Centralina Manufacturing Ecosystem Development Strategy

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Executive Summary

The world is looking in at the Greater Charlotte Region as much as the region is looking out to the global marketplace. In the future economics of world mega-regions and city-states, the Greater Charlotte Region has entered onto the global scene. Recent rankings within the top third of the world’s 100 most competitive cities yields both future opportunities and demands. The Region must ensure that it builds a sustainable framework on the foundation of its valuable existing manufacturing ecosystem assets in readiness for the impending foreign direct investments and manufacturing growth integral to success of our economic future.

This original US Department of Commerce, EDA Investing in Manufacturing Communities Partnership Grant titled Centralina Advanced Manufacturing Ecosystem Strategy Development project (the “Project”), provided a unique opportunity to do just that, inventory and assess the Region’s manufacturing ecosystem, and develop actionable strategies (an Implementation Plan) for ensuring that manufacturing remains a strong and globally-competitive component of the Region’s economy. The manufacturing ecosystem consists of the manufacturing companies along with their suppliers and customers, the educational and training systems that provide their workforce, the systems that support entrepreneurship and innovation, and the export and logistics systems that deliver their products to market. The Project was funded through a technical assistance grant award from the US Economic Development Agency’s “Investing in Manufacturing Communities Partnership” program (IMCP). Centralina Council of Governments (“CCOG”) and the Centralina Economic Development Commission (“CEDC”) were co-awardees to bring together a diverse set of manufacturing and regional stakeholders to advance this initiative. The result of this past 24 month grant project effort is the product before you, the Centralina Manufacturing Ecosystem Development Strategy (Meds).

Together, Centralina Council of Governments (CCOG) and Centralina Economic Development Commission (CEDC) were the founding members of what emerged as the Global Charlotte Manufacturing Community Consortium. The Project’s geographic scope encompasses the nine North Carolina counties that bound both CCOG and the EDA-designated Centralina Economic Development District (the Centralina Region): Anson, Cabarrus, Catawba, Gaston, Iredell, Lincoln, Mecklenburg, Rowan, Stanly and Union counties. Although the Project’s jurisdictional location is the Centralina Region1, the Project will impact and support the larger Greater Charlotte Region (GC Region) a 16-county footprint reflecting a 50-mile radius metropolitan economic zone centered on Charlotte that includes an additional seven counties where appropriate (Alexander, Catawba, and Cleveland counties in NC and Chester, Chesterfield, Lancaster, and York counties in South Carolina.). It is contiguous with the boundaries of the Charlotte Regional Partnership, the marketing and recruitment arm of the GC Region’s economic development commissions. College partners, Chambers, and of course the manufacturing community at large have been integral partners to the full initiative.

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1 For the purposes of this Report the term Centralina Region refers to the North Carolina counties of Anson, Cabarrus, Gaston, Iredell, Lincoln, Mecklenburg, Rowan, Stanly, and Union. These Counties make up the service area for the Centralina Council of Governments and the Centralina Economic Development Commission. Further, references will be made to the Greater Charlotte Region, which encompasses these nine counties and also includes the following additional counties: Alexander, Catawba, Cleveland-NC, Chester, Chesterfield, Lancaster, and York-SC.
Initial and subsequent partners came together to establish the Global Charlotte Manufacturing Community Consortium (the “Consortium”) for the express purpose of building on the region’s assets and bridging gaps in its manufacturing ecosystem to achieve the vision of a uniquely globally competitive region featuring the region’s core competency in Advanced Manufacturing. The Consortium was formed by all parties executing a Consortium Memorandum of Understanding, which specifies shared membership obligations and objectives. The formation of the Global Charlotte Manufacturing Community Consortium demonstrates a powerful commitment to accelerating the resurgence of manufacturing in its 16-county region through a collaborative partnership of workforce training, R&D resources, and exports\logistics to ensure the next stage of our manufacturing heritage and sustain our leading position in the global economy.

The partners included:

- Centralina Council of Governments (CCOG)
- Centralina Economic Development Commission (CEDC)
- Centralina Piedmont Community College
- Charlotte Regional Partnership
- Charlotte Works
- City of Charlotte
- Competitive Workforce Alliance – 7 Workforce Boards
- Charlotte Regional Workforce Development Partnership - 10 Community Colleges Alliance
- E4 Carolinas
- NC State University IES/Manufacturing Extension Partnership
- Regional Conference of Mayors of the Central Carolinas
- Siemens Energy Group, FMI Lithium, and STEAG (Corporate Industries)
- UNC Charlotte
- U.S. Commerce International Trade Administration (ITA) / U.S. Commercial Service (Charlotte)
- UTI / NASCAR Technical Institute

The Centralina Advanced Manufacturing Ecosystem Strategies IMCP Project has produced this Centralina Manufacturing Ecosystem Development Strategy (MEDS) Report (the “Report”) that summarizes the Project’s objectives, findings, and recommendations.

Manufacturing in the Greater Charlotte Region

Manufacturing contributes over 140,000 jobs in the Greater Charlotte Region, or 11.7 percent of the total regional workforce. Eighteen percent (188,033) of the GC Region’s 1,044,629 workers are employed in manufacturing (NC Commerce). For five of the 16 counties (Alexander-NC, Catawba-NC, Lincoln-NC, Chester-SC, and Chesterfield-SC) manufacturing exceeds 20% of the total employment, and over half of the GC Region’s manufacturing share of employment exceeds the national average of 10.8 percent².

² Economic Modeling Specialist Intl.
Since the initial recovery phases from the technical end of the Great Recession in 2009, annualized job growth in the advanced manufacturing sectors led by Energy is now projected to approach 2,000 per year in the Greater Charlotte Region. Given that the average manufacturing wage of $63,457 in North Carolina is 52% higher than all other (non-farm) jobs, the direct economic impact of that job growth is an annual infusion of $127 million into local economies. Recent data reflects that for every manufacturing job, 2.5 additional jobs are created. It has been projected that over the next five years, the multiplier effect of these new manufacturing jobs will result in approximately 25,000 new jobs added to the overall labor force, further strengthening the regional economy.

A Project to Support Manufacturing
The Project meets a regional need by operationalizing a primary finding from the 2012 Centralina Comprehensive Economic Development Strategy (CEDS): Advanced Manufacturing is a core competency of the Centralina Region supporting five of the region’s six target industry clusters. This competency is comprised of an aggregate mix of industry sector densities, workforce skill sets, and key knowledge-based assets that provide embedded cross-cluster support across these five primary target industry clusters: Aerospace/Defense, Automotive, Biomedical, Energy, and Logistics.

Currently there are no coordinated regional approaches to supporting the Advanced Manufacturing needs of these primary industry clusters.

An enhanced regional approach will help ensure that the Centralina Region maintains its competitive edge of this core competency that is so critical to the collaborative economy. The outcomes of this Project build upon a decade-long identified strategic focus for job creation and steady growth of the manufacturing sector, and provide a foundation for establishing just such a coordinated approach. The primary value for industries’ is strengthened collaborative outcomes across the region and a focus centered on three “Ps” of the business bottom line:

- **People**: ensure a qualified and trained talent pipeline to match demand and needs of industry;
- **Productivity**: increase access and unified support of advanced technology, R&D and process resources; and
- **Profit**: grow revenues from logistics and intermodal efficiencies coupled with expanded Export and Trade capacity, knowledge and volume for the region.

Recognizing the regional importance of advanced manufacturing for our region, CCOG and the CEDC assembled a Project team that included nine other partnering organizations, each bringing a specific set of expertise, networks, and knowledge base to the Project: the Charlotte Regional Partnership, the Charlotte Chamber of Commerce, Central Piedmont Community College, South Piedmont Community College, Rowan-Cabarrus Community College, Charlotte Works (Workforce Development Board), E4Carolinas, Stanly Economic Development Commission and the German International Cooperative “GIZ”. Other college partners, economic development organizations and

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3 2012 McKinsey Report
the manufacturing community at large were included in integral activities of the full initiative over the term of the project.

The Project partners sought to explore how the Centralina Region could support the continued growth of the advanced manufacturing sector in order to ensure the Centralina Region’s place in the global market. The purpose of the Project was to develop implementation-ready strategies to support and extend the Centralina Region’s primary core competitive competency in Advanced Manufacturing. The specific objectives of the Project were to research and develop:

- A framework for an industry-led, regional manufacturing coalition;
- An analysis and assessment of the regional manufacturing ecosystem; and
- A comprehensive advanced manufacturing strategic plan to collaboratively facilitate regional issues and support the healthy growth of ecosystem capacity and assets.

To assist in achieving the Project goals and objectives, several consultant teams were retained to assist with extensive research that was conducted on the Centralina Region’s manufacturing ecosystem:

1) Center for Regional Economic Competitiveness, Washington, DC
2) Center for Adult and Experiential Learning, Chicago, Illinois
3) M/H/R Services LLC, Charlotte, North Carolina

**Project Findings and Recommendations**

The findings revealed and validated that the regional comprehensive manufacturing ecosystem strategic plan is appropriately grounded upon fostering education and training; growing technology, innovation and entrepreneurship; and nurturing existing business to become globally competitive. The recommendations concentrate on steps the stakeholders can take to enhance and grow the Centralina Region’s advanced manufacturing ecosystem and yielded these foundational findings;

1. Global Charlotte Manufacturing Community Consortium: establish this industry-led regional alliance to link and support the existing sub-regional county coalitions on common issues through communication, content, and collaboration at a region wide world-ranked metropolitan scale. This Consortium\Alliance is already in fledgling formation via the Project’s two year IMCP strategic program efforts, and is committed to accelerating the resurgence of the “Charlotte USA” manufacturing ecosystem. Through a collaborative partnership of workforce training, R&D innovation resources, and exports\logistics, the Consortium will work to ensure the success of the next stage of our manufacturing heritage and sustain our leading position in the global economy. The Consortium will be organized as a relevant ecosystem vehicle to successfully accomplish the work required to achieve the objectives, not to serve as another independent organization or governmental structure. This coalition will bring together manufacturers, suppliers, educators, workforce boards, and economic developers to collaboratively implement manufacturing ecosystem plan strategies.
2. Advanced Manufacturing Branding Campaign: develop a branding campaign for advanced manufacturing occupations that markets the value of these careers and identifies the pathways to them within the Centralina Region.

3. Collaborative Industry Data and Communications Portal: utilize the alliance to educate and share resources that help spark entrepreneurship, R&D innovation and business growth supported by regional assets for global market access, in order to foster the Region’s increasing globally competitive advantage.

Success of this Project will sustain continued local job creation, community economic vitality, and a strategic competitive advantage for the Centralina Region as a global hub, anchored and known by its advanced manufacturing foundation and competency. The full findings and recommendations are provided in the following Report.
Introduction

The Centralina Advanced Manufacturing Ecosystem Strategy Development project provided a unique opportunity to inventory and assess the Region’s manufacturing ecosystem, and develop actionable strategies for ensuring that manufacturing remains a strong and globally-competitive component of the Region’s economy. The manufacturing ecosystem consists of the manufacturing companies along with their suppliers and customers, the educational and training systems that provide their workforce, the systems that support entrepreneurship and innovation, and the export and logistics systems that deliver their products to market. The result of this past 24 month effort is the Centralina Manufacturing Ecosystem Development Strategy (MEDS).

The Project was funded through a technical assistance grant award from the US Economic Development Agency’s “Investing in Manufacturing Communities Partnership” program (IMCP). Centralina Council of Governments (CCOG) and the Centralina Economic Development Commission (CEDC) were co-awardees to bring together a diverse set of manufacturing and regional stakeholders to form the Global Charlotte Manufacturing Consortium, which carried out the Project.

This Introduction documents the Project’s geographic scope, background context and methodologies. Subsequent sections of the Report document the Project’s findings and recommendations for each of four major elements of the Project:

- Mapping Key Value Chains
- Manufacturing Education Asset Inventory
- Entrepreneurial Support and Innovation
- Export and Logistics Assets and Advantages

The Consortium’s IMCP Implementation Strategies developed through the Project and based on those findings and recommendations are then laid out in the next section. Finally, a Conclusions section provides a summary of the Project’s genesis, findings, and implementation strategies, along with discussion of new insights garnered through the Project’s collaborative process and plans for putting the implementation strategies into action.

Geographic Scope

The Project’s geographic scope encompasses the nine North Carolina counties that bound both CCOG and the EDA-designated Centralina Economic Development District (the “Centralina Region”): Anson, Cabarrus, Catawba, Gaston, Iredell, Lincoln, Mecklenburg, Rowan, Stanly and Union counties. Although the Project’s jurisdictional location is the Centralina Region, the Project will impact and support the larger GC Region, reflecting the fifty-mile radius economic zone of influence around Charlotte, NC, as shown in the map below.
Background Context

The Centralina Region is one of the fastest growing in the country, and is expected to continue growing rapidly, due in part to its desirable geographic location (centered along the I-85 “Piedmont Crescent” corridor from Atlanta to Washington, DC, within two hours’ flight time or one days’ delivery by motor freight of 60% of the U.S. population.) Among other assets making the Centralina Region attractive are favorable business climate, growing trained workforce, relatively low cost of living, and numerous lifestyle amenities, including professional sports and outdoor recreation and overall quality of life. The Centralina Region is home to eight Fortune 500 firms. It continues to attract Corporate Headquarters operations from throughout the world.

As a region with deep roots in textile and furniture manufacturing, we know first-hand the economic dislocation of shuttered plants and jobs lost to overseas competitors. However, Manufacturing, Logistics, and Global Commerce are alive, strong, and growing in the Centralina Region. The publication New Geography recently ranked the Charlotte MSA 13th among the nation’s 66 largest MSAs for manufacturing4 and North Carolina is the nation’s ninth largest manufacturing state. As of the second quarter of 2015 more than 90,221 workers are employed in manufacturing in the Centralina Region5. The 2007 CEDS study identified over 1,200 firms specializing in sophisticated intelligent manufacturing, with energy, advanced materials, precision metrology, optoelectronic, and

5 Chmura Economic and Analytics, JobsEQ: Industry Data 2014 Q4
biomedical technology developing alongside 1,000+ traditional manufacturing firms as primary and fabricated metals, machinery, chemicals, plastics, electronics, transportation equipment, food and beverages. More than 2,462 manufacturing firms are located in within the GC Region. They range from Fortune 500 companies to entrepreneurial start-up operations with considerable potential for long-term success.

Most of Centralina Region’s manufacturing firms are small or medium-sized businesses, positioned to benefit from industry agglomeration and cluster efficiencies. The Charlotte Foreign Trade Zone is one of the largest in the state, and the U.S. Export Assistance Center in Charlotte helps many local firms navigate world trade issues. The Charlotte chapter of the North Carolina World Trade Association is one of the largest in the nation. The Manufacturing Extension Partnership is active in Charlotte and throughout North Carolina. Once considered a leader in textiles, today the Centralina Region has countless firms specializing in sophisticated intelligent manufacturing, with precision metrology, optoelectronic and biomedical technology developing alongside such traditional manufacturing as primary and fabricated metals, machinery, chemicals, plastics, electronics, transportation equipment, food and beverages.

Today’s communities must embrace the 21st Century reality that their unique identity and strengths in a globally competitive environment come from the combination of their workforce skills, technology and product knowledge, ability to produce and manufacture, and ability to market and deliver products to their consumers. Globally oriented companies know they must do all of these things well. Communities must now do the same under a highly coordinated and collaborative effort across organizations, workers, and industry clusters. Today’s challenge for communities is to build multiple competencies that spark new industries and products – to work not just to protect what you have, but to focus on the new products and markets that will create new jobs.

**Project Methodologies**

Recognizing this new reality, Centralina Council of Governments (“CCOG”) and the Centralina Economic Development Commission (“CEDC”) assembled a Project team that included nine other partnering organizations, each bringing a specific set of expertise, networks, and knowledge base to the Project: the Charlotte Regional Partnership, the Charlotte Chamber of Commerce, Central Piedmont Community College, South Piedmont Community College, Rowan-Cabarrus Community College, Charlotte Works, E4Carolinas, Stanly Economic Development Commission and the German International Cooperative “GIZ”. These partners formed the Global Charlotte Manufacturing Consortium, which carried out the Project (the “Consortium”).

The Project sought to explore how the Centralina Region could support the continued growth of regional manufacturing assets in order to ensure the Centralina Region’s place in the global market. The Consortium sought and was awarded funding from the US Economic Development Administration’s Investing in Manufacturing Communities Partnership (IMCP) program. Grant funds allowed for carrying out strategic planning activities and organization of collaborative sector partnerships within the Centralina Region to achieve the necessary foundation to help grow jobs in manufacturing through more strategically coordinated networking, research, and training that would facilitate greater capacity within the ecosystem.
The strategic planning activities undertaken in this Project included:

- **Mapping Key Value Chains.** An assessment of a substantial portion, including the key anchors, of the GC Region’s advanced manufacturing ecosystem: a regional manufacturer inventory, supply chain and value chain mapping, and comprehensive analysis of the GC Region’s manufacturing ecosystem, with particular emphasis on the Advanced Manufacturing “Super-Cluster”. Critical elements of the assessment were (a) updating the 2007 county by county inventory of manufacturing firms and (b) outreach to identify the GC Region’s smaller firms for future engagement in strategic plan activities.

- **Manufacturing Education Assets Inventory.** Performing an updated analysis, through 2014, of the current training, internships and apprenticeship programs available. This analysis allows focused evaluation of steps and resources required to increase scope and the scale of existing Advanced Manufacturing training, specialized internships, and enhanced apprenticeship programs to integrate with increased industry sectors participation, support, and partnership with the workforce and education systems.

- **Entrepreneurial Support and Innovation.** The Project looked at the current entrepreneurial and research and development (R&D) support systems and identified ways to better connect the R&D assets and entrepreneurial-innovation efforts within the Centralina Region’s advanced manufacturing ecosystem. A critical component of this strategic activity centers on enhancing existing partnerships with the University of North Carolina at Charlotte’s (UNC Charlotte) Charlotte Research Institute, the Energy Production and Infrastructure Center (“EPIC”) and other R&D service providers to fully support the manufacturing ecosystem’s potential.

- **Export and Logistics Assets and Advantages.** The Project included an Exports and Logistics Assets and Advantages review that promotes enhancing the regional industries’ Export capacity, expanding global volume, and increasing working knowledge of local industry and networks in support of Export\Import activities and accessing global markets. The Project also developed communications strategies to promote the Centralina Region as a national leader in Advanced Manufacturing & Logistics and highlight career pathways and job opportunities aligned with the regional high growth industries.

