manufacturing economy. The DIDIVA program is an award-winning industry image marketing and educational resource that includes an interactive online career resource toolkit, a statewide partnership network and advanced technology summer camps built by industry to educate youth, teachers and parents about career pathways in advanced technology industries.

The Virginia Manufacturers Association (VMA) represents the operational interests of the 5,600 manufacturers in the Commonwealth of Virginia. In 2006, the VMA partnered with the Virginia Biotechnology Association to establish the national award-winning Virginia Council on Advanced Technology Skills\(^2\) (VCATS) to achieve the following goals: (1) develop a workforce pipeline capable of meeting the cutting-edge requirements of existing and emerging employers in advanced technology, (2) educate the public about the benefits of advanced technology careers through marketing initiatives, (3) provide a customized fast track to credentials for a 21\(^{st}\) Century advanced technology career, and (4) provide a career pathway to advanced level training and specialized training based on industry requirements. VMA/VCATS also conducted the first Virginia Skills Gap Analysis of manufacturing occupations and defined the newly created manufacturing technician occupation in 2007. VCATS also received a United States Department of Labor (USDOL) Presidential Grant to develop the first manufacturing technician occupational certification in the United States. In 2010, the VMA incorporated VCATS within its Workforce Development Division to serve as the industry’s voice on issues impacting the recruitment, retention, development, and advancement of a skilled workforce for industry.

The Virginia Tobacco Indemnification and Community Revitalization Commission (TICRC) recognized that the full impact of advanced manufacturing on the Tobacco Region and the Commonwealth of Virginia will only be realized with a state-of-the-art workforce development program that is fully coordinated with advanced manufacturing companies. Therefore, the TICRC has provided a grant to CCAM to support its facility development ($2.5 million) and to support workforce and economic development in the Tobacco Region ($1.5 million). The TICRC-funded project involves convening a task force that includes industry, community colleges, universities, workforce training centers, workforce investment boards and one-stop career centers that will work collaboratively to: (1) assess current workforce training capabilities and future needs, (2) make recommendations for and implement curriculum modifications, and (3) identify desired training equipment and resources for the existing and potential new centers. This grant will leverage prior TICRC investment in the Southern Virginia Higher Education Center’s Research and Development Center for Advanced Manufacturing and Energy Efficiency (R&D CAMEE) and the Virginia Technical Institute. These TICRC initiatives are replicable partnership models and will be enhanced through the implementation of the advanced manufacturing workforce development program described here.

\(^1\) DIDIVA has been recognized as a national best practice and has been awarded the MarCom Gold Award and the Webby Awards – Best Association Website.

\(^2\) VCATS has been recognized for its pioneering advanced manufacturing workforce development assessment and certification efforts and is the recipient of the Southern Growth Innovator Award – Southern Growth Policies Board and the Excellence in Technology-based Economic Development Award - State Science & Technology Institute.
6.3 Program Description

The purpose of the Advanced Manufacturing Workforce Development Program is to create a market-driven skills pipeline for advanced manufacturing in Virginia. The process for how we educate and train individuals for employment opportunities in industry is informed by labor market analysis and produces individuals with the knowledge and skills necessary to support business retention, expansion, and attraction as illustrated in Figure 4.

Labor market analysis lays the foundation for creating the skills pipeline and identifying the needed training and education programs that are occupation-specific and tied to industry-identified skills and industry-recognized credentials. The program is grounded in knowing labor supply and demand, or the “quality and quantity”, of the workforce needed to support advanced manufacturing industry retention and expansion. This type of analysis determines the occupational-driven demand for education and training programs.

Workforce preparation, development and attainment efforts use supply and demand analysis to inform the development and provision of programs that target three tiers of training: (1) work readiness, (2) occupational and technical training, and (3) product and/or process specific training. The first two tiers of training target industry specific trends and projections ascertained from supply and demand analysis using publicly available labor and education data. The third training tier targets employer specific needs obtained in consultation with one or more company representatives such as human resource managers and plant managers.

The output of the workforce development program process is a market-driven talent supply for current and emerging advanced technology industries. Strategies such as industry image re-branding, career awareness and outreach services, career coaching, manufacturing technology camps and job boards are used to connect skilled individuals with employment and career advancement opportunities in the region.