- **IMCP Implementation Strategies.** A final overarching and inclusive step evaluated and advocated formation of a regional Consortium\Alliance to promote the Centralina Region’s manufacturing sectors growth, productivity, and prosperity by cultivating a collaborative Advanced Industries Manufacturing “Super-Cluster.” A primary strategic outcome of this plan includes the assessment and premise for establishing a permanent organizational entity\alliance to guide and implement the future strategic effort and plan recommendations. This alliance will bring together manufacturers, suppliers, educators, workforce boards, and economic developers to collaboratively implement strategies that support the initial four Project activities listed above that all play a role in optimal growth of the Centralina Region’s manufacturing community and ensuring a globally competitive ecosystem.
Mapping Key Value Chains

During the past 15 years, manufacturing has experienced significant national job losses. Many of those job losses occurred in manufacturing industries affected by offshoring, which now represent a smaller percentage of regional manufacturing jobs. The Greater Charlotte Region was harder hit than most and has only just begun to recuperate. Since 2010, the Greater Charlotte Region’s manufacturing sector has added over 13,300 net new jobs. This represents a growth rate during the past few years that is almost twice as fast as growth in overall US manufacturing employment. One key reason for this growth is the region’s attractiveness to foreign-owned firms, particularly German manufacturing firms. Unlike many other parts of the country where a single industry accounts for the core strength of their manufacturing base, the Greater Charlotte Region’s manufacturing sector has multiple strengths in several key clusters of industries including transportation equipment, energy, and defense and aerospace.

In order to better understand these important regional manufacturing clusters, this Value Chains assessment places a magnifying glass on several clusters to examine the value chains that drive them, emphasizing the role of eight key industries:

- Motor and generator manufacturing (NAICS 335312)
- Primary battery manufacturing (NAICS 335912)
- Turbine and turbine generator set units manufacturing (NAICS 333611)
- Electric power generation, transmission, and distribution (NAICS 2211)
- Heavy duty truck manufacturing (NAICS 33612)
- Aircraft parts and auxiliary equipment manufacturing (NAICS 336413)
- Ball and roller bearing manufacturing (NAICS 332991)
- Truck Transportation (NAICS 484)

The geographic scope for this Project element was the 16-county Greater Charlotte Region. Results are presented in this section of the Report, beginning with a current ecosystem assessment, followed by an examination of current trends and best practices, and concluding with recommendations.

Current Ecosystem Assessment

The GC Region has a diversified manufacturing sector. Unlike some regions where the automotive sector dominates the manufacturing landscape (e.g., Upstate South Carolina or Southeast Michigan,) the GC Region’s manufacturing sector is home to many different types of advanced manufacturers. This is important not only because it presents multiple market opportunities for regionally-based firms, but it also provides stability to the economy since it is not subject to any single industry’s economic cycles.

The GC Region has multiple strong industries, as shown in Figure 1. Automotive parts manufacturing represents a significant portion of the manufacturing sector. While the GC Region does not have a large passenger vehicle Original Equipment Manufacturer (OEM) along the lines of BMW in Upstate South Carolina or Nissan in Middle Tennessee, it has a number of large players in related automotive production. In 2014, there were over 10,000 jobs in the motor vehicle parts
manufacturing and motor vehicle manufacturing industries. Much of this employment came from firms like Daimler Trucks, but a significant share of employment can be tied to motor vehicle parts suppliers that feed into several different automotive supply chains throughout the southeast and nationally. As seen in Figure 1, these activities are relatively concentrated and pay average to above average annual wages.

The analysis focused on eight core industries. These industries were selected to align with industries identified in the *Prosperity for Greater Charlotte Comprehensive Economic Development Strategy*. The key clusters and the core industries selected for value-chain analysis are identified in Figure 2.
Several trends emerged from the analysis of the value chain linkages in these eight industries. For instance, two energy-related industries generally have strong forward and backward linkages within the GC Region: motor and generator manufacturing and primary battery manufacturing. This means that many of the key customers and suppliers for these industries are located within the GC Region, which captures a significant portion of the entire value chain. This also implies that the GC Region is particularly competitive in this value chain and could capture even more. Moreover, these particular industries have broad applications for a wide variety of manufacturing equipment and consumer products.

By contrast, turbine and turbine set units manufacturing has a narrower set of potential customers and applications, but one of those is the electric power generation, transmission, and distribution industry, reflecting the presence of Duke Energy. Turbine and turbine set units manufacturing also draws on the GC Region’s capacity for precision metalworking. This capacity is important for several other targeted regional industries, most notably aerospace-related activities and transportation equipment manufacturing. This sector is anchored by Daimler Trucks, but the GC Region has an extensive network of automotive parts manufacturers that not only supplies large OEMs like Daimler Trucks and automotive companies outside of the GC Region, but also provides important inputs for the GC Region’s trucking industry. Truck transportation is the primary method through which manufacturers ship their products to market, not just in the GC Region but in many other regions as well.
While each of the eight-targeted industries have their own value chains representing distinct buyer and supplier relationships, their commonly linked industries may well be among the most important in the GC Region’s overall manufacturing ecosystem. These industries are versatile because they can take advantage of multiple market opportunities, buffering the regional economy during downturns. Two industries that connect to multiple target industries include transmission, drives and gear manufacturing and engine equipment. These two industries make products that turn energy into work, and as a result are closely linked to the GC Region’s energy industries. As a result, these industries are likely to grow as the GC Region’s energy cluster develops.

Forging and stamping represents another industry critical to multiple value chains and reflects the importance of precision metal working to many of the GC Region’s target industries. The forging and stamping industry has grown faster in the GC Region than elsewhere. The talent required for metal working and the related skills are vital to the GC Region’s long-term growth. Similarly, other related metal working industries support the production of manufacturing equipment, including the production of metal valves, air and gas compressors, and fluid power process machinery. The GC Region’s central role in these industries means that its success depends not only on manufacturing’s success in the GC Region, but in the U.S. as a whole and even globally.

The GC Region has developed an extensive network of assets to support its manufacturing base. The GC Region’s educational institutions, support service providers, research centers, and infrastructure help make the GC Region a fertile environment for manufacturing and logistics. As described in this Report’s “Manufacturing Education Assets Inventory” section, local area industries are working collaboratively with the GC Region’s universities and community colleges to grow the talent pool and the GC Region is a national leader in developing apprenticeships for manufacturing trades. Building from the German apprenticeship model and with the leadership of area German manufacturers, the GC Region’s apprenticeship models are often cited as a model for effective delivery of apprenticeship programs in the U.S.

While workforce education and training often represents the most important foundation on which manufacturing must rely, a healthy manufacturing ecosystem can only thrive when innovation is also occurring. As documented in this Report’s “Entrepreneurial Support and Innovation” section, manufacturers in the GC Region have a number of technical and business support services that complement their efforts to grow and compete.

The GC Region also is well positioned as a global center for manufacturing because it has strong export and logistics infrastructure based in a multi-modal transportation network of rail, highway, air, and inter-modal connections that allows area companies to efficiently convey raw materials and component parts into the GC Region, and similarly ship completed products out to customers located anywhere in the world.

The GC Region has a strong foundation of assets upon which to continue growing its advanced manufacturing sector. To continue this growth, the GC Region must not only enhance the precision metalworking skills of its workforce, regional leaders must also be mindful of potential threats that could impact that metalworking tradition. For instance, companies using ferrous materials to make products are exploring innovative forms of newer and lighter materials that may not be as familiar to
area companies and their workers. In addition, regional manufacturers must also explore new and wider markets beyond the GC Region for their current and emerging products, in order to increase their footprint in the global market.

**Trends and Best Practices**

The key trends driving companies to map their value chains can be linked to increase costs associated with outsourcing and offshoring. This has created the need to look closer to home for firms that fill supply chain needs. Value chain mapping for manufacturers identifies relationships that provide an array of benefits that speak to the bottom line. Many firms have used or are using the information for:

- **Matchmaking events**: here industries are identified that are linked in the value chain and a business directory is created and utilized to invite these businesses to a matchmaking event that brings together manufacturers, suppliers, and customers. For example, a large OEM or first tier supplier would be able to get people's attention and leverage connections to create new business opportunities.
  - Fuzehub ([www.fuzehub.com](http://www.fuzehub.com)) a New York State initiative started out as a series of matchmaking events for manufactures and evolved into an online portal that helps small manufacturers identify resources and potential suppliers.

- **Supply chain optimization**: Creating programs to create supply chain optimization.

- **Supplier/technology scouting**: NIST MEP operate a program in partnership with RTI International that helps manufacturers find companies that either make products or have technologies that can help them solve challenges and/or fill gaps.

- **Supply chain entry assistance**: Small manufacturing firms often lack Electronic Data Interface (EDI) capabilities, which allows them to share information such as designs, financials, and other data with bigger firms, in order to build relationship for business interactions. Some support organizations can use the data collected through supply chain or value chain mapping exercises to identify the smaller firms that need to build the EDI capacity and assist them with obtaining the right certifications to do business with the larger firms.
  - One example of this is, SFMade ([www.sfmade.org](http://www.sfmade.org)) a non-profit group in San Francisco. They provide basic business services to small manufacturers in San Francisco and play an important connector role to services. One of their great successes was the DodoCase which makes cases for iPads and other electronic devices. SF Made helped connect the creators to an old book bindery that was struggling and soon to be going out of business, who could competitively produce the cases. This helped a small startup manufacture their product locally and prevented the book bindery from going out of business.

- **Identifying potential economic development targets**: By identifying the industries that are most closely linked, economic developers can determine a region’s economic strengths, its emerging opportunities, and potential gaps.

- **Developing partnerships**: With increasing risk and costs of mass-customization and production development, larger OEMs are co-designing and developing products with their key manufacturing suppliers.
Recommendations

The analysis and data from mapping key value chains will help practitioners target their attention and focus on a variety of areas that will enable continued growth and resiliency of the GC Region’s manufacturing sector. The data provides a roadmap of the customer and supplier value chains and relationships. This will assist economic developers and help manufacturers identify spin off effects and gaps of industries within the existing networks. The value chain mapping report’s Current Ecosystem Assessment also allows for understanding the multi-sector linkages and inter-industry expansion and growth opportunities. Lastly, the GC Region can create a recruitment message supported by defined data on market opportunities and sector stability for both expansions and prospects.

Several recommendations resulted from the mapping of key value chains accomplished in this project. These recommendations can help build on existing strengths and generate potential opportunities for the GC Region’s manufacturing sectors, and are described below in more detail.

Enhance Overall Support for Sector Driven Innovation

Advanced, mass-customizing industries drive the regional manufacturing sector’s growth. Energy, Automotive and Machinery manufacturing are all key components in this growth cycle characterized by intensive R&D and a high concentration of STEM workers. These industries contribute to a regional manufacturing “Supercluster”, and efforts that build these will likely involve expanding existing value chain strengths and filling the value chain gaps. Economic development efforts that focus on the GC Region’s targeted industries’ direct suppliers and customers offer the most promising strategy for creating more jobs and growing prosperity in the GC Region, taking advantage of the broad applications of an array of manufacturing equipment and consumer products produced that are integral to many OEM value chains.

Guide Identification of Cross-Linkages within Regional Value Chain

The GC Region is a key supplier of energy-related parts and equipment. If businesses take advantage of related product and service opportunities, not only for Duke Energy but also for other energy providers, this could represent the next generation of manufacturing in the GC Region. The manufacturing of motors, generators, batteries, and turbine production cross-link and highly integrate the GC Region’s capacity for precision metalworking. These skills are vital for many other industries, most notably aerospace-related activities, which have grown dramatically in nearby Greensboro and Charleston.

The GC Region has an important role in multiple value chains for the transportation equipment industry. As a center for commercial vehicle production and auto parts, transportation manufacturing relies on key OEMs like Daimler Trucks and bus manufacturing (e.g., Thomasville in nearby regions) but also suggests that the after-market auto parts manufacturing industry continues to represent a key opportunity. Changes in composite and lightweight materials may ultimately transform the vehicle parts manufacturing sector. The GC Region must access the innovations occurring as a result of automotive R&D and NASCAR prototype testing. This will allow efficient transfer of knowledge to area manufacturers to ensure that they stay ahead of the technology curve.
Tap Multi-Sector Value Chain for Expansion and Diversification

Industries that buy from, and sell to, many of the GC Region’s targeted industries represent important multi-sector value chain participation in the GC Region’s overall manufacturing ecosystem. They offer the greatest potential for new markets expansion and for local diversification. Local linkages are important, but value chain connections that extend beyond the GC Region are also vital to growth. Local firms rely on larger area companies as customers, but many also supply their products well beyond the GC Region to national and global markets.

Prepare Manufacturers for Technology Advances

Metalworking will remain vital to the GC Region’s manufacturers for years to come; however, the movement toward new and different materials is a trend to which area manufacturers need to pay attention. “Light weighting” is clearly a trend aimed at developing lighter, stronger materials through use of composites. Preparing companies and their workers for these technologies will require companies to engage with the GC Region’s sources of innovation and real world problem-solving at UNC Charlotte, North Carolina State or Clemson University that are leaders in innovation. Success will also involve working closely with technical assistance support services such as the North Carolina State Industrial Extension Service (part of the National Institute of Science and Technology’s Manufacturing Extension Partnership (NIST/MEP) and the UNC Charlotte Small Business and Technology Development Center as well as other knowledge-sharing resources like E4 Carolinas to deploy these innovations in companies.

In summary, the Current Ecosystem Assessment and resulting data support industry and economic development practitioner understanding of the spin-off effects from working with suppliers or customers in certain industries and how their success can benefit other industries. The process of identifying specific companies within each of these value chains and understanding inter-industry linkages can enhance the foundation for supplier-customer matchmaking as well as provide more targeted business recruitment focus and incentives rationale. The results not only benefit the company receiving assistance directly, but also strengthen the cluster of related suppliers and customers within the GC Region.

With the Key Value Chains for the Greater Charlotte Region’s Investing in Manufacturing Communities Partnership Report, economic developers can better tell the story to prospective new companies exploring the GC Region as a potential future location as well as investment consideration by existing industries. The GC Region’s manufacturing ecosystem is dynamic and innovative – with a strong foundation anchored in advanced technologies and advanced manufacturing. These competencies secure the GC Region’s economic prosperity and leading position in the global economy.

To read the full report see: Appendix A: Mapping Key Value Chains for the Greater Charlotte Region’s Investing in Manufacturing Communities Partnership Strategic Plan
Manufacturing Education Asset Inventory

The Centralina Region’s advanced manufacturing industries are incredibly diverse and connect to other target industry sectors (aerospace, automotive, energy and biomedical) through the varied education opportunities and skill development needs. Many of the traditional skill sets under the advanced manufacturing umbrella are well developed in the Centralina Region, including Industrial Maintenance, Industrial Technology, Engineering and Management. This strong base has allowed the manufacturing industry to remain a sustained pillar of the regional economy.

The geographic scope for this Project element was the nine-county Centralina Region. Results of this element of the Project are presented in this section of the Report, beginning with a current ecosystem assessment, followed by an examination of current trends and best practices, and concluding with recommendations.

Current Ecosystem Assessment

There are several secondary and post-secondary education pathways to support the skill development needs of the advanced manufacturing sector. In total there are 99 program offerings throughout the Centralina Region, 40 of which are at the pre-associate certificate level. While this preponderance of pre-associate level training opportunities aligns with the proportion and number of individuals working at that level, their aspirations and the Centralina Region’s potential for advancement may be limited without more opportunities for higher-level learning.

The specialty tracks within this sector range from electrical and mechanical system technology to machine tool and welding technology. As shown in Figure 3, most of these specialty areas offer a number of short-term opportunities for development of skills that support the advanced manufacturing sector. These allow for rapid assistance to people looking to transition into the industry or diversify their skill set while currently employed. What is lacking is the opportunity to continue this learning onto a higher level of degree completion, either through the community college system into an associate of applied science or an associate of science that would then lead to a bachelor degree, or through the four-year institutions. There is also a need to develop opportunities that will build skills particular to quality assurance and industrial engineering to support this sector.
Figure 3: Advanced Manufacturing Programs in the CCOG Region

C=Certificate, A=Associate, PAC= Post-Associate Certificate, B= Bachelor, PBC= Post-Bachelor Certificate, M= Master, D= Doctoral, *=Minor Only

<table>
<thead>
<tr>
<th>Manufacturing Programs</th>
<th>Belmont Abbey College</th>
<th>Central Piedmont Community College</th>
<th>Davidson College</th>
<th>DeVry University North Carolina</th>
<th>Gaston College</th>
<th>ITT Technical Institute-Charlotte</th>
<th>Johnson C. Smith University</th>
<th>Mitchell Community College</th>
<th>Pfeiffer University</th>
<th>Rowan-Cabarrus Community College</th>
<th>South Piedmont Community College</th>
<th>Stanly Community College</th>
<th>University of North Carolina at Charlotte</th>
<th>University of Phoenix-Charlotte Campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning, Heating and Refrigeration Technology</td>
<td>A, C</td>
<td>C</td>
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<td>C</td>
<td>A, C</td>
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<td>Architectural Technology</td>
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<tr>
<td>Automotive Systems Technology</td>
<td>B</td>
<td>A, C, A, C</td>
<td>A, C</td>
<td>A, C</td>
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<td>Civil Engineering Technology</td>
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<tr>
<td>Computer Engineering Technology</td>
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<tr>
<td>Construction Technology</td>
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<td>A, C</td>
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<td>A, C</td>
<td>B, M, D</td>
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<tr>
<td>Drafting and Design Technology</td>
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<tr>
<td>General Occupational Technology</td>
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<tr>
<td>Industrial Systems Technology</td>
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<tr>
<td>Mechanical Engineering Technology</td>
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<tr>
<td>Welding Technology</td>
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<td>A, C</td>
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</table>
Many of the skills developed within advanced manufacturing competencies are applicable to the plans of study for engineering, energy, automotive and aerospace sectors/competencies such as maintenance, mechanics, machining, and management. Individuals who have developed these competencies while working in these feeder sectors but who may not have earned the academic or industry credentials that validate those competencies are well positioned to transition into higher-level roles in advanced manufacturing. More deliberate transition programs could increase the availability of advanced manufacturing workers, and could include incumbent worker training, dislocated worker training, and continuation of two-year associate degrees to university programs. As a key component of such a transition program, colleges can work with students to validate the skills developed elsewhere as a way of advancing towards completion of new credentials much more rapidly.\footnote{Prosperity for Greater Charlotte: Jobs, Workforce & Education Alignment Strategy}

Collaboration with educational institutions has improved and continues to advance due to the emphasis being placed on skilled workforce development by the Centralina Region’s manufacturing community. The Centralina Region, together with the larger GC Region, is home to 10 state-sponsored community colleges, which together formed the Charlotte Regional Workforce Development Partnership that recently rebranded and organized as the Charlotte Regional Collaborative for a Global Economy. UNC Charlotte and the ten community colleges all offer nationally-recognized and innovative workforce training programs in partnership with local industry. Central Piedmont Community College (CPCC), the state’s largest community college, has partnered with area manufacturers and the Charlotte Mecklenburg Schools (CMS) K-12 public education system to create an apprenticeship program that allows high school students to work at companies like Siemens while they take job-related courses at CPCC. CPCC has also inaugurated a Center for Global Workforce and Logistics specifically to help provide the training and education needed for the anticipated 7,000 new jobs generated by the Charlotte Intermodal Facility over the next 20 years. Four other community colleges within the GC Region (Gaston College, York Tech, South Piedmont Community College, and Catawba Valley Community College) have established their own apprenticeship programs in the last 2 years, focusing on industry-specific advanced manufacturing courses and training.

The charts in Figures 4 and 5 (next page) provide the most recent information relative to the Centralina Region’s various apprenticeship programs supporting manufacturing businesses and developing the manufacturing workforce pipeline. Figure 4 includes detail on program participant eligibility, hours of On-the-Job Training and Job-Related Instruction, credential received by program participant (the type of certification and Associate degree if applicable), and the long-term job placement opportunity for program completers. The chart in Figure 5 provides further detail for each Apprenticeship program. This chart catalogs the various Skilled Trades developed per program, relevant Employer Partners, program service area per County within the Centralina Region, Community College partners and High School Systems (per county) where program participants are recruited into the program.

For a full analysis of the Centralina Region’s Advanced Manufacturing sector Education Asset Inventory see: Appendix B: Manufacturing Education Asset Inventory Update
### Figure 4: Apprenticeship Programs Supporting Advanced Manufacturing in the CCOG Region

Data for this overview was gathered via program information provided through the Higher Education institutions that run the various Apprenticeship programs and in collaboration with M/H/R Services LLC. All of this information is current as of June 2015.

<table>
<thead>
<tr>
<th>Program / Driver:</th>
<th>Eligibility</th>
<th>Hours of OJT and JRI</th>
<th>Credential Received</th>
<th>Long Term Job Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apprenticeship 2000:</strong> Employer Driven program established by Blum and Daetwyler in 1995. Once program functional, 6 other manufacturers joined it. Recently 3 left program.</td>
<td>Minimum 2.5 GPA Should have completed courses in Algebra 1&amp;2, Geometry, Physics, Drafting, Computer application, Attendance</td>
<td>8000 hours / including 1,750 of job related instruction</td>
<td>Journeyman's Certificate for DOL Registered Job: AAS Degree in Mechatronics Engineering Technology</td>
<td>Guaranteed employment after graduation at a predetermined starting annual wage, regardless of registered occupation.</td>
</tr>
<tr>
<td><strong>Apprenticeship Charlotte:</strong> Community College centered encouraged by Siemens in addition to &amp; then alternative to Apprenticeship 2000.</td>
<td>Admission to CPCC is pathway for high school students to enter Apprenticeship Charlotte programs with employers. Graduation requirements depend on registered occupation and employer</td>
<td>Up to 8000 hours / including 1,750 of job related instruction - depending on certification levels</td>
<td>Journeyman's Certificate for DOL Registered Job: AAS Degree in one of 8 Engineering Technology academic programs in which an AAS degree can be granted by CPCC.</td>
<td>No promise of employment by CPCC; terms and conditions of employment vary depending on Employer Partner policies</td>
</tr>
<tr>
<td>Program / Driver:</td>
<td>Eligibility</td>
<td>Hours of OJT and JRI</td>
<td>Credential Received</td>
<td>Long Term Job Placement</td>
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</tr>
<tr>
<td><strong>Apprenticeship Catawba:</strong></td>
<td>Minimum 3.0 GPA, Excellent math/technical skills, good attendance record</td>
<td>8000 hours / including 1,750 of job related instruction</td>
<td>Journeyman Certificate for DOL Registered Job: AAS Degree in Mechatronics Engineering Technology OR Computer Integrated Machining Technology</td>
<td>guaranteed employment based on satisfactory job performance and additional scholarship opportunities to continue education and obtain 4-year degree (may vary by company)</td>
</tr>
<tr>
<td>Apprenticeship 20/20:</td>
<td>At 1st: Minimum 2.5 H.S. GPA, Should have completed courses in Algebra 1&amp;2, etc.</td>
<td>At 1st: 8000 hours / including 1,750 of job related instruction. Now developing other programs.</td>
<td>Journeyman's Certificate for DOL Registered Job: AAS Degree in Mechatronics Engineering Technology OR in Industrial Systems Technology, depending on job</td>
<td>At 1st: guaranteed employment after graduation at a predetermined starting annual wage, regardless of registered occupation. With development of shorter programs for other jobs, marketing materials no longer mention guarantee.</td>
</tr>
<tr>
<td>Apprenticeship 321:</td>
<td>2013: STEAG hired community college students for first class of apprentices, then recruited high school grads in 2014. For new program, Gaston College to use Work Keys and math competency tests for students.</td>
<td>2013: 2 jobs registered with NC DOL agency: 1) 4,000 OJT; 2) 6,000 OJT with related classes.</td>
<td>Journeyman's Certificate for DOL Registered Jobs: As length of STEAG program not sufficient for apprentices to earn AAS degree, Gaston College awards certificate or diploma for directly related coursework and employer continues to sponsor willing students for AAS degree using tuition reimbursement program.</td>
<td>No firm promise of employment by STEAG; but all graduates have been offered jobs. For new program sponsored by CC, no firm offers of jobs, but competitive wages paid and tuition costs absorbed by employer. Prospects for employment very high.</td>
</tr>
</tbody>
</table>
The following overview provides further detail per Apprenticeship program. This chart catalogs the various Skilled Trades developed per program, relevant Employer Partners, program service area per County within the Centralina COG Region, Community College partners and High School Systems (per county) where program participants are recruited into the program.

**Figure 5: Apprenticeship Program Employer Partners in the CCOG Region**

<table>
<thead>
<tr>
<th>Program / Driver:</th>
<th>Skilled Trades</th>
<th>Employer Partners</th>
<th>Counties</th>
<th>Community Colleges</th>
<th>Recruiting High School System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprenticeship 2000: Employer Driven program established by Blum and Daetwyler in 1995. Once program functional, 6 other manufacturers joined it. Recently 3 left program.</td>
<td>CNC Machinist Welding Fabricator Tool &amp; Die Maker Machine Technician Mold/Plastics Technician Mechatronics Electrician Mechatronics Technician</td>
<td>Ameritech, Blum, Chiron, Daetwyler, Pfaff Molds</td>
<td>Iredell, Lincoln, Mecklenburg</td>
<td>Central Piedmont Community College</td>
<td>Iredell, Lincoln, Mecklenburg</td>
</tr>
<tr>
<td>Apprenticeship Charlotte: Community College centered encouraged by Siemens in addition to &amp; then alternative to Apprenticeship 2000.</td>
<td>CNC Machinist Welding Fabricator Tool &amp; Die Maker Machine Technician Mold/Plastics Technician Mechatronics Electrician Mechatronics Technician and others TBD</td>
<td>Bosch-Rexroth, HAWE Hydraulics, Daimler, Muratec, and Siemens</td>
<td>Mecklenburg and Others</td>
<td>Central Piedmont Community College</td>
<td>Charlotte-Mecklenburg System (CMS)</td>
</tr>
<tr>
<td>Apprenticeship Catawba: Employer Driven program modeled after Apprenticeship 2000 and including former employer partner (Sarstedt)</td>
<td>Mechanical Maintenance Technician Electrical Maintenance Technician Mechatronics Technician Tool &amp; Die Maker CNC Machinist</td>
<td>Aptar, Continental, GKN, Sarstedt, Technibilt, Tenowo, ZF</td>
<td>Catawba, Lincoln</td>
<td>Catawba Valley Community College</td>
<td>Catawba, Lincoln</td>
</tr>
<tr>
<td>Program / Driver:</td>
<td>Skilled Trades</td>
<td>Employer Partners</td>
<td>Counties</td>
<td>Community Colleges</td>
<td>Recruiting High School System</td>
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<tr>
<td><strong>Apprenticeship 20/20:</strong> Employer Driven program modeled at first after Apprenticeship 2000, but changing to Community College driven program.</td>
<td>At 1st: CNC Machinist Welding Fabricator Tool &amp; Die Maker Electrician Mold/Plastics Technician Maintenance Technician</td>
<td>At 1st: Greiner Bio-One, Safran Turbomeca, Vanguard Pai Lung were 3 employers who paid ($20,000) to start program with help of Golden Leaf grant. Now Greiner Bio-One is reportedly only company with apprentices.</td>
<td>Anson, Union</td>
<td>South Piedmont Community College</td>
<td>Anson, Union</td>
</tr>
<tr>
<td><strong>Apprenticeship 321:</strong> Registered as single employer driven (STEAG Energy Services) program in 2013; becoming a community college driven multi-employer program 2015.</td>
<td>STEAG initially registered 2 DOL recognized jobs: 1) Machinery Mechanic 2) Chemical Operator. Gaston College now registering at least 2 more jobs: 3) Multi-Machine Set Up Operator; 4) Tool Setter. If prospective Employer Partner with registered program (Daimler Trucks) joins Apprenticeship 321, it has 6 additional apprentices jobs registered with NCDOL.</td>
<td>Program Member: Aptar, CLT Packaging, Firestone Fibers, Kaco, Lanxess, Rockwood Lithium, and Wix Filters Apprenticeship Sponsors: STEAG Energy LLC, Daimler Trucks North America (2 plants)</td>
<td>Gaston, Lincoln</td>
<td>Gaston Community College</td>
<td>Cleveland, Gaston, Lincoln</td>
</tr>
</tbody>
</table>

NOTE: Information regarding the status of Registered Apprenticeship programs for manufacturing sector employers in the North Carolina counties of the Charlotte Region was updated in collaboration with M/H/R Services LLC.
**Trends and Current Practices**

The Manufacturing sector has been an early adopter, and leader in reinvestments in the American Apprenticeship model. The renaissance is even more prominent specifically in the Centralina nine county region with many manufacturing employers leading apprenticeship development and sustainability to continue creating a talented workforce pipeline for the Region. With the evolution in the American manufacturing sector to more technology based and the need for highly skilled workers, apprenticeship programs are great mechanisms to engage with a long-term talent pipeline, create an environment which contextualizes learning in a hands-on, industry-driven format and supports long term degree attainment for the workforce. The Greater Charlotte Region is currently enjoying several innovative approaches to apprenticeship programs in the manufacturing sector and is on a path to further cultivate and sustain these models for long term success – both for the workforce and the employer partners. To benefit future development of these programs this section provides an overview of apprenticeship program best practices from examples at a national level.

**Focus on Skill Development:**

**Focus on “Soft Skills” as much as the Technical “Hard Skills”** – “Soft Skills” are sometimes referred to as “Critical Skills”. Many programs have begun to have a heavier focus on these non-technical skills through the On-the-Job Training aspect of the apprenticeship program. These skills include critical thinking, problem solving, collaboration, teamwork and communication skills. These are all critical for a successful workforce and by folding skill development on these areas into the technical skill sets also developed within an apprenticeship model employers are positioned to create a well-rounded worker.

**Incorporate Technical Learning with Skill Remediation** – Many apprenticeship programs have had to overcome barriers of skill remediation particularly in the math and science fields. The State of Washington created the I-BEST model for learning (Integrated Basic Education and Skills Training) which is a nationally recognized model that quickly boosts students’ literacy and work skills and in some examples has been applied in the apprenticeship or pre-apprenticeship programs to create a larger applicant and program participant pool.

**Partnership Development and Sustainability:**

**Build Multi-Employer Partnerships** – While the particular skill needs and proprietary functions across employers may vary greatly there are several successful apprenticeship programs that work with several employers to identify foundational skill needs that will benefit the pipeline for the sector, as opposed to the employer themselves. These partnerships benefit the development of the workforce as a group and ensure that there are career opportunities on a more consistent basis due to multiple entry points across the group of employers alleviating the need for one employer to absorb all Apprenticeship graduates.

**Nurture Partnership with Community Colleges** – Community Colleges are key partners in the success of apprenticeship programs, as evidenced in all the models in the Greater Charlotte Region. Nationally there has been success across economy sectors by drawing upon the infrastructure for
training opportunities that exists within a Community College Instruction or System. The Colleges can offer the Related Training and Instruction for many skilled trades that would benefit not just the manufacturing sector but other industries core to the Greater Charlotte economy.

**Focus on Program Structure:**

**Leverage National Training Resources and Input** – National partnerships have helped to sustain apprenticeship programs and lessen the cost of training development for individual employer partners. Developing a Coalition of Industry from other manufacturing sector employers across the country will provide key input on national trends and needs, at the foundational level, within the industry and the workforce pipeline. For example the Energy Providers Coalition for Education (EPCE) includes employers from all over the country who help to inform education curriculum at the pre-apprenticeship and apprenticeship levels. This model creates a large network of industry leaders and increases collaboration among industry and education beyond the geographic area of where the business is located.

**Include Placement Services and Follow Up for Program Graduates** – Programs have begun to invest in post-program services to ensure that the apprentice completer has found employment (if not directly offered as a part of the apprenticeship program) and has been successful in their job placement (validating the learning that occurred during OJT and Related Training offered in the program). This creates a holistic feedback loop to both employer and education partner to continue modifying apprenticeship program structure to ensure long term employability for their graduates.

**Provide Financial Assistance to Students** – Supporting students tuition costs associated with the apprenticeship program (either partial or full tuition payments or reimbursement) directly contributes to the success of program students and helps either supplement or eliminate the financial burden that Higher Education programs represent for many workers. Financial assistance can be provided for tuition, textbooks and fees.

The following two programs are good examples of how Statewide and National partnerships have come together to support apprenticeship programs. This information was gathered from their website information. The link to each website which contains contact information on program leadership is included in the overview.

**Aerospace Joint Apprenticeship Committee (AJAC) – State of Washington Model**

In 2008 the State of Washington funded the creation of the Aerospace Joint Apprenticeship Committee to serve as a state-wide sector partnership to develop Apprenticeship programs serving the number of various trades supporting the Aerospace industry throughout Washington. AJAC is a statewide, nonprofit 501(c) 3 aerospace and advanced manufacturing registered apprenticeship program.

AJAC and its advisory committee, comprised of employers and employees, have developed and implemented the following registered apprenticeship programs based on employer and industry need:
• Machinist (Aircraft-Oriented)
• Aircraft Mechanic Airframe
• Precision Metal Fabricator
• Tool and Die Maker
• Industrial Maintenance Mechanic
• Aircraft Interiors Assembly Mechanic (In Development)
• Composite Technician (In Development)

Apprenticeship combines supervised on-the-job training experience with college-level classroom instruction enabling:

• Employees to earn a living wage while they learn on-the-job from a mentor and attend class one night a week at a local community or technical college
• Employers to increase their workforce skills without disrupting production

AJAC’s program offers:

• Employers across Washington State a proven method to capture these knowledge and skills
• Apprentices the tools necessary to learn and master these skills, advance in their career and become a master tradesperson
• Step by step process for employers to begin an apprenticeship
• Central guidance for employer mentors and apprentices

In addition to obtaining journey-level certification as a master tradesperson, AJAC’s unique program sets the apprentice on a path towards an associate’s degree that can articulate into a four-year degree. Companies across Washington State who participate as registered Training Agents with AJAC can enroll current employees in an existing AJAC program. If a company has 15 or more employees that need training in one of AJAC’s currently registered occupations, AJAC can create a new program exclusively for that company. More information can be found at: http://www.ajactraining.org/

Energy Providers Coalition for Education (EPCE) – National Model
The Energy Providers Coalition for Education (EPCE) is a group of representatives from the energy industry that develops, sponsors, and promotes industry-driven, standardized, quality online learning programs to meet the workforce needs of the energy industry. EPCE is the premier source of online energy education, built to address the critical employment needs of the evolving utility industry. EPCE members represent energy leaders across the country, from Washington State to Florida, who collaborate with accredited education providers to develop utility-specific solutions to education and training needs. Since June 2000, EPCE has served as a national resource for online energy education programs that are:

• High Quality - interactive and instructor lead; offered by fully accredited leading institutions
• Industry Supported - designed by and for the industry to address workforce challenge faced by energy companies today
• Convenient - available online 24/7; study anytime, anywhere
In response to member need EPCE created an innovative blended learning approach to the typical Apprenticeship program. EPCE created and implemented an online program in Electric Power Technology courses to meet specific training needs within approved apprenticeship training programs. The EPCE sponsored online Electric Power Technology Education program, delivered by the Bismarck State College National Energy Center of Excellence, provides apprentices with a core set of skills and competencies as well as a foundation in electrical systems, transformers and electric components. EPCE developed and regularly maintains and updates coursework within the apprenticeship programs through a national curriculum committee made up of representatives from major industry organizations.

Advantages of the Apprenticeship Programs:

- Apprentices have a foundation of knowledge from the online, industry specific courses, which allows the on-the-job instruction to go deeper into the subject matter
- After gaining more knowledge, apprentices are better prepared to step up to their responsibilities, show increased confidence, and be inquisitive and engaged
- The online courses allow for flexibility with the company apprenticeship schedule, allowing for 4, 8, 12 and 16 week offerings
- Apprentices receive college credit for the courses
- Upon completion of the apprenticeship program, apprentices are well on the way to obtaining an associate’s college degree
- The program increases the number of college graduates at the company
- The online courses are attractively priced when compared to other outsourced training options

More information can be found at: http://epceonline.org/apprenticeship-program

Recommendations

Greater demand for matching trained employees is growing exponentially and resources for implementing programs to greater scale across the region are required. The region must increase uniformity and training capacities for attainment of certifications, diplomas, and other industry-recognized credentials to prepare students and eligible adult workers for high-wage, high-skill employment or re-employment in growth industry sectors and develop standardized credentials that are widely recognized by employers and other educational institutions.

A 2013 report\(^7\) by the Boston Consulting Group identified three manufacturing occupations in which there is a significant gap between demand for those skilled workers and the available supply in the Charlotte area and four other metropolitan regions: CNC Operators, Machinists, and Industrial Machinery Mechanics. Furthermore, the 2007 CH2MHill “Advanced Manufacturing: Major Report” identified gaps in eight additional job sectors based on technologies common to the

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\(^7\) “Made in the American, Again: The U.S. Skills Gap: Could it Threaten a Manufacturing Renaissance?”, The Boston Consulting Group, August 2013

Below are some recommendations for activities that can strengthen and grow the Region’s training and education assets the region's manufacturing sector.

**Expand awareness of the Advanced Manufacturing sector and career pathways**

The Region is at the forefront of providing a pipeline of highly trained and educated professionals for the advanced manufacturing sector. The critical issue is achieving and expanding career pathways awareness, with related issues of economic development, business engagement, college to career alignment, and social justice. The Region’s stakeholders need to increase awareness of career pathways that lead to and support the talent pipeline for projected in-demand occupations in the advanced manufacturing sector. It is imperative that the region formalize structures for workforce system partnerships across the region, in order to develop and brand a regional message promoting these pathways. By formalizing the structure and roles of the various actors, regional collaboration will be strengthened, which will reduce duplication of efforts and leverage resources. Developing a messaging platform for career pathway awareness, will allow for engaging targeted industries at a higher level, giving way to opportunities for more direct input from industry on workforce demands to ensure alignment with career pathway messaging.

**Invest in existing and new Advanced Manufacturing training centers**

Six of the Greater Charlotte Region’s 10 community colleges have established Advanced Manufacturing Training Centers. The Centers have forged unique local industry sector partnerships for industry equipment support and investment and all colleges have coordinated training and curriculum partnering with local industries. This regional distribution of training assets strengthens the talent pipeline ecosystem, region wide in support of a collaborative and coordinated manufacturing workforce strategy. These colleges have also been at the national leading edge in apprenticeship and certified skills programs that support a regional competitive advantage exhibited most prominently in the Siemens –CPCC workforce training partnership and the Apprentice 2000 and Carolina Apprenticeship programs. Investments will ensure a growing pipeline of talent with the education and training needed by local manufacturers.