The 2007 Skilled Trades Gap Analysis report commissioned by the Virginia Workforce Council and the VMA, and prepared by Mangum Economic Consulting, LLC found that job growth in skilled trades was expected to far outstrip employment growth in most other manufacturing occupations. Moreover, when the estimated number of annual openings in skilled trades was
compared with the estimated number of workers graduating from associated training programs, it was found that the cumulative shortfall in trained workers between 2007 and 2012 may be as high 46,000 workers. In addition, these training gaps were in some instances further exacerbated by apparent regional imbalances between the demand for trained skilled trades workers and the location of existing training programs. In addition, the same study found that according to manufacturing employers surveyed entry-level workers suffer from low skills as shown in Figure 5. Specifically, the study found that:

- Nearly half of the manufacturers who responded to the survey rated the soft skills and measurable skills preparation of recent entry-level hires as fair to very poor.
- Seven out of ten rated recent entry-level hires’ knowledge of basic manufacturing principles as fair to very poor.

Leveraging the ongoing efforts of the Virginia Council on Advanced Technology Skills (VCATS), the Advanced Manufacturing Workforce Development Program will promote the development of soft skills across all manufacturing occupations, and will define the skills needed for specific technical occupations since they will require various levels of training and educational achievement. Specific focus will be given to “middle skills” occupations requiring more than a high school diploma but less than a four-year degree. The 2007 Skilled Trades Gap Analysis illuminated the need to focus on middle-skills occupations due to employment projections for the newly industry-defined Manufacturing Technician (MT) job role. Subsequently, VCATS identified the MT work readiness skill standard, the basic manufacturing technical skills, and developed the MT training and assessment program in response to employer-identified competencies. To date more than 900 VCATS MT assessments have been given resulting in 213 certified Manufacturing Specialists and 139 certified Manufacturing Technicians.

In August 2011, the VMA commissioned additional research on the projected middle skills gap for manufacturing in the Commonwealth. The preliminary research shows that in the Capital

![Figure 5 – Manufacturing Employers’ Evaluation of Entry Level Workers](source: 2007 Skilled Trades Gap Analysis, Mangum Economic Consulting, LLC.)
There should be additional requirements for career and technical education in Virginia's K-12 education system.

Virginia should have a standardized manufacturing skills credential system...that certifies workers for competencies at the entry-level and continues up through the college level.

The public image of manufacturing occupations is a major contributing factor to the problems employers experience in recruiting skilled workers.

Figure 6 – Manufacturers’ Perspectives on Educational Needs

Source: 2007 Skilled Trades Gap Analysis, Mangum Economic Consulting, LLC.

Workforce Investment Area, 76% of the annual openings in manufacturing jobs are in “middle skills” occupations or those jobs requiring more than a high school diploma but less than a Bachelor’s Degree. The advanced manufacturing workforce development program will provide a balanced focus on the continuum of occupations employed by industry to ensure educational and training offerings are not under-preparing or over-preparing the workforce based upon projected employment openings. Additional research will be conducted to augment the middle skills gap analysis to include suppliers to the manufacturing industry.

The program will identify the needed curricula, training facilities, and programs based on the specifications of required skills provided by the industry trends and projections as well as individual companies. The curricula will be developed and assessed collaboratively by all of the stakeholders and validated by industry. The program will also include a teacher training and support program that educates teachers and training providers on the curricula and provides the educators and trainers with the capability to deliver the programs. This is extremely important since teachers and trainers at all levels are often required to deliver programs with little education themselves in how best to teach the concepts.

In the current approach to workforce development, the K-12 schools, community colleges, universities, and training centers develop educational and training programs, deliver those programs to the students, and produce graduates that enter the workforce. The organizations perform an excellent job with this model independently; however, there is not a consistent method used across all organizations to create the curricula and deliver the programs with the broad based input from industry. Similarly, feedback from industry on the quality and effectiveness of the programs is not routinely or consistently available and used to improve the competency and skill levels of the graduates, program completers and the system. This approach is visible at all levels of the workforce system from K-12 through the workforce investment system and universities and is a result of the difficulty in creating and using strong and broad connections to industry as shown in Figure 6.
The Advanced Manufacturing Workforce Development Program provides the ability to address this challenge and the potential to provide very strong enhancements to the current workforce development system. Adopting the VCATS workforce development policy framework, the program consists of the following five elements as illustrated in Figure 7 and listed below:

1. **Exploration** – Outreach and awareness activities including the Dream it Do it Virginia (DIDIVA), internships leading to employment upon commercialization of new advanced technologies, and advanced technology summer camps.