**Expand additional regional apprenticeship and internship program capacity**

While programs currently exist, the programs are small in scale compared to the actual industry need for trained workers. Current programs need to be expanded and resources need to target regional manufacturers to increase participation to afford development of programs that are responsive to workforce needs. Regional partners should request and deploy funding targeted to expanding advanced manufacturing training capacity, from federal sources such as DOL,WIOA, TAACCT, and NIST. Additionally, regional Apprenticeship and Workplace Learning Conferences should be coordinated to inform manufacturers and potential workers of these programs and opportunities.
Facilitate additional funding for manufacturing affiliated curriculum and degree programs

Collaboration with educational institutions has improved and continues to advance due to the emphasis placed on skilled workforce development by the Region’s manufacturing community. UNCC and the community colleges all offer nationally recognized and innovative workforce training programs in partnership with local industry. CPCC has inaugurated a Center for Global Workforce and Logistics specifically to help provide the training and education needed for the anticipated 7,000 new jobs generated by the Charlotte Intermodal Facility over the next 20 years. It is imperative that funds are available that allow for our educational system to be responsive to industries workforce needs by developing curriculum, to prevent skilled workforce gaps in the talent pipeline.
Entrepreneurial Support and Innovation

It is widely acknowledged by economic practitioners and policy makers that entrepreneurship is a key characteristic needed to drive regional prosperity. Similarly, many also suggest that innovation is the principal means by which regions nurture economic prosperity and global competitiveness. This new era of manufacturing called “advanced manufacturing” has evolved to incorporate software solutions, 3D printing, the utilization of “Big Data,” and service integration. This new stage will require both an entrepreneurial spirit and a capacity for innovation from the Region’s manufacturers. In order to ensure that the manufacturing sector can continue to make gains, we must ensure our systems support entrepreneurship and grow capacity for innovation.

The geographic scope of this element of the Project is the 9-county Centralina Region. Results of this element of the Project are presented in this section of the Report, beginning with a current ecosystem assessment, followed by an examination of current trends and practices, and concluding with recommendations.

Current Ecosystem Assessment

The Centralina Region has a wealth of assets for research and innovation supporting its advanced manufacturing competencies. Chief among them are: the Business Innovation & Growth (BIG) Council; the NC Research Campus (“NCRC”); UNC Charlotte; and the National Institute of Science and Technology’s Manufacturing Extension Partnership (NIST/MEP). Each is described in more detail below.

The Business Innovation & Growth (BIG) Council

BIG is a non-profit membership-based organization whose member are [state what kinds of entities]. BIG’s mission is to lead development of “high-impact, high-growth entrepreneurs” and proactively grow their businesses by providing education, resources, leadership, and visibility. BIG educates members on best practices for growth-oriented companies and provides “concierge services” (resources and access) which would not otherwise be available to the entrepreneur.

The North Carolina Research Campus (NCRC)

NCRC is a $350 million facility for biotechnology applied research located on the former Pillowtex mill site in Kannapolis, NC, just northeast of Charlotte. Its research capabilities support the Centralina Region’s Biomedical and Life Science manufacturing target cluster. All of the campus’ partners and collaborators have access to the support of the UNC Charlotte’s Bioinformatics Services Division and the David H. Murdock Research Institute (DHMRI), which houses the largest and most advanced collection of scientific equipment in genomics, proteomics, metabolomics, light microscopy and nuclear magnetic resonance.
University of North Carolina at Charlotte

UNC Charlotte is a Doctoral and Research Intensive university and the fourth largest in the 16-campus UNC system. It supports the Region’s advanced manufacturing competencies with an array of academic programs and university research assets. Highly aligned with the key innovation industry clusters of the Region, UNC Charlotte has identified advanced manufacturing, Energy Production and Infrastructure, and Informatics as the three focus areas for research. UNC Charlotte has assembled a strong manufacturing sciences faculty and associated facility capabilities with a national reputation, including the Center for Precision Metrology, North Carolina Motorsports and Automotive Research Center, Optoelectronics Research Center, and the new Energy Production and Infrastructure Center (“EPIC”).

UNC Charlotte’s research capabilities include 13 faculty members actively engaged in advanced manufacturing research on one of the largest, most prestigious, and best equipped teams at any university in the USA. The team includes six of the 20 US Fellows of the prestigious International Academy for Production Engineering, and leaders from the Society of Manufacturing Engineers and its North American Manufacturing Research Institute, the Manufacturing Engineering Division of the American Society of Mechanical Engineers, and the American Society for Precision Engineering.

Further, UNC Charlotte has strong experience working on cooperative R&D with industrial partners and operates six different research consortia (National Science Foundation, Industry/University Cooperative Research Centers) in metrology, free form optics, meta-materials, robotics, information security, and sustainable building systems. Additional research centers in lean logistics, energy production and infrastructure, motorsports and automotive engineering, optoelectronics, and biomedical engineering all offer additional R&D talent and infrastructure for existing and emerging manufacturing firms. The William States Lee College of Engineering at UNC Charlotte offers programs in mechanical engineering, electrical engineering, civil engineering, systems engineering, and engineering technology. The College of Computing and Informatics offers programs in computer science, software and information systems, and bioinformatics along with a new and growing initiative in data science and business analytics. Engineering students complete a sequence of design-build courses, with hands-on experience in manufacturing labs, which are continually updated to incorporate R&D results.

At UNC Charlotte, the Charlotte Research Institute (CRI) is the portal for business-university partnerships, focusing on applied research and technology transfer in intelligent energy, manufacturing and precision metrology, eBusiness technology, optoelectronics and optical communications, biosciences and biotechnology. CRI connects businesses, researchers, governmental agencies, and academia with exceptional facilities and equipment to enhance intellectual capital, accelerate tech commercialization, and create global educational and industry partnerships. CRI is home to several significant research assets supporting Advanced Industries: US-MADE (U.S. Manufacturing Advancement through Digital Enterprise), EPIC (Energy Production and Infrastructure Center), PORTAL (Partnership, Outreach and Research to Accelerate Learning), Ventureprise, and the University’s Office of Technology Transfer.
EPIC Laboratories support sponsored research projects and provide unique and specialized testing environments (such as Smart Grid, High-bay Structures, Materials Characterization, Large Manufacturing, Renewable Power, and Photovoltaic Research).

**UNC Charlotte: EPIC High-Bay Structures Laboratory:**
Faculty and students can conduct research and assist industry partners to improve material designs and create new innovative infrastructure solutions for a variety of industries.

UNC Charlotte invested $35 million to construct the PORTAL building which opened in February 2014 on the CRI campus which offers over 90,000 square feet of space for R&D partnerships, innovation, and business startup as well as a secure facility for classified R&D. The Office of Technology Transfer is located in the building along with Ventureprise, Inc., the university’s entrepreneur support operation.

Ventureprise is a non-profit organization anchored at UNC Charlotte and governed by a 14-person board of directors that represents all key stakeholders including entrepreneurs, investors, higher education, research organizations, industry, and local government. Ventureprise is both a community organization and UNC Charlotte’s focal point for a full range of commercialization and entrepreneur support services. Ventureprise serves resident companies and hundreds of additional companies that participate in educational and consulting programs. Ventureprise focuses on serving innovation-driven enterprises in the Charlotte metro area, on average assisting 20-24 startups and early stage commercial ventures and incubates 6 to 10 student businesses annually.

The Small Business and Technology Development Center (SBTDC) organization is housed on the UNC Charlotte campus. The director and five counselors provide business advisory services to about 700 small businesses annually. Special services include export assistance and Small Business Innovation Research/Small Business Technology Transfer assistance and also houses the district U.S. Export/Import Bank.

**The National Institute of Science and Technology / Manufacturing Extension Partnership**
NIST/MEP programs in North Carolina are provided through the North Carolina State University Industrial Extension Service (IES). The IES’ Growth and Innovation Services include Innovation Engineering, Technology Scouting, and Technology Driven Market Intelligence, and New Product Development Systems consulting and one-on-one industry engagements. Two regional offices are located in the Region and actively engage with area partners.
The Region’s support systems for entrepreneurship, R&D, and innovation solutions are aligned to bring concepts to the shop floor and geared to business performance needs. However, these systems need to increase efficiency for connecting these manufacturing firms with R & D potential for innovation, profitability, and job growth. That is, the regional actors must make greater efforts to communicate the existence of these programs and encourage users of these services to become peer-to-peer mentors for developing new businesses and innovative solutions in the manufacturing community.

**Trends and Current Practices**

Nationally, most manufacturing sectors are seeing a requirement to innovate and to implement corporate entrepreneurial practices in order to satisfy the changing demands on manufacturers. Factors that are contributing to manufacturing entrepreneurship include the economy’s rebounding from the Great Recession and the increase in automation leading to needs for smaller but more highly skilled employee base. Automation has reduced the advantages of outsourcing manufacturing to countries with lower labor costs, paving the way for entrepreneurial manufacturing in the domestic market. Many sectors now demand high-quality and high-value items, which is opening up opportunities for innovative manufacturing in the U.S.

In addition, academia is also noting the trend of emerging practices exhibiting both entrepreneurial thinking and innovation, identifying an implicit coordination between the two among manufacturing firms. Additionally, studies on regional growth theories are providing new insights on the significance of entrepreneurship, on competition-led processes and innovation. Such studies illustrate the connections and positive effects of entrepreneurship on job creation and competitiveness, which ultimately contributes to the restructuring of regional economies.

Key trends and emerging practices:

- Manufacturing companies are doing more with a reduced labor force, by leveraging automated/virtual manufacturing and “reshoring” resources. These practices help to streamline processes while realizing cost savings on equipment and labor.
- Refinement of product development, manufacturing, and supply chain processes aid manufacturers in realizing business value from mass customization.
- Companies will continue to explore the question: Should process design or technology automation come first? Many product lifecycle management (PLM) systems now are being designed for configuration around generic processes. Therefore, some companies will opt to start with a Product Life Management software overhaul first and then fix their processes.
- Manufacturers are bringing more 3D printing tasks in-house as key patents expire and high quality 3D printing becomes more economical.
- More cross-functional technology integration to enable synergies between marketing, sales, engineering, and manufacturing.
- Requirements for management software are growing, which allow companies to verify and validate how well their products actually meet customer needs.
- Continued advancement in electronic engineering notebook technology.
- Logistical innovation and efficiency - lean manufacturing.
Recommendations

While the Centralina Region has made great strides in this area, the scale of transfer of technology to shop floor and commercialization of R&D lags other major centers in the state and the nation. In order for the Centralina Region to enhance its ability to compete in this global economy, stakeholders need to build upon existing partnerships to create entrepreneurial and innovation capacity and capital.

This can be accomplished if providers and businesses can work together to address gaps and allow the sharing of best practices and successes. New and emerging industries and technologies must be supported through improved entrepreneurial support systems and targeted infrastructure improvements. The Centralina Region’s industries must increase integration of new technologies to remain competitive and leverage new logistics assets and infrastructure to access global markets (such as the new intermodal facility at the Charlotte Douglas Airport and regional telecom infrastructure).

Below are several recommendations for efforts that can strengthen and grow the Centralina Region’s Research and Development and Innovation assets and infrastructure.

Investigate and promote avenues for more cost effective access to state-of-the-art facilities and technical assistance

For the U.S. manufacturing sector, the greatest growth areas after the Great Recession were in the computer and electronics sectors, heavily centered in technology. The trend of fostering R & D in an effort to fuel innovation has replaced process improvement as the key focus area for growing the manufacturing base. In order to support this new growth area, investments must be increased for entities such as manufacturing extension services, to effectively stimulate small and medium enterprises to improve, use, or acquire technology to encourage innovation. Further, new and existing industries must have access to facilities and expertise for R & D. Institutions operating these facilities need to collaborate to increase shared access and leverage more industry investments with government funding. This will allow for funding to be utilized more efficiently, ensuring facilities are equipped with state of the art equipment relevant to current industry needs.

Expand focus and investments for building regional capacity for work with private firms on Technology Innovation and Transfer

Service providers need to increase outreach efforts and vehicles, to inform and engage regional industries with the resources currently available, to better meet the demand for technology development motivated by industry-identified problems and transition from laboratory to factory. Broad knowledge of resources will increase usage and will allow for lobbying Federal and State agencies for increased financial support for these services. Additionally, regional resource providers should develop partnerships to leverage the cost of providing services to businesses. Investing in UNC Charlotte’s Charlotte Research Institute and the existing community colleges network in a collaborative effort for technology distribution and “lab to shop floor” success with local industry sector partnerships and economic development networks, will be attractive to potential outside investors.
Export and Logistics Assets and Advantages

As U.S. business, civic, and government leaders seek to increase revenues and employment and promote overall economic competitiveness, they must adapt to rapidly changing global realities that are shifting the focus of demand for U.S. produced goods and services. Given these global opportunities, the volume of total international trade grew by 26 percent between 2009 and 2013, reaching $17.4 trillion. While exports are not the only reason that these firms prospered, a global perspective, which often includes an investment in innovation and R&D, strong supply chains and logistics, and a talented staff, are all factors that contribute to enhanced revenue performance.

In a February, 2015 announcement, U.S. Secretary of Commerce Penny Pritzker stressed the fact that exports are critical to economic growth and job creation in communities across the country. “With 95 percent of the world’s consumers living outside the United States, opening more markets to ‘Made in America’ goods and services is fundamental to our nation’s competitiveness, job creation, and the economic security of our families,” she said.

Since 2009, exports have helped pull the U.S. economy out of the devastating recession that occurred between 2007 and 2009. Growing from about $1.8 trillion in 2008 to $2.35 trillion in 2014, exports have contributed more to the growth of gross domestic product (GDP) in this recovery than in the previous recovery. During the past 20-year period, with the exception of when the economy was in a recession, export growth has been steady, with an average growth rate of about 6.4 percent in nominal terms and about 5.0 percent in real terms, as shown in Figure 6.

In addition, exports, whether measured on a nominal or real basis, have set record highs in each of the last four years. This growth in exports has helped to generate many benefits for the U.S. economy, including providing support for millions of high-paying jobs.

1. The production of exported goods and services creates jobs, both directly and indirectly in the supply chain. One study finds that every $1 billion in new exports creates 5,400 additional jobs.

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2. Export sector jobs pay well; for every $10 billion in sales in a metropolitan export industry, its workers earn 10 to 20 percent higher wages than those in non-exporting jobs.9

U.S. Metropolitan Statistical Areas continue to be critical drivers of the nation’s export economy, with goods exports from 134 metropolitan areas achieving record highs in 2013. An International Trade Administration profile of U.S. exporters provided the following:

- More than 304,000 U.S. companies exported goods in 2013, which is a 10 percent increase from 2009. Manufacturing firms account for less than a quarter of U.S. exporters (74,398); however, this sector accounted for 60 percent of total known export value in 2013.
- Small- and medium-sized enterprises, or SMEs, which are firms with fewer than 500 employees, accounted for 98 percent of the number of U.S. exporters in 2013 and $471 billion in known value of goods exports.
- Jobs supported by total exports were 11.3 million in 2013, an increase of 1.6 million since 2009.

U.S. Secretary of Commerce Penny Pritzker announced new data on February 27, 2015 that showed 26 states achieved records in goods exports in 2014. Total merchandise exports from all 50 states helped the U.S. achieve the fifth consecutive record-setting year of exports, which reached $2.35 trillion in 2014.

The top 15 of the 26 States that set new records for Exports in 2014 are:
Texas ($289.0 billion);
California ($174.1 billion);
Washington ($90.6 billion);
Illinois ($68.2 billion);
Louisiana ($65.1 billion);
Ohio ($52.1 billion);
Georgia ($39.4 billion);
Indiana ($35.5 billion);
Tennessee ($33.0 billion);
North Carolina ($31.3 billion);
South Carolina ($29.7 billion);
Kentucky ($27.5 billion);
Wisconsin ($23.4 billion);
Minnesota ($21.4 billion);
Arizona ($21.1 billion);

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Export & Logistic assets provide major competitive economic advantages for the Greater Charlotte Region and are important foundations to the IMCP Global Charlotte Manufacturing Ecosystem Development Strategy (MEDS).

The geographic scope of this element of the Project is the 9-county Centralina Region. Results of this element of the Project are presented in this section of the Report, beginning with a current ecosystem assessment, followed by an examination of current trends and practices, and concluding with recommendations.

**Current Ecosystem Assessment**

The Exports and Logistics ecosystem assessment looks at both the Charlotte MSA’s exports themselves and at its export institutions and assets.

**Ecosystem Exports**

The Charlotte MSA contributes strongly to the NC and national export industry:

- In 2011, the Charlotte MSA exported more than $6.2 billion in goods around the world, up $2 billion since 2006.
- In 2012, the Charlotte MSA was the 42nd largest export market in the United States, with merchandise shipments totaling $6.3 billion, up 1.1 percent from 2011.
- In 2013, the Charlotte-Concord-Gastonia, NC-SC MSA became the 31st largest export market in the United States with merchandise shipments totaling $10.7 billion. This made it the #1 fastest-growing export market among the top 50 U.S. metro areas (with a 69.0 percent annual growth rate, as shown in Figure 7).
- In 2013, the Charlotte-Concord-Gastonia, NC-SC MSA was one of seven out of the top 50 metropolitan areas that saw their exports more than double since 2009 (up 158%).

![Figure 7: Fifteen Top 50 Metro Areas Saw Double-Digit Export Growth in 2013](image_url)
- Over 1000 foreign-based companies call the Charlotte area home, representing over 50 countries, including Germany (189 firms), the United Kingdom (120), and Canada (90). (Source: Charlotte Chamber)

- In 2011 (latest data available), 2,858 companies exported goods from the Charlotte metropolitan area. Of these, 2,440 were small- or medium-sized exporters with fewer than 500 employees.

As shown in Figure 8, the Charlotte MSA is a major exporter among the nation’s MSAs of these products: textiles and fabrics; primary metal manufacturing; fabricated metal products; and nonmetallic mineral products.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Value</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation Equipment</td>
<td>$3.1 billion</td>
<td>29.1%</td>
</tr>
<tr>
<td>Machinery, Except Electrical</td>
<td>$2.2 billion</td>
<td>20.2%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>$1.1 billion</td>
<td>9.9%</td>
</tr>
<tr>
<td>Paper</td>
<td>$634 million</td>
<td>5.9%</td>
</tr>
<tr>
<td>Plastics and Rubber Products</td>
<td>$617 million</td>
<td>5.8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Value</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico</td>
<td>$3.9 billion</td>
<td>36.0%</td>
</tr>
<tr>
<td>Canada</td>
<td>$1.8 billion</td>
<td>16.4%</td>
</tr>
<tr>
<td>China</td>
<td>$635 million</td>
<td>5.9%</td>
</tr>
<tr>
<td>Germany</td>
<td>$335 million</td>
<td>3.1%</td>
</tr>
<tr>
<td>France</td>
<td>$324 million</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

Source: Office of Trade and Industry Information, Manufacturing and Services, ITA, US Commerce

According to data from the International Trade Administration (ITA) data, the Charlotte MSA Region’s Trade Export Chains include 851 manufacturing entities, which are distributed by size as shown in the Figure 9. The figure also shows the Charlotte MSA region’s rank among of the 386 MSAs in the nation.

<table>
<thead>
<tr>
<th>Size (Employees)</th>
<th>Number of Firms</th>
<th>National MSA Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>151</td>
<td>24</td>
</tr>
<tr>
<td>1-19</td>
<td>157</td>
<td>30</td>
</tr>
<tr>
<td>20-99</td>
<td>172</td>
<td>27</td>
</tr>
<tr>
<td>100-499</td>
<td>125</td>
<td>23</td>
</tr>
<tr>
<td>500+</td>
<td>246</td>
<td>17</td>
</tr>
</tbody>
</table>

Source: Office of Trade and Industry Information, Manufacturing and Services, ITA, US Commerce
Figure 10: Export Values by County in 2013

<table>
<thead>
<tr>
<th>County</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mecklenburg County</td>
<td>$5.6 billion</td>
</tr>
<tr>
<td>York County</td>
<td>$1.3 billion</td>
</tr>
<tr>
<td>Union County</td>
<td>$1.0 billion</td>
</tr>
<tr>
<td>Gaston County</td>
<td>$678 million</td>
</tr>
<tr>
<td>Cabarrus County</td>
<td>$662 million</td>
</tr>
<tr>
<td>Iredell County</td>
<td>$555 million</td>
</tr>
<tr>
<td>Rowan County</td>
<td>$448 million</td>
</tr>
<tr>
<td>Lancaster County</td>
<td>$223 million</td>
</tr>
<tr>
<td>Lincoln County</td>
<td>$168 million</td>
</tr>
<tr>
<td>Stanly County</td>
<td>$148 million</td>
</tr>
<tr>
<td>Chester County</td>
<td>$58 million</td>
</tr>
</tbody>
</table>

Source: Office of Trade & Industry Information, Manufacturing and Services, ITA, U.S. Department of Commerce

Ecosystem Logistics Assets

In 2014 Site selection magazine ranked Charlotte 5th in the nation for new and expanded distribution operations, with 192 facilities. Charlotte is also the nation’s 12th largest trucking center, with more than 339 firms. More than 817 transportation and warehousing companies call “Charlotte USA” home. The Region boasts more than 60 freight forwarders, custom house brokers and professional international service providers. These logistics assets coupled with the Airport and rail infrastructure form a rich network of assets to support the continued growth and success of the Region.

Co-located at the Charlotte Douglas International Airport, the Region’s new $92 million Charlotte Intermodal Facility, privately built and operated by Norfolk-Southern Railway, is expected to generate over $7 billion in regional economic impacts and create more than 7,000 jobs in the Region by 2030. The 200-acre facility has the capability to move 200,000 TEU per year, with parking for up to 1,331 trucks and potential for future expansion capacity on-site. The facility significantly expands capacity for distribution and the transfer of goods between rail, highways, air and connected seaports in Charleston, Savannah and Norfolk. The Region is the center of the country’s largest consolidated rail system—Norfolk Southern and CSX link 43,200 miles of rail between Charlotte and 23 Eastern states.

Charlotte Douglas International Airport (CLT) is the largest airport in the Region and one of the largest in North Carolina and South Carolina. It is the second largest hub to American Airlines, the world’s largest airline. Over the last 20 years, CLT has become not only one of the busiest airports in the U.S., but in the entire world, averaging more than 700 departures each day. Charlotte Douglas
International Airport is the nation’s 6th largest airport in operations, and 8th busiest in passengers. Growth has been remarkable over the last 10 years increasing from 25 million total passengers in 2004, to 44.3 million total passengers in 2014.

Building to keep up with demand is ongoing and a soon to be finished completion of $1 billion in facility expansions known as CLT 2015 includes two new decks, expansion of the terminal and new entry and exit lanes. The results have been a changing landscape at CLT during a period of extraordinary growth but still means CLT is at or near capacity.

A recently completed airfield capacity and terminal capacity enhancement studies looked at possible and potential passenger growth forecasts and have formed the Airport’s new Master Plan Update. “Destination CLT” encompasses the first phase, a collaborative effort with airline partners and the FAA representing a $2.5 billion capital investment in capacity enhancement projects that define future development by CLT through 2035.

CLT officials are currently planning the next phase of an economic development plan that has been more than 15 years in the making. The CLT Aviation Department has been assembling the key land parcels surrounding the Airport with the aim of creating an economically viable Logistics-oriented commercial/industrial development, leveraging the conjunction of the Airport, Intermodal Facility, Interstates I-85, I-77, and I-485, and other major highways, and ensuring compatibility of new development with Airport and Logistics land uses. This significant undertaking will take years to fully develop but this globally focused initiative is aligned to attract businesses such as manufacturing, warehousing, transportation, trucking, distribution, research, development and data to the available 6,000 acres of assembled land.

**Export, Trade Partners and Assets**

Charlotte is home to the main office of the NC District for the U.S. Commerce, International Trade Administration/Commercial Services (ITA). ITA works to improve the global business environment and helps U.S. organizations compete at home and abroad. ITA supports President Obama’s recovery agenda and the National Export Initiative (NEI/NEXT) to sustain economic growth and support American jobs. As an MOU partner with the Global Charlotte Manufacturing Consortium, ITA connects the Consortium to the U.S. Commercial Service (USCS), the US Export Assistance Center (USEAC), and the U.S. District Export Council in Charlotte. The Charlotte USCS and USEAC provide technical advice to local firms regarding implementation of export strategies, and assistance in navigating world trade issues. They also promote USEAC’s technical assistance to regional manufacturing industries. The ITA/USCS and Export Assistance Center, and District Export Council with other institutions are already helping to expand the Centralina Region’s Trade and International Investment success and facilitate a Metropolitan Export Initiative (MEI) in alignment with efforts of the Region’s Global Vision Leaders Group (described below) and with other regional partners.

The Region’s manufacturing ecosystem benefits directly from support for the U.S. Administration’s NEI/NEXT initiative implementation provided by the US Commercial Service Office and the US Export Assistance Center based in Charlotte. With their assistance, the Region’s section of the *FY 2015-16 Strategic Plan for North Carolina Commercial Services and the Export Assistance Center* responds directly to Strategic Goal One of the U.S. Department of Commerce: “Expand the U.S. economy
through increased exports and inward foreign investment that lead to more and better American jobs.” Below are excerpts from that Plan illustrating the two primary platforms in support of that goal:

**Increase opportunities for U.S. companies by opening markets globally.**

**Key Strategies**

- Ensure U.S. commercial and economic interests are advanced in trade agreements and in other international fora.
- Ensure that U.S. commercial interests are advanced with foreign governments.
- Reduce foreign trade barriers.

**Events/Activities in Support of these Strategies:**

- Increase awareness of Commercial Advocacy support available to partners and exporters through outreach to industry associations and business likely to need Commercial Advocacy such as NC Military Business Center, Council of Textile Associations, and National Textile Credit Association.
- Present at events and business roundtables to demonstrate the benefits of Free Trade Areas
- Sending export needs assessment survey to 5 geographic regions to gather SME input related to trade barriers and market access issues.
- Will work with local partners and District Export Council to host client roundtables and jointly counsel clients on overcoming barriers to market access.

**Increase U.S. exports by broadening and deepening the U.S. exporter base.**

**Key Strategies**

- Educate U.S. companies and communities on the benefits of exporting.
- Provide tailored export assistance to U.S. companies and communities to connect U.S. companies to foreign markets and qualified buyers and partners.
- Utilize public-private partnerships to increase U.S. exports worldwide.

**Events/Activities in Support of these Strategies:**

- Educate U.S. companies and communities on the benefits of exporting.
- Organize and promote Export University 101 and 201 sessions focused on feedback from exporter needs survey.
- Provide customized export counseling to companies. Counseling in underserved areas such as the rural parts of Western and Eastern North Carolina will be supported by outreach to rural chambers of commerce and EDOs. Also target minority, women, and military owned businesses through local industry groups and association outreach.
- Utilize public-private partnerships to increase U.S. exports worldwide.
- Partner with Economic Development Organizations to broaden and deepen clients assisted beyond those already known to the USEAC.
In addition, the Small Business Administration (SBA) and U.S. Export-Import Bank work to help the Centralina Region’s small- and medium-sized firms compete in the global marketplace by providing export assistance through identifying qualified international buyers and representatives, advocating on their behalf, and developing trade finance and insurance strategies.

UNCC operates the Region’s Small Business and Technology Development Center (SBTDC) organization. The director and five counselors provide business advisory services to about 700 small businesses annually. Special services include export assistance and Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) assistance and house the district U.S. Export-Import Bank.

The Charlotte chapter of the North Carolina World Trade Association is one of the largest in the nation and works proactively with the US Commercial Service and District Export Council in promoting export capacity and services for the region’s firms.

The Charlotte Regional Partnership (CRP) serves as a catalyst for government and business collaboration to market and promote the Greater Charlotte Region as a highly competitive, vibrant region with a very attractive quality of life. Throughout the year, CRP’s business development team works with site selection advisors and corporate decision-makers throughout North and South America, Europe and Asia. The work the CRP does is so critical that more than 170 private companies, 16 counties, three cities and one state have made a financial commitment to the CRP, to promote regionalism and market the Region’s brand “Charlotte USA”.

The Charlotte Foreign Trade Zone (FTZ) # 57 is one of the largest in the state and is managed by the CRP. In July of 2014, FTZ #57 was approved to reorganize under the Alternative Site Framework (ASF) management style with an expanded 15-county designated service area (Alexander, Anson, Caldwell, Cabarrus, Catawba, Cleveland, Gaston, Iredell, Lincoln, Mecklenburg, Polk, Rowan, Rutherford, Stanly and Union counties in NC.) The new framework will allow FTZ #57 to use simpler and faster procedures to obtain FTZ designation for companies. The ASF allows zone designation to be brought to any company that needs it, eliminating the need for the Charlotte Regional Partnership, as grantee, to predict where the zone will be needed and pre-designate sites. Subzones and usage-driven sites can be designated anywhere in the service area within 30-days using a simple application form. This streamlined process is a benefit for companies as they do not have to wait months for FTZ approval.

Trends and Best Practices
This section provides an overview of current trends and best practices for developing globally competitive Exports and Logistics, using examples at a national level. These include:

- Metropolitan Area Global Export Strategic Plans
- Greater Portland Global Cities Project
- National Export Initiative (NEI/NEXT)
Metropolitan Area Global Export Strategic Plans

Given the compelling case for metropolitan exporting, more and more state and local leaders across the country have expressed interest in developing and implementing unique, ground-up metropolitan export plans for their regional markets. These leaders not only aspire to increase exporting from their jurisdictions but seek practical guidance on how to get to work right away.

From the 2012 Brookings – Rockefeller Project on State and Metropolitan Innovation; Ten Steps to Delivering a Metropolitan Export Plan, the key findings and the steps outlined here have provide an accurate roadmap for economic development practitioners, government leaders, businesses, and other local stakeholders pursuing this effort in many regions:

- **Go Metro to go global**—markets are regional and export metropolitan area strategies foster regional collaboration in economic development.
- **Organize for Success**—the planning effort must have the stated commitment of local leaders and be well-organized at the outset to create a culture of change in economic development practice.
- **Produce a Data-Driven Market Scan**—a credible export plan is built on a solid foundation of data and information about the Region’s export performance and potential.
- **Capture local Market insight**—at the heart of the local market assessment is direct input from firms and service providers obtained through surveys and one-on-one interviews.
- **Champion exports now**—promoting and communicating exports’ importance to the Region’s long-term economic future is critical to ensure the export plan is embraced.
- **Develop a customized export plan**—a clear, easy-to-read document will serve as a strong vehicle for galvanizing stakeholders to act on and support the exports opportunity.
- **Prepare for implementation**—a detailed implementation (or business) plan that delineates how the export plan will be executed must include details on deliverables, phasing, budgets, and the division of labor among lead organizations.
- **Identify and promote policy priorities**—metro leaders should articulate and advance a state and federal policy agenda that will foster an environment for enabling the Region’s exports to thrive.
- **Track and publicize progress**—the metro export team will need to identify metrics that are most realistic to collect locally and dedicate resources to maintaining, analyzing, and reporting progress.
- **Mainstream exports into Economic Development**—for a region’s economy to fully benefit from international trade, exports must be an integral part of a multi-pronged economic growth agenda that includes innovation, transportation and logistics, and global talent.

An additional report by Brookings in 2014, Accelerating Exports in the Middle Market; Global Opportunities for U.S. Firms and Metro Areas, provided the following four key takeaways for Metro areas seeking to pursue updated and new global export strategies:
Align support among providers and programs
Export support services—whether offered by local, state, or federal entities—get delivered at the regional level. Firms are agnostic about who provides help, as long as it is easily accessible, high quality, and meets their needs.

Proactively recruit companies to become exporters
With strong company relationships as well as local market knowledge and functional scale, economic development partners at the metro level are best positioned to identify and reach individual middle market firms with export potential.

Integrate exports with mainstream economic development strategies
Beyond actions to better reach and deliver export assistance to firms, execution of some metro export plan initiatives are beginning to integrate exporting with overall economic development plans and industry cluster development efforts.

Catalyze a cultural shift toward global fluency
Increasing fundamental global awareness and overcoming parochial views is required to inspire exporting, cultivate international connections, and spur regional investment in trade support activities.

Greater Portland Global Cities Project
The 2013-2015 Portland Global Cities project partnered with Brookings to incorporate the best practices outlined above. As an early adopter of these best practices, and part of the Centralina Region’s metro cohort of similarly sized metropolitan regions with an IMCP strategic planning award, it provided an instructive example for this region and its Metropolitan Export Initiative being led in collaboration with the USCS North Carolina District Office.

With annual exports of more than $21 billion, Greater Portland was one of only four regions in the nation that doubled exports in the past decade. After a year of study in cooperation with the Brookings Institution, Greater Portland has developed a new strategy that aims to double regional exports over the next five years. The Greater Portland Export Initiative is a newly-developed business plan to help local companies’ access to global markets and grow jobs.

The Office of Mayor Sam Adams of the City Portland and the Portland Development Commission led the process, with an export task force that included the Port of Portland, Greater Portland Inc., Business Oregon, the U.S. Export Assistance Center, and other regional stakeholders. The process included a market assessment, survey and company interviews that produced the following findings:

Portland is a very competitive exporting region, influenced heavily by computer and electronic equipment manufacturing. The metals and transportation equipment industry ranks high, but findings suggest there is more potential. The regional economy is dominated by small and medium enterprises that could benefit from increased exporting. Certain regional competitive advantages could be better translated into export strengths.
Based on the market assessment and discussions with regional stakeholders, Greater Portland’s Export Initiative encompasses four strategies:

1) Support and Leverage Primary Exporters – This strategy calls for increasing the local share of the computer and electronic manufacturing supply chain and addressing regional policy issues to enhance the long-term competitiveness of the industry.

2) Catalyze Under-Exporters – Greater Portland will work with a select group of key manufacturers to access new markets and will provide market intelligence, product diversification and targeted trade missions.

3) Enhance the Export Pipeline – The region will work to increase the number of small and medium-size businesses exporting, develop an export-services roadmap, training economic development professionals in key aspects of export assistance, and create a web-based “one-stop shop” resource center, in an effort to promote an export culture and provide intensive export mentoring.

4) Market Portland’s Global Edge – The final strategy calls for building on existing industry work and identifying specific clusters with perceived high export potential – beginning with “We Build Green Cities” and expanding to other industries – and maximizing the region’s visibility in the international marketplace through international branding and marketing.

**National Export Initiative (NEI/NEXT)**

On the national level, the second phase of President Obama’s National Export Initiative (NEI/NEXT) was launched by Commerce Secretary Pritzker was launched in May 2014. A key objective of this “NEXT” phase is strengthening partnerships with states and communities in support of exporters and investment attraction, is a key objective for the second phase of President Obama’s National Export Initiative (NEI/NEXT), which Commerce Secretary Pritzker launched in May 2014. Through NEI/NEXT, 20 federal agencies are advancing program and policy improvements to provide exporters:

- provide exporters with more tailored assistance and information;
- streamline export reporting requirements;
- expand access to export financing;
- ensure market access and a level playing field; and,
- collaborate with state and local organizations.

More specifically, NEI/NEXT supports local economic ecosystems by:

- Continuing to build U.S. trade advocacy and export promotion efforts:
  - NEI interagency advocacy support through 2013, has resulted in more than 200 wins for U.S. companies competing for foreign government tenders, including nearly $160 billion in U.S. export content.
  - The number of trade missions increased by 20 percent and the number of companies going on trade missions doubled under the NEI, resulting in $9 billion in export successes.
• Educating U.S. companies about markets opened by free trade agreements (FTAs) and export opportunities derived from trade negotiations such as the Trans-Pacific Partnership (TPP), Transatlantic Trade and Investment Partnership (T-TIP), and Trade in Services Agreement.
• Enforcing U.S. trade rights under international agreements.
• Aggressively investigating unfair trade practices affecting U.S. exports or imports into the U.S. market.

NEI/NEXT will help more American companies reach more overseas markets by improving data, providing information on specific export opportunities, working more closely with financing organizations and service providers, and partnering with states and communities to empower local export efforts.

**Recommendations**

Charlotte Region’s manufacturing ecosystem is comprised of a tremendous base of exporting and logistics-dependent industries and manufacturers that are already the existing foundation for future economic success and potential. Combined with improving the mobility and efficiency of freight operations, developing new linkages and promoting the intermodal transfer of goods will further develop and strengthen our world class economic base and increase its global competitiveness. The assets, partners, and insight from leading practices discussed above support the following recommendations:

There are two recommendations for efforts that can strengthen the Region’s Export and Logistics assets and infrastructure:

1) Expand export/import capacity, volume, and local network knowledge
2) Advocate targeted initiatives and implement investments to support a robust regional Exports & Logistics infrastructure

Each is described in more detail below.

**Expand export/import capacity, volume, and local network knowledge**

• Increase National/Global Awareness of the Centralina Region as a uniquely competitive Manufacturing & Logistics Hub through enhanced marketing that will align with the *Charlotte Global Hub of Commerce Strategic Plan* by the Global Vision Leaders Group.
• Use the regional alliance platform (proposed as part of the IMCP Strategic Plan) to reach small- to medium-sized businesses for increased access to available technical assistance resources, export capacity building, and capital resources.
Advocate targeted initiatives and implement investments to support a robust regional Exports & Logistics infrastructure

- Complete the Metropolitan Export Initiative launched in Feb 2015 with ITA and local US Commercial Service office, engaged with the proposed IMCP Strategy regional alliance platform.
- Promote Charlotte Intermodal Facility to bring current volume (145,000 TEU/year) to designed capacity (200,000 TEU) and prepare to implement plans to develop additional 100 acres to increase capacity to 350,000 TEU/year), and expand industrial space around the Airport
- Complete the Regional Freight Mobility Plan initiated Sept 2015
- Advocate investments in transportation and basic infrastructure to reduce traffic congestion and support population and business growth
- Implement regional exporting operational efficiencies and training opportunities for aggregate growth of exports, production capacity and jobs, with assistance of data and program support from US Commercial Service & Export Assistance Center, District Export Council, US Economic Development Administration (EDA), NIST-MEP, SBA, and National Association of Manufacturers

These recommendations address gaps and specific needs related to expanding our regional Trade and Export capacity to capture market opportunity, increase investments, and ensure incumbent industry viability, including advanced Intermodal Logistics and Freight Mobility planning. Implementation of these recommendations will support and allow the Centralina Advanced Manufacturing Ecosystem to optimize its growth through priority focus on export trade and foreign direct investment that will fuel our manufacturing economic health and sustainability.
IMCP Implementation Strategies and Objectives

A primary deliverable of the Project is a set of Implementation Strategies for enhanced support of the Centralina Region’s advanced manufacturing ecosystem. The Global Charlotte Manufacturing Consortium’s proposed Manufacturing Ecosystem Development Strategy (MEDS) builds on the strengths and addresses the weaknesses of the Centralina Region’s Manufacturing Cluster and Advanced Manufacturing ecosystem through four over-arching primary strategic objectives and five supporting strategic objectives, as described below.