2. **Readiness** - Career readiness strategies and programs including the Workplace Readiness Skills (K-12), the Virginia Career Readiness Certificate (CRC), and more specifically the CRC + Applied Technology as a skills ‘readiness’ indicator for manufacturing occupations.

3. **Education & Training** – Education and skills pathways leading to key competencies and credentials targeting industry’s specific skill needs; programs connected to employment and career advancement opportunities.

4. **Assessment & Certification** – Competency-based industry-validated and recognized certificates and credentials for a skilled workforce and talent pipeline.

5. **Employment & Advancement** – Online and in-person career resources to connect individuals with industry employment opportunities.

6. **Industry Skills Pipeline and Partnership Network** – Strategic partnerships to disseminate information and implement integrated advanced manufacturing workforce development strategies, programs and services.

The first fundamental characteristic of the proposed program is to provide one place in the Commonwealth that companies can turn to when they need to hire workers in advanced manufacturing. As was documented in the 2007 Skilled Trades Gap Analysis and during the development of CCAM, industry companies consistently stated that they found it difficult in Virginia to know where to turn when they needed help with their workforce needs, either new skills needed or new workers they wanted to hire.

DIDIVA is the entity in the Commonwealth that assimilates the necessary information for employment and careers in advanced manufacturing. Manufacturing companies will then know that there is one contact they need to make to get the help they need as shown in Figure 8. Furthermore, employers can use the DIDIVA single point of contact as a means to provide feedback to the workforce development system to ensure that the needs of industry are continually assessed and being met.
Using DIDIVA as a gateway actually helps both the manufacturing industry and the educational and training organizations. Industrial organizations frequently struggle with knowing where to come within Virginia for information about prospective employees. Similarly educational organizations often struggle with finding opportunities for their graduates for internships or full-time jobs especially if those opportunities are in another geographic region of the Commonwealth. The single point of contact helps both sides of the partnership to: (1) increase the awareness of career opportunities in advanced manufacturing, (2) provide input on the workforce skills currently needed by the manufacturing industry, (3) provide input on the types of jobs that will be emerging in manufacturing in the future, (4) access potential employees with
the education and skills needed by manufacturing, and (5) provide feedback on the quality and preparation of the potential employees.

The second fundamental characteristic of the proposed program is to leverage the strong connection of the Program Workforce Team (CCAM, VIF, and VMA) with the manufacturing companies to define the jobs expected in the future and the skills required for those jobs, focusing on work readiness, as well as to provide a feedback mechanism from industry to the Program Workforce Team on the quality and effectiveness of the existing public and private sector workforce programs. The proposed program will use the Program Workforce Team, modeled after the currently operating VCATS, to allow industry to say what is needed and then to help assess the outcomes.

The four key outcomes to be created by the Program Workforce Team are shown in green in Figure 9 and include: (1) Future Jobs and Required Skills (quantity and quality of the workforce), (2) Global Standards and Best Practices (adoption or adaptation of existing training programs), (3) Assessment Methods and Analysis of Performance (measuring industry’s satisfaction with program completers skill levels), and (4) creation of additional Workforce Readiness Levels for specific advanced manufacturing occupations such as the Manufacturing Technician Level 2.

The specific coordinated activities of the program to be performed by the Program Workforce Team and its industry members are:

- Identification of the stakeholders in the Commonwealth’s workforce development system and engagement of those stakeholders in all elements included in this program.

![Integrated “One-Stop” Workforce Development Program](source: Virginia Manufacturers Association.)
• Definition of “mega trends” impacting businesses and thus impacting the workforce needs. Examples of “mega trends” include population aging; urbanization; climate change; natural resource depletion; long-term energy solutions; market-based regionalization of manufacturing; and increasing globalization of workforce. The mega trends will drive future products and technologies and the types and locations of jobs.

• Analysis of workforce development programs in other states and countries and identification of best practices for adoption. Virginia’s advanced manufacturing sector includes companies headquartered in the United States, as well as Japan, Germany, United Kingdom, Sweden, among others, thus, providing global connections and insight.

• Definition of job levels and the skills needed for occupations employed by the advanced manufacturing industry, and its suppliers, since they will require various levels of training and educational achievement. Specific focus will be given to “middle skills” occupations requiring more than a high school diploma but less than a four-year degree. The Program Workforce Team will define a set of Workforce Readiness Levels that will characterize the skill levels required in the projected occupations. The team will use existing state, national and international standards as appropriate to ensure that the program is consistent with established standards.