Primary Strategic Objectives

1) **Regional Collaboration. Develop a Global Charlotte Manufacturing Coalition to serve as the organizational platform and convening body to facilitate and support the implementation of the Primary and Supporting Strategic Objectives**

This is the key strategic recommendation of the Project: to organize and launch an industry-led collaboration and communication coalition with a primary mission to enhance the Centralina Region’s manufacturing ecosystem by:

- Advancing the state of an aligned and trained talent pipeline,
- Growing R&D technology and innovation implementation, and
- Increasing production exports and trade expansion.

This coalition would act as a regional convener of manufacturing ecosystem stakeholders and as a platform for optimizing the efficiency and impacts of existing sub-regional networks of industry-sector partnerships. It will bring together manufacturers, suppliers, educators, workforce boards, business chambers and economic developers to work collaboratively with CCOG and CEDC to implement Advanced Manufacturing strategies.

The Coalition’s strategic role would entail meeting regularly, acting as a forum for networking and information exchange and providing input into long-term strategic implementation, to advance communications, content, and collaboration on manufacturing industry interests at a regional scale effectiveness. This would occur through coordinated networking, research and training, which also includes our partnering colleges, research institutions, and export logistics organizations. This could best function initially as result of the plan analysis at the Charlotte Regional Partnership’s Existing Industry Council that is integrated with the Economic Development Advisory Council and the related Business Advisory Council. Formal support of this Coalition by the CEDC and CCOG would allow integration of aligned workforce marketing, export initiatives around supply chain analysis, and a web communication portal dedicated to these components and existing economic strategic plans.
The primary value for industries’ participation in the coalition is the collaborative outcomes relating to the three “Ps” of the business bottom line:

**People:** ensuring a qualified and trained talent pipeline to match demand and need of industry;

**Productivity:** unified support of advanced technology R&D and process resources; and

**Profit:** increased revenues from logistics and intermodal efficiencies, coupled with expanded Export and Trade capacity, knowledge and volume for the Region.

Proposed Coalition Activities

- Facilitate increasing operational deployment of training and apprenticeship collaborations, job placement, and industry sector partnerships.
- Commission the mapping and updating of the Region's remaining manufacturing industries’ supply chains and value chains.
- Leverage regional R & D assets and innovation/entrepreneurial efforts to wider networks, opportunity, and partnering of local industry and economic sectors.
- Provide communication outreach and peer-to-peer education in order to:
  - Increase export capacity, volume, and local networks knowledge for manufacturers.
  - Reach small- to medium-sized businesses for increased access to available technical assistance resources, export capacity building, and capital resources.
  - Expand private-sector support and investments in the Advanced Manufacturing Centers and training facilities within existing community college networks.
- Enhance marketing of the Region as an Advanced Manufacturing/Logistics Global Hub.

2) **Key Value Chains. Utilize the Supply Chain-Value Chain assessment to support regional business retention, expansion, and development plans**

- Promote new business-to-business relationship opportunities revealed by Report data, support matchmaking events, and communicate successes.
- Target potential opportunities for collaborative R & D for new products based on supply chain relationships and value chain market expansions.
- Assess industry cluster\chain density for strengths and weakness or gaps for targeted expansion marketing, existing chain support, or infill recruitment.
- Evaluate, identify, and support key export expansion opportunities for existing industry sectors revealed by report data when correlated to demand of global markets.

3) **Education & Training. Recruit greater industry participation in demand-based expansion of regional college curriculums for advanced manufacturing, and monitor alignment of course offerings, Apprenticeships, Internships, and training resources for employers**

- Invest in existing and new Advanced Manufacturing Training Centers.
- Expand regional apprenticeship and internship program capacity.
- Facilitate additional funding for manufacturing-affiliated curricula and degree programs
- Work with regional partners to create and promote awareness of Advanced Manufacturing Career Pathways

4) Export & Logistics. Utilize and promote existing resources to grow the Centralina Region’s Export/Import capacity, volume, and local network knowledge, in partnership with U.S. International Trade Administration
- Support and leverage primary exporters by increasing the local share of the manufacturing supply chain to enhance the long-term competitiveness of the industry.
- Increase the number of small and medium-size businesses engaged in exporting by developing an export-services roadmap to connect them to available resources.
- Promote an export culture among economic development professionals by providing export mentoring and training in key aspects of export assistance.

Supporting Strategic Objectives

Integral to the IMCP Implementation Plan are the following supporting objectives that augment the targeted reach and implementation cohesiveness of the above four primary strategic objectives:

1) Career Pathways. Endorse and support initiatives and efforts to increase the awareness of career pathways, benefits and employment opportunities in advanced manufacturing.

2) Exports and Logistics Infrastructure. Endorse and support targeted initiatives and strategic investments that grow a robust regional Exports and Logistics, including:

3) Entrepreneurial Support. Investigate and promote avenues for more cost-effective access to state-of-the-art facilities and technical assistance.

4) Technology Transfer. Build regional capacity for Technology Innovation and Transfer, working to reach more of the Region’s 2200+ manufacturing firms.

5) Progress Tracking. Develop a database and gather data to measure progress towards achieving the strategic objectives and other indicators of the health and growth of Region’s advanced manufacturing cluster. These additional indicators include tracking metrics and results as defined in Figure 11.
Overall Goals

- Increase GDP by 25% by 2025
- Increase manufacturing employment by 5% over two years
- Increase manufacturing exports by 2% per year

Economic Indicators

- Employment growth rate - overall & by cluster
- Unemployment - % unemployed within the manufacturing sector
- Average wages - payroll per person, overall median wage by occupation & cluster
- Cost of living index
- Exports - value of mfg and commodity exports per worker & region
- Productivity - overall productivity, by occupation and by cluster

Innovation Output Indicators

- Patent - number of institutional patents, both private and public, and individual patents
- Company formations - number of incorporations, survival rates, and retention rates
- Venture capital investments
- Fast growth firms, measure the number of Fortune 500 companies, measure the growth/productivity of identified baseline companies

Education Indicators

- Percentage of growth in post-secondary credentials aligning with AM career pathways
- Increase number of new apprenticeship/internship programs
- Increase number of new apprentices/interns
- Increase STEM based certificate and degree offerings
Conclusion

As U.S. business, civic, and government leaders seek to increase revenues and employment while promoting overall economic competitiveness, they must adapt to rapidly changing global realities that are shifting the focus of demand for U.S. produced goods and services. Given these global opportunities, the volume of total international trade grew by 26 percent between 2009 and 2013, reaching $17.4 trillion.\(^{10}\) While exports are not the only reason that these firms prospered, a global perspective, which often includes an investment in innovation and R&D, strong supply chains and logistics, and a talented staff, are all factors that contribute to enhanced revenue performance.

Metros with a higher proportion of economic output attributed to exports show comparatively stronger economic growth overall. Specifically, metros that export more aggressively average economic growth almost double that of metros with lower export intensity.\(^{11}\) Further, every $1 billion in U.S. exports supports 5,600 jobs.\(^{12}\)

Through the depths of the recession in 2005 to 2009, smaller and mid-sized manufacturing firms that exported experienced over 35 percent revenue growth while firms that did not export saw revenue decline by seven percent. While multinationals and start-ups dominate both public policy and media attention, the power of U.S. job creation lies with middle market firms ($10 M to $1 B revenue and 100 to 500 employees). Nationally, these 200,000 firms account for only three percent of all businesses, but they created 70 percent of all jobs in 2013. Between 2007 and 2010, middle market companies added 2.2 million new jobs, while big businesses lost 3.7 million jobs.\(^{13}\) In total, they generate about one-third of all private employment, as well as national GDP and this has trended higher each year from 2011 through 2014.

Brookings Institute’s 2015 Global Metro Monitor, the fourth edition of the report, analyzes data on the performance of the world’s 300 largest metropolitan areas based on their annualized growth rates of GDP per capita and employment. The Charlotte MSA’s ranking is 110 of 300 in Economic Performance of the World’s Largest Metropolitan Economies 2013–2014. The report includes validation that metropolitan economies are home to 20 percent of the world’s population and jobs, but account for almost half of global GDP, underscoring that the global economy is truly a metropolitan region based economy comprised of world class cities.

The Centralina Region is one of those metropolitan regions at the threshold of great opportunity.

- Dynamic population growth, resurgent economic growth, emerging on the global economic and the socio-political stage.
- Second fastest growing region in the USA over the past decade among those with populations greater than one million.

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\(^{12}\) U.S. Department of Commerce

\(^{13}\) National Center for the Middle Market, *Market that Moves America*, 2011
The Charlotte Intermodal Facility is poised to capture expanded import/export growth from Panama Canal and is the central axis location for serving both the Norfolk Southern Crescent Corridor and CSX Railroads Intermodal networks.

Advanced Manufacturing, the Centralina Region’s validated regional core competency, is embedded across five of our six primary industry sectors effectively yielding a regional multi-industrial supercluster.

It is a strategic imperative that the Centralina Region has a cohesive, coherent system of supports for a sustainable, competitive world-class Manufacturing Ecosystem, including:

- A collaborative coalition of workforce training, R&D resources, and logistics partners to support and implement advanced manufacturing economic development strategies through an organized alliance entity that provides a platform of continuing, coordinated communication and leadership across all components.

- A Freight Mobility Plan that evolves with a focus on Exports and Logistics/Intermodal capacity and prowess to support our nationally validated “Prosperity for Greater Charlotte” Comprehensive Economic Development Strategy. In other words, systems to assure efficient and cost-effective flow of imports/exports, developed and achieved through leveraging our foundation and success of existing comprehensive planning frameworks.

- A global branding initiative and implementation strategy currently advancing as the Charlotte Global Hub of Commerce Strategic Plan, “Create It, Make It, Move It,” is being developed by a 100+ public-private CEO task force known as the Global Vision Leaders Group. This effort will encompass and integrate marketing and leadership roles with global strategies built around the GC Region’s competitive advantages and existing core assets. The effort parallels and aligns upon the foundations of this IMCP Plan Report prioritizing our strategic focus:

  - Workforce (talent pipeline)/Create it;
  - Advanced Industries (manufacturing, R&D, innovation)/Make it; and
  - Logistics/Transportation (infrastructure w Exports focus)/Move it.

Success of this imperative to establish our world-class Manufacturing Ecosystem will solidify the future economic pillars of a Greater Charlotte 21st Century global hub anchored by advanced manufacturing competencies that crosscut the entire economic base of our Region.

The Project sought to support a spectrum of industry needs and strengthen the regional manufacturing ecosystem by operationalizing a primary finding of the 2012 CEDS; advanced manufacturing as a core competency of the Centralina Region. However, as the strategic planning Project’s original focus and critical challenge, there was no singularly led alliance/platform with a coordinated comprehensive approach on a regional scale to support the advanced manufacturing needs of this diverse multitude of primary industry sectors. Although successful manufacturing alliances are present at sub regional levels, linkages at a regional scale are minimal, leaving many common policy and resource issues unaddressed and potentially hindering full ecosystem potential.
The purpose of this Project was to assess and provide strategic design and tools to pursue an initiative that could establish a regionally coordinated approach to build upon a decade-long identified strategic focus on jobs creation and rebirth of our foundational manufacturing assets. Project implementation will continue to ensure local job creation, community economic vitality, and provide strategic competitive advantages for a Greater Charlotte 21st Century global hub of commerce, logistics, and exports.

The Global Charlotte Manufacturing Consortium’s proposed strategic recommendations presented here address the Centralina Region’s Manufacturing Cluster and Advanced Manufacturing ecosystem strengths and assets. The next steps have been defined and promulgated by the IMCP Centralina Advanced Manufacturing Strategic Planning Grant activities over past 24 months. The key outcome and focus is a singular Strategic Overarching Strategy, organize and launch an industry led collaboration and communication vehicle (i.e. Coalition/Alliance or “Manufacturing Matters” model) as the regional convener or platform entity for optimizing efficiencies of the existing sub-region local county networks of industry sector partnerships with Colleges, Workforce Boards, Business Chambers and local Economic Development organizations. This platform entity’s primary mission is to advance the state of an aligned and trained talent pipeline, grow R&D technology and innovation implementation, and increase production exports and trade expansion for regional network of industry.

The alliance is proposed to be organized as a relevant ecosystem vehicle to successfully accomplish the work required to achieve the objectives, not to serve as another independent organization or governmental structure. The plan’s recommendations will assist Charlotte Regional Partnership/ Centralina Economic Development Commission/ Centralina Council of Governments in supporting a Greater Charlotte Manufacturing Consortium/Industry Council with strategy implementation and developing further federal and state support for continued growth and productivity of the advanced manufacturing community. This coalition would uniquely connect in the most effective way the manufacturers, suppliers, educators, workforce boards, and economic developers to collaboratively implement advanced manufacturing strategies and develop a web-based, virtual center to support the regional framework.

In conjunction with larger leading manufacturers presently engaged in growing a robust manufacturing ecosystem, this industry led intermediary platform would seek to engage small and medium sized manufacturing firms that may not have capacity or access to all available resources for the manufacturing community. Increased industry sector participation, support, and partnership with the workforce and education systems will result in improved operational structures that ultimately provide easier access to these resources for small to medium sized firms in the system.

Through a Coalition/Alliance, Manufacturing Matters or other branded platform, the activities and partnerships of the Greater Charlotte Region's proposed entity will enhance our existing ecosystem to grow jobs in manufacturing and related industry clusters through use and deployment of three primary strategic plan tools. As capacity and resources emerge, the entity will pursue three identified foundational supporting objectives:
Primary

- Develop national/global awareness of the GC Region as a uniquely competitive Manufacturing & Logistics Hub through enhanced marketing and branding campaign for Advanced Manufacturing that will align with the Workforce Development Boards incorporating new Workforce Investment Opportunities Act (WIOA) plans, State and private funding and the Charlotte Global Hub of Commerce Strategic marketing plan by the Global Vision Leaders Group. This will help re-engineer the communication message around high growth, high opportunity career pathways, promoting apprenticeship programs, and integrating greater private sector participation and communications support.

- Distribute and promote utilization of the manufacturing supply chain and value chain data and findings. This will provide immediate business-to-business opportunities plus local cost efficiency gains for vendors and customers, targeted recruitment and gap remediation for local Economic Development agencies, and industry wide match making avenues to strengthen clusters and the entire regional ecosystem system.

- Increase export capacity, volume, and local network knowledge for manufacturers via the new coalition\’s enhancement of communication, assistance and linkage of industry members to US Commercial Service, Charlotte District Export Council and benefits of #57 Free Trade Zone with new Alternate Site Framework status.

Supporting

- Leverage regional R & D assets and innovation/entrepreneurial efforts to wider networks, opportunity, and partnering of local industry and business sectors with our regional R&D assets and entrepreneurial-innovation efforts through UNC Charlotte\CRI\EPIC system but also Ventureprise, E4Carolinas network, and other entrepreneurial organizations.

- Support operational enhancements of connecting community college training, internships and apprenticeship programs with workforce demand (increase the efficiency of certification, job placement, and sector partnerships) via collaboration and coordination of the Region’s many leading programs with industry sector partners.

- Expand and invest in the Advanced Manufacturing Centers and training facilities within existing community college networks and UNC Charlotte and the Charlotte Research Institute in a collaborative effort with local industry sector partnerships and economic development entities.

The efforts should begin with three primary start-up initiatives to optimize focus and maximize available time and resources. Once successful traction and strength are achieved, the other strategies could be added, as market and timing demands allow, based on the coalition leadership’s assessment.
1) Promotion of manufacturing careers and scientific/technological education pathway choices to support manufacturing and create a regional advanced manufacturing pathway (See Appendix C, which details actionable steps for implementation):
   - Establish common value messaging and regional linkage of the advanced manufacturing training centers, colleges, and public/private school districts currently in the Centralina Region, and market that system to students, parents, adult re-learners and advanced manufacturers.
   - A grassroots campaign to increase student and parent interest in high-skill advanced manufacturing careers as main objective of a regional marketing effort to jump-start our regional talent development pipeline to next scale level.
   - Increase the frequency and level of communication with regional employers and align our various local efforts into a coordinated campaign.

2) Supply Chain \ Value Chain relationship and development:
   - Analyze and promote the illuminated business-to-business opportunities in addition to general indirect local cost efficiencies for sector vendors and customers.
   - Support and facilitate the local and regional EDC targeted recruitment and gap remediation of industry within the chain sectors based on the current and ongoing updated data.
   - Build supply chain solutions such as an on-line match-making system that will serve to link both advanced manufacturers and vendors and coordinate with EDCs to hold two matchmaking events over the next year and pursue regular recurrence.
   - Develop local networking opportunities and highly valued educational events between vendors and advanced manufacturing companies.

3) Stimulate innovation in the Greater Charlotte Region’s advanced manufacturing clusters:
   - Match manufacturing firms with licensable technologies and assist in the commercialization of the resulting products.
   - Provide technology search and assessment services, especially to small and medium sized advanced manufacturers in the Region, if possible focusing on disruptive technologies if the expertise exists, match them to a targeted cluster or primary technology in the Region.
   - Provide manufacturer resources to help assess and link resulting generated products specifically with potential export market assistance to capture global opportunity as applicable.

Long-term quantifiable impacts from the implementation of the strategic planning proposed under this Project will be in the number of manufacturing firms participating in the Coalition. The increased number using Advanced Manufacturing technologies as industries of the future. The number of new manufacturing jobs created requiring advanced manufacturing skills that will build our economy. The annual number of participants and graduates of Advanced Manufacturing workforce training/apprenticeship programs that will become partners on this regional path to enhance prosperity. The investments made for enhancing and expanding the Community Colleges Advanced Manufacturing Training Centers. Finally, the investments made by private sector
manufacturing firms in training, R&D partnerships, and Export market initiatives that will accrue for their profitability, growth and sustainability of their futures as engines of our economy.

There is an economic structural shift in the U.S. to advanced manufacturing as one of the key supports of our country’s global future and merits the basis for our Charlotte metropolitan advantage as a globally competitive community. With an advanced manufacturing ecosystem having been identified as a regional strength and competency over the past decade and validated as presented in this study, our key manufacturing clusters provide an excellent framework that is uniquely one of the best in the nation. Re-alignment and re-tooling is required, putting demands on both business, education, and the public sector.

The Greater Charlotte Region has developed a historical tradition and successful reputation for a “Can Do” attitude. This Centralina Manufacturing Ecosystem Development Strategy (MEDS) provides a framework for unified action and our newest “All In” opportunity to support our future success as a world class community and home to the best advanced manufacturing ecosystem from across the globe.
Appendix A: Mapping Key Value Chains for the Greater Charlotte Region
Global Charlotte Manufacturing Consortium:

Mapping Key Value Chains for the Greater Charlotte Region’s Investing in Manufacturing Communities Partnership (IMCP) Strategic Plan

May 29, 2015
Executive summary

A center for advanced manufacturing, the Charlotte region has a diverse base of manufacturers buoyed by a network of assets that bolster the region’s talent and innovative capacity. The region’s advanced manufacturing industries offer cross-cutting capabilities in precision metalworking, industrial machinery, and the use of advanced processes and automation that support an array of national industries. Within The Greater Charlotte region, manufacturing currently contributes over 140,000 jobs, or 11.7 percent of total regional employment. This makes manufacturing the region’s 4th largest employing economic sector, and it is found in every part of The Greater Charlotte region. Manufacturing employment as a share of overall employment exceeds the national average in almost every county of the region.

During the past 15 years, manufacturing experienced significant national job losses. Many of those job losses occurred in manufacturing industries affected by offshoring, which now represent a smaller percentage of regional manufacturing jobs. The Greater Charlotte region was harder hit than most and has only just begun to recuperate. Since 2010, the Greater Charlotte region’s manufacturing sector has added over 13,300 net new jobs. This represents a growth rate during the past few years that is almost twice as fast as growth in overall US manufacturing employment. One key reason for this growth is the region’s attractiveness to foreign-owned firms, particularly German manufacturing firms. Unlike many other parts of the country where a single industry accounts for the core strength of their manufacturing base, the Greater Charlotte region’s manufacturing sector has multiple strengths in several key clusters of industries including transportation equipment, energy, and defense and aerospace.

In order to better understand these important regional manufacturing clusters, this report places a magnifying glass on several clusters to examine the value chains that drive them, emphasizing the role of eight key industries:

- Motor and generator manufacturing (NAICS 335312)
- Primary battery manufacturing (NAICS 335912)
- Turbine and turbine generator set units manufacturing (NAICS 333611)
- Electric power generation, transmission, and distribution (NAICS 2211)
- Heavy duty truck manufacturing (NAICS 33612)
- Aircraft parts and auxiliary equipment manufacturing (NAICS 336413)
- Ball and roller bearing manufacturing (NAICS 332991)
- Truck Transportation (NAICS 484)

In analyzing these industry linkages, we seek to understand their respective buying and selling relationships. By identifying the industries that are most closely linked to these industries, we can determine the Greater Charlotte region’s economic strengths, its emerging opportunities, and potential gaps. Throughout this analysis, we pay particularly close attention to those linked industries that buy from or sell to multiple targeted industries as potential sources for innovation and growth across sectors.
Several trends emerged from the analysis of the value chain linkages in these eight industries. For instance, two energy-related industries—motor and generator manufacturing and primary battery manufacturing—generally have strong forward and backward linkages within the region. This means that many of the key customers and suppliers for these industries are located within The Greater Charlotte region, and the region has captured a significant portion of the entire value chain. This also implies that the region is particularly competitive in this value chain and could capture even more. Moreover, these particular industries have broad applications for a wide variety of manufacturing equipment and consumer products.

By contrast, turbine and turbine set units manufacturing has a narrower set of potential customers and applications, but one of those is the electric power generation, transmission, and distribution industry, reflecting the presence of Duke Energy. Turbine and turbine set units manufacturing also draws on the region’s capacity for precision metalworking. This capacity is important for several other targeted regional industries, most notably aerospace-related activities and transportation equipment manufacturing. This sector is anchored by Daimler Trucks, but the region has an extensive network of automotive parts manufacturers that not only supplies large OEMs like Daimler Trucks and automotive companies outside of the region, but also provides important inputs for the region’s trucking industry. Truck transportation is the primary method through which manufacturers ship their products to market, not just in The Greater Charlotte region but in many other regions as well.

While each of the eight targeted industries have their own value chains representing distinct buyer and supplier relationships, their commonly linked industries may well be among the most important in the region’s overall manufacturing ecosystem. These industries are versatile because they can take advantage of multiple market opportunities, buffering the regional economy during downturns. Two industries that connect to multiple target industries include transmission, drives and gear manufacturing and engine equipment. These two industries make products that turn energy into work, and as a result are closely linked to the region’s energy industries. As a result, these industries are likely to grow as the region’s energy cluster develops.

Forging and stamping represents another industry critical to multiple value chains and reflects the importance of precision metal working to many of the region’s target industries. The forging and stamping industry has grown faster in The Greater Charlotte region than elsewhere. The talent required for metal working and the related skills are vital to the region’s long-term growth. Similarly, other related metal working industries support the production of manufacturing equipment, including the production of metal valves, air and gas compressors, and fluid power process machinery. The Greater Charlotte region’s central role in these industries means that its success depends not only on manufacturing’s success in the region, but nationally and even globally.

The Greater Charlotte region has developed an extensive network of assets to support its manufacturing base. The region’s educational institutions, support service providers, research centers, and infrastructure help make the region a fertile environment for manufacturing and logistics. Beginning
with its higher education institutions, UNC Charlotte trains engineers for the region’s manufacturers. In 2013, roughly 300 students graduated with 4-year engineering degrees and another 150 graduated with 4-year engineering technology degrees. UNC Charlotte was the primary local source for these graduates. In addition, UNC-Charlotte was also responsible for the 116 graduate-level engineers. The community colleges provided technicians to support local industries. In 2013, 725 students completed either certificates or associates degrees in engineering, engineering technology and precision production. Primarily, these graduates came from Central Piedmont Community College, York Technical College, Stanly Community College and Gaston College. Local area industries are working collaboratively with these colleges to grow the talent pool and Charlotte is a national leader in developing apprenticeships for manufacturing trades. Building from the German apprenticeship model and with the leadership of area German manufacturers, Charlotte’s apprenticeship models are often cited as a model for effective delivery of apprenticeship programs in the U.S.

While workforce education and training often represents the most important foundation on which manufacturing must rely, a healthy manufacturing ecosystem can only thrive when innovation is also occurring. Within the Greater Charlotte region, manufacturers have a number of technical and business support services that complement their efforts to grow and compete. The region also supports research and innovation through a variety of research assets available at UNC-Charlotte and several other area institutions. These research units include UNC Charlotte’s North Carolina Motor Sports and Automotive Research Center, Center for Precision Metrology, Energy Production and Integration Center, and the North Carolina Research Campus in Kannapolis.

Within the Greater Charlotte region, assets are available to help manufacturers receive the technical support and business support they need to grow and become more competitive. Technical support services are available through the North Carolina Small Business and Technology Development Center, the North Carolina State Industrial Extension Service, the South Carolina Manufacturing Extension Partnership, and the Manufacturing Solutions Center at Catawba Valley Community College. The Greater Charlotte region has initiatives and business groups that promote and advocate on behalf of the region’s manufacturers or specific segments of the region’s manufacturing sector. These groups include the CEO Roundtable for Carolinas’ Advanced Manufacturing Companies, E4 Carolinas—an industry-led trade association created to promote the energy sector in both North and South Carolina, and other statewide groups like the North Carolina Aerospace Alliance. There are also numerous organizations designed to help small businesses find new markets and entrepreneurs to overcome the challenges associated with start-up and new product deployment.

The region also is well positioned as a global center for manufacturing because it has a multi-modal transportation network that can provide area companies with the ability to efficiently convey raw materials and component parts into the region, and similarly ship completed products out to customers located anywhere in the world. The region specializes in small freight shipping and professional services, relying on its international air transportation network (e.g., one of the nation’s busiest airports
in Charlotte Douglas International Airport) combined with several key smaller regional airports. In addition, the main highways serving the Greater Charlotte region provide easy access to the growing southeastern markets as well as the rest of the nation. The region also benefits from a strategic location within the consolidated rail system of Norfolk Southern and CSX Transportation that can easily connect Regional companies to major port facilities in Wilmington, Morehead City, and Charleston, SC.

The Greater Charlotte region has a strong foundation of assets upon which to continue growing its advanced manufacturing sector. To continue this growth, the region must not only enhance the precision metalworking skills of its workforce, regional leaders must also be mindful of potential threats that could impact that metalworking tradition. For instance, companies using ferrous materials to make products are exploring innovative forms of newer and lighter materials that may not be as familiar to area companies and their workers. In addition, regional manufacturers must also explore new and wider markets beyond The region for their current and emerging products.
Introduction

The Charlotte region is perhaps best known as a world leader in banking and business services, but it is also one of the country’s important centers for advanced manufacturing. It has a diverse base of companies, along with many assets that bolster the region’s talent and innovative capacity. This report examines the components of the region’s manufacturing ecosystem and its emerging strengths and opportunities.

The Greater Charlotte region is a 16-county region around Charlotte comprised of 12 North Carolina counties and 4 South Carolina counties. The region is home to 2.8 million residents and its economy supported 1.2 million jobs in 2014. It is also an area that has experienced significant growth since the start of the decade. Between 2010 and 2014, the population grew 1.4 percent annually and employment grew even faster, at 2.5 percent annually. Both of these rates exceeded national trends during this period, making the Greater Charlotte region one of the country’s economic hotspots.

The manufacturing sector is one economic area that helped to propel the region’s economy coming out of the 2007 to 2009 national Great Recession. Unlike many other parts of the country, the Greater Charlotte region’s manufacturing sector is not driven by a single sector. Instead it has multiple strengths, including transportation equipment, energy, and defense and aerospace. Beyond the leading firms and suppliers in each of these markets, there are firms that are linked to multiple markets, and these firms are vital to the overall strength of the region’s manufacturing ecosystem. The commonality surrounding all of these advanced manufacturing industries is that they support the nation’s advanced manufacturing industries, drawing on the region’s cross-cutting capabilities in precision metalworking, industrial machinery, and the use of advanced processes and automation.
The firms that make up the Greater Charlotte region’s “Manufacturing Supercluster” allow the region to participate in many different manufacturing supply chains. The region’s many research and development and technology transfer institutions have a strong working relationship with area manufacturers. Combined with the region’s abundant distribution and transportation facilities, area manufacturers are able to “Create it, Make it and Move it” in the region.

The report begins by documenting the manufacturing sector’s importance to the Greater Charlotte regional economy. Not only has it been one of the region’s economic drivers coming out of the Recession, but this growth has been driven in large part by advanced industries, such as energy and automotive-related manufacturing. The success is due in part to the region’s focus on these advanced industries in its regional development efforts.

The report then examines the inter-industry linkages associated with eight critical or “core” industries to the region’s manufacturing sector: (1) motor and generator manufacturing; (2) primary battery manufacturing; (3) turbine and turbine generator set units manufacturing; (4) electric power generation, transmission, and distribution; (5) heavy duty truck manufacturing; (6) aircraft parts and auxiliary equipment manufacturing; (7) ball and roller bearing manufacturing; and (8) truck transportation. These linkages represent the elements of a value chain from raw inputs to final consumer demand. By analyzing the value chains associated with these eight industries, we can better understand the supplier and market opportunities associated with each of these core industries.

Figure 1: The Greater Charlotte Region
We pay particular attention to the industries in the value chain that buy from and sell to multiple targeted industries. The value chain structures are based on national buying and selling patterns. However, once we apply regionally-specific data to these structures, we can better identify regional economic strengths, emerging opportunities, and the gaps that might eventually be filled through the economic development process. We have also compiled company lists that identify the regional companies comprising the industries associated with the eight value-chains. Combined, this knowledge will help inform strategies to grow and strengthen the region’s targeted industries clusters.

While companies represent the key component of a region’s manufacturing ecosystem, other regional assets help shape it. These assets include educational institutions that train manufacturing workers, support service providers that help companies become more competitive, research centers that help companies innovate, and infrastructure that facilitates the movement of products to markets. Many of these assets were described in detail in the region’s Comprehensive Economic Development Strategy (CEDS) document. This report builds upon that effort, by examining in-depth the key assets that directly support the region’s manufacturing sector.

We conclude the report by highlighting key findings that emerge from this analysis. We also offer some insights into how these findings can be used in support of efforts to grow the region’s manufacturing sector. This report supports the Greater Charlotte region’s Investing in Manufacturing Communities Partnerships (IMCP) effort, as it will help to inform the region’s outreach efforts to small and medium-sized companies. This will not only make small and medium-sized manufacturers aware of the regional assets available to them, but also potentially introduce them to new market opportunities.

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1 IMCP is a federal program that leverages resources from multiple agencies to support the manufacturing sector. It encourages regions to develop comprehensive economic development strategies that will strengthen the competitiveness of the region’s manufacturers and expand efforts to grow supply chains and promote exports. More information is available here: http://www.eda.gov/challenges/imcp/
Manufacturing is foundational to the Greater Charlotte regional economy

Although often overshadowed by finance and other advanced services, the manufacturing sector is a vital component of the Greater Charlotte region’s economy. It currently contributes over 140,000 jobs in the Greater Charlotte region, or 11.7 percent of total regional employment. This makes manufacturing the region’s 4th largest employing economic sector behind trade, transportation and utilities; professional and business services; and government. As demonstrated in Figure 2, the largest number of manufacturing jobs are found in Mecklenburg (33,315 manufacturing jobs), Catawba (21,363 manufacturing jobs), and Gaston (13,513 manufacturing jobs) counties. However, manufacturing is central to the economies of every county throughout the 16-county region. As shown in Figure 3, manufacturing employment as a proportion of total county employment exceeds the national average in every county but Mecklenburg and Cabarrus. In several smaller counties, (e.g., Alexander, Chester, Chesterfield), manufacturing represents approximately one out of every three available jobs.

Manufacturing remains important to the region despite significant job losses over the past 15 years. Figure 4 shows that the Greater Charlotte region was harder hit than most and has only just begun to recuperate. At the Great Recession’s nadir, only 59 percent of the number of manufacturing jobs...
remained that existed in 2001. While this mirrored North Carolina manufacturing trends, the decline was much sharper decline than what occurred nationally or in South Carolina. However, these trends mask the transformation that has taken place within the region’s manufacturing sector. Many of those job losses occurred in manufacturing industries affected by offshoring, such as textiles, apparel, and furniture manufacturing. In 2001, these industries represented 33.2 percent of the region’s manufacturing jobs. Today, they represent only 18.8 percent of manufacturing jobs. Several counties in the 16-county area were particularly hard hit by losses in these industries. Furniture has a key economic driver for Catawba and Alexander counties, just as textiles and apparel were vital to the economies of Gaston and Cabarrus counties. These industries saw sharp employment decreases due to off-shoring.

At the same time, other manufacturing industries grew but quite modestly. Since the end of the Great Recession, however, key aspects of the region’s manufacturing sector have shown significant strength. Since 2010, the Greater Charlotte region’s manufacturing sector has grown almost twice as fast (2.5 percent annually between 2010 and 2014) as the US manufacturing sector (1.3 percent during the same period). This is almost as fast as South Carolina’s (2.7 percent), but more than 3 times faster than North Carolina’s (0.7 percent).

Part of this growth is due to the region’s attractiveness to foreign-owned firms. The Charlotte Chamber of Commerce maintains a directory of these firms, identifying almost 330 foreign-owned manufacturing firms from 33 countries. These global companies account for approximately 37,500 jobs in the region. Figure 5 shows the leading countries of origin for these regional manufacturers.
Far and away, the region’s largest group of foreign-owned manufacturers hails from Germany. Daimler Trucks, Schaeffler Group, and Siemens are among the region’s largest and most prominent manufacturers. There are currently 78 German-owned manufacturers in the Greater Charlotte region, which is almost two and a half times more firms than the next most common country of origin—Canada. Many of these companies have been here for decades, attracted by reliable power and transportation infrastructure and a skilled workforce. These companies are often world leaders in the precision production processes that feed into all aspects of manufacturing. The number of companies has grown over the years, as the presence of German companies has attracted other German companies. In some instances, these companies came to the Greater Charlotte region because these German companies could find the local suppliers they needed. The presence of these, and many of the other foreign-owned firms, is a testament to the region’s attractiveness as a manufacturing location. Many of these operations are sophisticated, knowledge-intensive manufacturing activities, and it is these advanced activities that drive the region’s manufacturing sector.

*In 2014, the Centralina region was home to 328 foreign-owned manufacturing firms from 33 countries.*
‘Advanced Industries’ power the Greater Charlotte region’s manufacturing sector

Much of the post-recession growth in the manufacturing sector has been powered by the region’s manufacturers, particularly in industries related to automotive and energy. Many of these manufacturing industries lie at the core of what the Brookings Institution refers to as ‘Advanced Industries’. These industries, which are likely to shape the country’s economic future, are characterized by intensive Research and Development (R&D) activities and a high concentration of Science, Technology, Engineering and Mathematics (STEM) workers. In total, the Brookings Institution researchers identified 50 advanced industries within the US economy, of which 35 fall within the manufacturing sector. These industries are vitally important to the Greater Charlotte region, not just because of the jobs they create but also because they sell their products globally, which brings new money into the region. As a result, they create economic activities beyond just their direct employment. The full list of advanced industries and their employment (for the region and each county) are available in Appendix A.

Within the Greater Charlotte region, there are over 106,000 jobs within these advanced industries and almost 50,000 of those jobs are in manufacturing. The region has strengths within many of the manufacturing-oriented advanced industries. Figure 6 shows the region’s advanced industries that have 750 or more jobs and are in the manufacturing sector. Each bubble reflects one industry’s average wage (on the Y-Axis), relative concentration (on the X-Axis), and regional employment (the bubble size).

Among the region’s advanced industries, 43 of the region’s 47 industries present pay their workers average wages greater than the regional average wage of $47,777. Moreover, if we only consider the region’s advanced manufacturing industries, 27 of the 35 industries present pay average wages greater than the region’s average annual manufacturing wage of $51,863. In some instances, average wages are significantly higher than the regional average. For example, the average wage for household


Industries must meet two specific criteria to be considered an ‘Advanced Industry’: 1) Its share of R&D spending per worker must fall in the 80th or higher percentile of all industries thereby exceeding $450 per worker, and 2) Its share of workers that whose occupations require a high degree of STEM knowledge must also be above the national average (21 percent of all workers).

We have also included Energy Generation, Transmission and Distribution due to its importance to the regional economy, and the region’s manufacturers.

We measure relative concentration using location quotients (LQ), which measure the relative percentage of the region’s industry employment, as compared with the cluster’s national employment share. An LQ greater than 1.0 means that the region has a larger relative concentration of industry employment than the overall national economy. Furthermore, if the industry’s LQ is growing over time, then industry employment is becoming more concentrated in the region; this suggests an improvement in the region’s relative competitiveness.

These average wages do not include additional compensation or benefits.
appliance manufacturing is over $135,000, due in part to the presence of GE Electrolux’s North American Headquarters. This is an important reminder that not all manufacturing jobs are production jobs, and manufacturing can create jobs across a wide range of occupations.

Figure 6 also demonstrates that the Greater Charlotte region has a diversified manufacturing sector. Unlike Upstate South Carolina or Southeast Michigan where the automotive sector dominates the manufacturing landscape, the Greater Charlotte region’s manufacturing sector is home to many different types of advanced manufacturers. This is important not only because it presents multiple market opportunities for regionally-based firms, but it also brings stability to the region’s economy since it is not subject to any single industry’s economic cycles.