• Definition of the needed curricula, training facilities, and programs based on the specifications of required skills provided by the industrial companies. The curricula will be developed and assessed collaboratively by all of the stakeholders and validated by industry.

Figure 9 – Advanced Manufacturing Workforce Development Program Outcomes

Source: Commonwealth Center for Advanced Manufacturing.
• Creation of a teacher training and support program that educates teachers and training providers on the curricula and provides the educators and trainers with the capability to deliver the programs. This is extremely important since teachers and trainers at all levels are often required to deliver programs with little education themselves in how best to teach the concepts.

• Creation of an integrated internship and advanced technology summer camp program that provides students at all levels (1) the opportunity to work with a company as an apprentice or an intern to gain direct knowledge of the manufacturing work environment and company practices, and (2) participate in a summer camp built and facilitated by industry employers providing youth the opportunity to learn directly from industry experts.

• Collaboration with the industry companies and training centers including K-12 schools/high schools, community colleges, 4-year colleges/universities and other non-traditional educational and training providers, such as higher education centers and technical training providers, to implement the delivery of the desired curricula and create methods for evaluating its effectiveness through industry-based assessments.

• Expansion and infusion of the Dream It Do it Virginia (DIDIVA) advanced manufacturing careers awareness program to serve as the umbrella for aligning industry, education and training partners, community stakeholders with the program. DIDIVA provides the framework for sustaining the process for managing the comprehensive workforce program and the public-facing portal for “one-stop” access to advanced manufacturers’ workforce needs in Virginia.

The TICRC funding provides Phase I of an overall workforce development program in advanced manufacturing. The proposed extension builds on that work. Phase II will expand the program to an additional key region of the Commonwealth. Phase III will expand the program to the remainder of the Commonwealth. A fourth and final Phase will be the ongoing operation of the program. The program must be assessed between phases to ensure that it is working as expected.

6.4 Impact

The impact of the program is an integrated workforce development system for the Commonwealth that is aligned with the needs of the advanced manufacturing industry. The many excellent, though widely distributed, workforce development resources of the Commonwealth will be collaboratively integrated into a seamless and cohesive system that provides easy access for industry. The products of that system, the future employees, will be trained with the skills industry needs rather than what the system thinks they need. There will also be a clear set of metrics for evaluating the effectiveness and efficiency of the workforce development system over time.

6.5 Outcomes

Consistent with the VCATS workforce development program elements, the outcomes for the workforce development program include the following:

Explore

• A single public-facing portal (DIDIVA) to ensure “one-stop” access to the program aligned to the skills needs of advanced manufacturers in Virginia.
• A partnership network (DIDIVA) consisting of educators, economic developers, workforce professionals, and industry leaders equipped with consistent methods and collateral materials to increase awareness of career opportunities in advanced technology industries targeting youth, teachers, parents, guidance counselors, transitioning workers, displaced workers, and transitioning military.

• An internship and summer camp program that provides students with the practical experience needed in an industrial environment.

Ready
• Skills measure for advanced manufacturing occupation-specific work readiness levels including skills assessment instruments used consistently system-wide.

Educate & Train
• A single point of contact through which employers in advanced manufacturing can provide feedback to the Commonwealth’s workforce development system on the skills needed by the industry.

• A cohesive and coordinated set of curricula for implementation at all levels of education (high school, community college, apprenticeship, and university) focused on advanced manufacturing.

• A competency-based manufacturing technician (MT) training and assessment program including an advanced technology “immersion” learning experience designed and validated by industry partners and aligned to the VCATS MT Certification.

• A training program that teaches the teachers and trainers about the curricula and how to deliver the programs in the classrooms, laboratories and onsite at companies.

Assess & Certify
• An assessment program and process designed to continuously evaluate the effectiveness of the Commonwealth’s advanced manufacturing workforce system in delivering the workers with the appropriate skills.

Employ
• A single point of contact through which employers in advanced manufacturing can gain access to prospective employees with the appropriate skills for their jobs.

Partnership Network
• A corporate partners program in which CCAM industry members “adopt” a region of the Commonwealth and develop relationships with governmental leaders and educational leaders in that region. The goal is to allow each region to learn directly from companies their specific workforce trends.

7. Recommendations for the Richmond Region
The following actions are instrumental to achieving the success that is possible for the Richmond Region in advanced manufacturing. These actions represent very bold steps, but they are capable of producing significant results and can help achieve the goal of the Richmond Region being the
leader in the revitalization of advanced manufacturing in the United States. Some of these actions have been envisioned as part of the Advanced Manufacturing Innovation Zone (AMIZ) proposed by the University of Virginia, Virginia Tech, and John Tyler Community College [9]:

- Integrate Virginia Commonwealth University (VCU) into the partnerships with the University of Virginia, Virginia Tech, Virginia State University, and Longwood University in the applied research centers the Commonwealth Center for Advanced Manufacturing (CCAM) and the Commonwealth Center for Applied Logistics Systems (CCALS). The success of the Advanced Manufacturing Innovation Zone (AMIZ) and the Advanced Logistics Innovation Zone (ALIZ) depends on CCAM and CCALS. VCU can and should be an integral component of these partnerships and should develop research and educational capabilities in support of these partnerships.

- Engage the Richmond Region’s companies in the public-private partnerships formed by CCAM and CCALS. The centers are in their formative stages and the opportunity is now for Richmond Region’s companies to take a leadership role in their development.

- Create a public-private partnership that develops a test cell capability on the Crosspointe site. This test cell should be owned by the universities and used to support research and educational activities as well as be available to Rolls-Royce for commercial testing thus allowing the growth of their manufacturing in Virginia. The test cell will provide the economic anchor that is capable of catapulting the AMIZ to the highest possible levels of advanced manufacturing jobs. The test cell will also provide the university partners with a research and educational capability that is not found elsewhere in the United States. This provides the potential for the university partnership to grow to levels comparable to the Jet Propulsion Laboratory (JPL). JPL grew out of the California Institute of Technology (Cal Tech) in the days prior to World War II, and Cal Tech now operates the JPL for NASA. Many will argue that JPL is a primary reason that Cal Tech is one of the nation’s premier engineering schools. The potential for such capability in Virginia now exists as part of the AMIZ and must be created to capitalize on the potential of AMIZ.

- Implement the workforce development program as presented in this proposal. Most companies will tell you that their most critical issue is being able to find the talent needed to fill the jobs they are creating. Some reports have stated that as many as 600,000 manufacturing jobs are currently unfilled in the United States because companies cannot find qualified workers to fill those positions. Companies will locate in regions where the workforce is excellent and a pipeline exists to produce the workers of the future. The implementation of the proposed program will require a public-private partnership that engages industry, universities, community colleges, K-12 school systems, and state, local, and federal government. This will not be easy because of the distributed nature of the workforce system in Virginia, but this may well be the most critical key to success for advanced manufacturing in Virginia.

- Create a manufacturing workforce academy as part of the AMIZ. This academy can be jointly located with CCAM and the test cell and used as a focal point for training, linkages to industry, internships, and similar activities. The workforce academy will also be a magnet to attract companies to locate nearby since a source of skilled labor will be readily available along with training and skills enhancement. This academy can also be linked with existing workforce training programs ongoing in other parts of Virginia.

- Create a Governor’s School for Advanced Manufacturing. This program will highlight the opportunities available in advanced manufacturing and prepare students for careers in manufacturing regardless of whether they want four-year degrees, community college
degrees, advanced degrees, certificate programs, or high school diplomas. The program would also support a general enhancement of interest by students in a variety of STEM (Science, Technology, Engineering, and Mathematics) fields.

- Create the Advanced Logistics Innovation Zone (ALIZ) around the Commonwealth Center for Applied Logistics Systems (CCALS). There are numerous opportunities for linkages with industry and government. CCALS has already engaged Boehringer Ingelheim, LMI, LMR, the Army Logistics University, and others in the partnership to plan and create CCALS. A possible focal point for the ALIZ is the Meadowville Technology Park which could become home to the CCALS and is already home to Northrop Grumman and soon to be home to Amazon. The CCALS will not only serve the logistics industrial and government enterprises in the region, but as mentioned previously logistics is central to the success of advanced manufacturing in the region.

- Create other applied research centers like CCAM and CCALS in other industry sectors so as to better connect universities with industry. Energy, information technology, and healthcare are examples where such partnerships can be extremely beneficial and where the Richmond Region has a strong presence and opportunity. The proposed workforce model can be replicated in those business sectors as well. The model may need adjustment depending upon the uniqueness of each particular sector, but the model has demonstrated relevance and success and should be further promoted and pursued. A network of “Commonwealth Centers” is envisioned with each serving a unique industry sector and bringing together the capabilities of multiple Universities as partners.

8. References


[5] Advanced Manufacturing Research Center (AMRC), University of Sheffield, United Kingdom, www.amrc.co.uk.