The Greater Charlotte region has multiple strong industries, as shown in Figure 6. Automotive parts manufacturing represents a significant portion of the manufacturing sector. While the region does not have a large passenger vehicle Original Equipment Manufacturer (OEM) along the lines of BMW in Upstate South Carolina or Nissan in Middle Tennessee, it has a number of large players in related automotive production. In 2014, there were over 10,000 jobs in the motor vehicle parts manufacturing sector.
and motor vehicle manufacturing industries. Much of this employment came from firms like Daimler Trucks, but a significant share of employment can be tied to motor vehicle parts suppliers that feed into several different automotive supply chains throughout the southeast and nationally. As seen in Figure 6, these activities are relatively concentrated in the region, and pay average to above average annual wages.

Several other advanced industries illustrate why the energy sector is also critical to the region’s economy and to its manufacturing sector. Home to Duke Energy, the nation’s largest electric power company, the region is an important center for the electric power generation, transmission and distribution industry. Not only does this industry employ over 4,400 people in the region, but due to Duke Energy’s headquarters, the average wages are more than twice the regional average.

Access to an affordable and reliable energy infrastructure makes the region attractive not only for power production, but for manufacturing as well. Two other vital energy-related advanced industries are highly concentrated within the Greater Charlotte region. Perhaps most prominent is the engine, turbine, and power transmission equipment manufacturing industry, which is represented by Siemens. Siemens’ current Chief Executive, Eric Speigel, also serves on President Obama’s Advanced Manufacturing Partnership, which guides the President’s efforts to establish federally funded innovation hubs throughout the nation. This industry accounts for almost 3,000 jobs and is more than three times more concentrated in the region than nationwide. In addition, an emerging industry known as “other electrical equipment manufacturing” is even more concentrated and employs more people. This industry, which accounts for over 4,000 regional jobs, includes activities related to cable and battery manufacturing. With projects like Alevo coming online in the next several years, this industry will likely experience continued regional growth.

Beyond automotive and energy, the Charlotte region possesses several other existing and emerging areas of manufacturing strength. For instance, the region has existing strength in machinery manufacturing. Both industrial machinery and general purpose machinery manufacturing are relatively concentrated within the region, and combined they employed more than 5,500 workers. Similarly, the chemical product and preparation manufacturing and basic chemical manufacturing industries are relatively small but good paying manufacturing industries.

The region also has several other emerging advanced industries. These emerging sectors may not employ a large number of workers, but they demonstrate regional growth potential. These industries include measuring and control instruments manufacturing, an industry that has almost doubled in employment since 2010. Similarly, aerospace product and parts manufacturing, led by recognizable companies like Curtiss Wright Controls, added over 300 jobs in the past four years. Emerging opportunities are also apparent in life sciences manufacturing industries like pharmaceutical and medicine manufacturing and medical equipment manufacturing. While these industries are not nearly as concentrated in the Greater Charlotte region as they are in the Research Triangle, they continue to show
strong growth trends. Since 2010, both industries have grown faster regionally than they have nationwide.

The data presented in Figure 6 illustrate the Greater Charlotte region’s manufacturing strengths. As noted above, the region has a diversified manufacturing base that feeds into many different markets and supply chains. However, looking at the region’s manufacturing landscape through the lens of these advanced industries reveals only a part of the story. The next section will reveal how linkages between these industries reflect an important aspect of the regional manufacturing ecosystem.

Value Chains: Identifying inter-industry linkages

By using a nationally defined set of ‘Advanced Industries,’ the previous section analyzed the Greater Charlotte region’s manufacturing sector using a “top-down” approach. The goal of this analysis was to identify which industries are more active and concentrated in the Greater Charlotte region when compared to the rest of the U.S. economy. In the following section, the analysis takes a ‘bottom-up’ approach by examining the connections between multiple industries. As a result, we undertake a ‘value-chain’ analysis of the several targeted industries. In looking at value chains, we are looking at the industry to industry buying and selling relationships, based on available quantitative data.7

We start with a single ‘core’ industry that represents a significant contributor to the local economy, and analyzing its inter-industry linkages through buying and selling patterns. These core industries represent key clusters important to the region and often serve in the same way that a grain of sand serves as the core of the “pearl” that is the gem of the region’s economy.

The model used here, which was developed by Dr. Edward Feser of the University of Illinois Urbana-Champaign, identifies backward and forward linkages for each industry.8 It therefore attempts to account for all the buying and selling between all industries in the U.S. economy. In an ideal world this model would be based on global buying and selling patterns, but those data are unavailable. However, the U.S. economy serves as a reasonable proxy because it is well developed and a deeply integrated economy. Once we have determined these inter-industry connections, we can then apply regionally-specific data9 to better identify regional economic strengths, emerging opportunities, and the gaps that

7 By contrast, a ‘supply chain’ analysis would examine individual firm to firm relationships that require extensive qualitative research and firm cooperation.

8 The model is based upon the U.S. Census Bureau’s Economic Census and Benchmark Input-Output data developed by the U.S. Bureau of Economic Analysis.

9 Unless noted otherwise, the analysis uses Economic Modeling Specialists International (EMSI) representation of U.S. Bureau of Labor Statistics data. We used EMSI wage and employment data at the metropolitan statistical area and industry level for the value chain analyses. The EMSI data combine U.S. Bureau of Labor Statistics employment payroll data from its Quarterly Census of Employment and Wages with EMSI estimates for data cells that BLS privacy standards do not allow it to disclose publicly. EMSI utilizes available BLS data through June 2014 to project employment through year end. We analyzed growth trends for industry sectors by comparing 2010 employment levels to EMSI-projected 2020 levels. For the employment concentrations, we looked at each industry sector’s national location quotient (LQ) for 2014.
might eventually be filled through the economic development process. This knowledge will help inform strategies to grow and strengthen the region’s targeted industry clusters.

For each of the core industries we will present a value chain diagram (or “value chain map”). These diagrams lay out each core industry’s forward linkages (sales made by the core industry, or market opportunities) and backward linkages (purchases made by the core industry, or supplier opportunities).\(^{10}\) The linked industries identified in these diagrams do not represent all of the linkages. Instead, they focus on those relationships that are most extensive in terms of the size of the transactions and “close” in terms of how directly the core industry interacts with other U.S. industries through either a buying or selling relationship. In order to determine the most significant linked industries, our model considers three factors:

- The directionality of the flows. Are the linkages forward or backward linkages?
- The structure of the flows. Who does the core industry buy from, or sell to, most directly?
- The volume of flows. What industries does the core industry buy from, and sell to, the most?

Figure 7 provides a guide for reading the value-chain diagrams that will follow in the report.\(^{11}\) The colored boxes indicate how concentrated each linked industry is in the local economy. The up or down arrows in the linked industry boxes depict whether an industry is growing or declining regionally. The colored arrows leading to and from the core industry indicate the flow of trade—whether the core industry is purchasing or selling within the key sector. The purpose is to identify industries and firms that have extensive trading relationships and are experiencing positive growth in the Greater Charlotte region. Linked industries that are growing or highly concentrated within the region reinforce the potential strength of the core industry and bode well for efforts for further development of the core industry. Conversely, where linked industries are not present or not heavily concentrated, there may be gaps that need to be better understood in order to help grow the core industry.

The value-chain diagrams are not intended to map the connections between each and every firm within an industry, but rather to paint an overall picture of how one core industry connects to related industries. The focus is on linkages—what kinds of industries are more closely networked with the core industry? It should also be noted that if an industry does not appear on the list, it does not mean that those relationships do not exist. It does, however, suggest that strong connections and extensive business relationships are less common and less direct.

\(^{10}\) This approach does not account for the ultimate consumer of these goods (final demand), therefore if an aircraft manufacturer sells jets to the Department of Defense, “Government” would not appear as a forward linkage.

\(^{11}\) It should be noted that the core industry often buys and sells with other firms in its own industry. As a result, the diagrams regularly show that core industries are often closely linked to themselves.
Mapping target value chains

The analysis presented here focuses on eight core industries. These industries were selected in consultation with the Centralina Council of Governments and align with industries identified in the *Prosperity for Greater Charlotte Comprehensive Economic Development Strategy*. The key clusters and the core industries selected for value-chain analysis are identified in Figure 8.

Charlotte has an especially strong and diverse energy manufacturing sector. Given the importance of energy to the region’s future economic development efforts, we focus our analysis on several of the primary manufacturing activities associated with the energy industry. As a result, we selected three core industries that produce equipment linked to generating and storing energy. These industries include primary battery manufacturing, motor and generator manufacturing, and turbine and turbine generator set units manufacturing. In addition, we have included energy generation, transmission and distribution. The region is headquarters to Duke Energy, the nation’s largest private electric power company, and therefore is important to the regional economy. The industry also provides a vital service to manufacturers who are large customers of electric power.

The four other core industries that we examine relate to several other regional targets. While the region is home to a wide array of automotive parts manufacturers, we have selected heavy duty truck

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manufacturing as the core industry for the automotive sector, reflecting the local presence of Daimler Trucks—one of the region’s largest OEMs. By contrast, the region’s aerospace and defense industry lacks a single large OEM, but it does account for a wide range of sophisticated manufacturing activities. We selected the aircraft parts and auxiliary equipment manufacturing industry, reflecting the local importance of companies like Curtiss-Wright Controls, a parts manufacturer with relatively broad ties to multiple aviation industry supply chains. Although a wide range of firms in these industries are involved in precision metalworking, we selected ball and roller bearing manufacturing as representative of this segment of the economy because these components are so critical as inputs to a large variety of manufactured goods. Finally, the distribution and logistics industry is an important complementary industry for the region’s manufacturers, and we focus our analysis on the truck transportation as the cluster’s largest employing industry.

The next section will explain the findings from each of these eight value chains. In our analysis, we will consider the supplier and market opportunities associated with each of the core industries and will note any potential gaps that may exist within the regional value chain. Regional companies in the core and linked are mapped, by value chain, in Appendix B. The individual companies are identified in the Excel Workbook associated with Appendix C.
We conclude the section by discussing some of the common findings arising from the overall value-chain analysis. We will also highlight those industries that supply or buy from multiple core industries. These overlapping linked industries are important contributors to the region’s manufacturing ecosystem, and their future development may prove important for the regional manufacturing strategy.

**Motor and generator manufacturing**

The motor and generator manufacturing industry in the Greater Charlotte region is highly concentrated and has strong forward and backward linkages. The industry now employs over 1,100 employees, having grown 2.4 percent annually between 2010 and 2014. This growth rate is more than three times faster than the industry’s national growth rate during the same period. The motors produced in the region serve varying purposes. For instance, Baldor Electric Company in King’s Mountain makes larger electrical motors for industrial purposes. By contrast, AMSO in Statesville makes smaller motors used for power seats and windows in automobiles. Given this variety of applications, this industry has a wide array of both backward and forward linkages. Overall, in 2014 North Carolina had the nation’s fourth highest number of employees in the motor and generator manufacturing industry, while South Carolina came in at 13th.

**Supplier opportunities**

Figure 9 shows that there are a number of small but growing local industries that supply the motor and generator manufacturing industry. Continued growth in the motor and generator manufacturing industry may create additional demand for several of these emerging industries. Forging, stamping, and sintering, and crown and closure manufacturing is another important supplier industry, as it grew 14.8 percent annually between 2010 and 2014 and now employs over 1,000 workers regionally.

Industries such as engine equipment; speed changer, industrial high-speed drive, and gear manufacturing and mechanical power transmission equipment; and gasket, packing, and sealing device manufacturing have all experienced faster than average growth over the past four years. None of these industries have more than 600 employees, but they are all relatively concentrated in the region. This concentration is expected to increase as employment is projected to grow regionally but decline nationally between 2014 and 2020.

Only two backwardly linked industries lost employment in the region between 2010 and 2014. One of these industries—clay product and refractory manufacturing—has a high relative concentration, but lost more than 100 net new jobs over the past four years, and the industry is projected to continue shedding jobs through 2020. Power, distribution, and specialty transformer manufacturing also lost employment, but it has fewer than 30 local jobs, essentially meaning that this may represent a local gap in the value chain.
Market opportunities

The motor and generator manufacturing industry sells to many other industries, several of which are growing and highly concentrated in the region. There are market opportunities for industries producing consumer products, instrumentation, and manufacturing equipment. Air and gas compressor and pump and pumping equipment represent two of the region’s largest and most concentrated industries. Both industries employ more than 1,000 people in the Greater Charlotte region and are highly concentrated. These industries represent clear regional strengths. They are projected to continue growing nationally, but not as quickly as they are projected to grow regionally. This growth should provide important sources of local demand for the region’s motor and generator manufacturing industry.

Two industries related to instrumentation represent emerging opportunities. Analytical laboratory instrument manufacturing and electro-medical and electrotherapeutic apparatus manufacturing are two relatively small industries that are likely to purchase motors, and that have experienced growth since 2010. The former employs about 300 workers in the region, but added 100 since 2010. The latter employs only 60 employees, but most of that employment came in the past four years.
The region also has several gaps that could create increased regional demand for motors and generators if they were filled. These gaps are found in industries that produce consumer-oriented products, such as small electrical appliance manufacturing and household laundry equipment manufacturing. It is possible that the region could appeal to these types of activities since it already has a strength in other consumer goods areas, namely power-driven hand tool manufacturing. This industry employs about 400 people, and is almost four times more concentrated in the region than it is nationally.

**Primary battery manufacturing**

Battery manufacturing represents an important economic development opportunity for the Greater Charlotte region. The industry has a strong history in the region, with several large battery manufacturers, including Duracell in Lancaster, SC, and Celgard in Charlotte. In addition, FMC Lithium makes some of the Lithium chemicals used in Lithium batteries. Charlotte battery manufacturing activities are also likely to grow as Alevo—a manufacturer of large scale storage battery systems—moves forward with its recently announced investment in Concord. The new Alevo plant will be supplied by Parker Hannifin. Parker Hannifin has its second largest location in Charlotte, which is a large power circuitry board package unit, combined with storage battery units. 13

This industry has grown since 2010, and is now four and half times more concentrated in the Greater Charlotte region than it is nationally. Among the linked industries, the region has a strong set of both backward and forward linked industries.

**Supplier opportunities**

Figure 10 shows that an assortment of component parts manufacturing industries comprise the potential supplier base for the primary battery manufacturing industry. Many of these supplier industries have a relatively strong regional presence. Industries such as synthetic dye and pigment manufacturing, plastics packaging materials, nonferrous rolling, drawing, extruding, and alloying, forging and stamping, and miscellaneous electrical equipment and component manufacturing, all have significant employment and have relatively high concentrations of employment in the Greater Charlotte region. Two plastics-related industries—plastics packaging materials and other plastic product manufacturing—both added over 600 net new jobs since 2010. In both instances, these growth rates far exceeded the national annual growth rate for this industry during the same period.

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Not all supplier industries have shown the same kind of growth. Two other backwardly linked industries lost employment over the past four years. Paperboard container manufacturing, which employs over 2,700 workers around the region, lost 150 jobs since 2010. Of course, not all of these workers produce products for the battery manufacturing industry, so there are likely many other factors causing this decline. Laminated plastics plate, sheet and shape manufacturing, which employ many fewer workers in the region, similarly lost over 200 net jobs since 2010. Increased future demand in primary battery manufacturing may help to reverse these trends for companies in these industries that are doing business with battery manufacturers.

Carbon and graphite product manufacturing represents a gap in the Regional value chain with no employment. That said, a number of the companies engaged in motor sports often have some capacity in this area and therefore might be able fill this gap by applying this knowledge toward new products for the region’s battery manufacturers.
Market opportunities

Batteries are vital components in a wide variety of products and equipment, and as a result it is no surprise that the industry has a wide variety of forwardly linked industries, ranging from air transportation to lighting fixture manufacturing. The region experienced growth in all the closely linked forward linkages, with the exception of snack food manufacturing. Consumer products industries like power-driven hand tool manufacturing are also purchasers of batteries. As a result, growth in firms like Stanley Black and Decker in Fort Mill, SC, or Robert Bosch Tools in Lincolnton, NC will create demand for battery manufacturers.

Several component manufacturers are among the close forward linked industries, including special tool, die, jig and fixture manufacturing, electricity and signal testing instruments, and watch, clock and other measuring and controlling device manufacturing. None of these three industries are highly concentrated in the region, but they all experienced employment growth between 2010 and 2014. Growth in metal valve manufacturing creates demand for batteries, as it is linked closely to the primary battery manufacturing industry as both a supplier and a customer industry.

Figure 11: Turbine and turbine set units manufacturing value chain
Several services, such as maintenance of both commercial and household goods, also generated demand for battery manufacturers. Due in part to the strength of the region’s economy, both of these industries experienced faster than average growth between 2010 and 2014. Air transportation is another large local service industry creating demand for battery manufacturing.

**Turbine and turbine generator set units manufacturing**

Turbine and turbine generator set units manufacturing is emblematic of the region’s strengths in energy-related manufacturing, particularly as it is related to nuclear energy. This industry is highly concentrated in the region and employs roughly 2,000 people. Represented primarily by companies like Siemens Energy and ANDRITZ Hydro Corporation, the industry grew substantially over the past four years, adding almost 1,000 jobs since 2010. This growth is projected to continue, but at slightly slower pace through 2020.

The industry has witnessed the recent relocation of prominent nuclear energy equipment manufacturers to the region. Siemens’ relocated its 60-Hz large-scale gas turbine manufacturing and its instrumentation and control group division to Charlotte in 2010. Areva, a global leader in the design and construction of nuclear power plants and other nuclear services, relocated its North American headquarters to Charlotte in 2013. Charlotte is also the headquarters for Babcock & Wilcox Nuclear Energy, Inc. and Generation mPower LLC, while Fort Mill is home to URS Corporation’s Nuclear Center.

**Supplier opportunities**

Figure 11 shows that there are several strong industries on the supply side of the turbine and turbine generator set units manufacturing industry, many of which are among Brookings’ Advanced Industries. With more than 1,600 employees and a very high and growing employment concentration in the region, metal valve manufacturing represents one of the region’s industry specializations, with companies such as Charlotte Pipe and Foundry. Other supplier industries with high and growing or stable employment concentrations include: speed changer, industrial high-speed drive, and gear manufacturing; rubber and plastics hoses and belting manufacturing; forging, stamping, and sintering, and crown and closure manufacturing; other engine equipment manufacturing; and fluid power process machinery. Custom roll forming and ferrous metal foundries are two manufacturing industries that represent potential growth opportunities for the region, with companies such as Paragon Foundries in Mecklenburg County.

This industry also creates supplier opportunities in the service sector. The specialized design services industry presents one potential emerging industry. Although it currently has a relatively low employment concentration, it does account for almost 700 jobs. Moreover, industry employment has grown in the Greater Charlotte region since 2010, with nuclear energy consulting companies like STEAG Energy Services in Kings Mountain, NC, a manufacturer of products used in coal-fired power plants to reduce emissions. Growth in the turbine manufacturing industry is likely to create increased demand for these kinds of services.
Market opportunities

Not surprisingly, there are only a limited number of market opportunities for turbine manufacturers within the greater Charlotte area. For instance, ship building and repairing is one of the industries that purchases from turbine manufacturers and those industries are concentrated in the Hampton Roads area and will not likely have a local presence. Locally, electric power generation, transmission, and distribution firms like Duke Energy are likely to serve as the biggest customer for the region’s turbine manufacturers.

This industry, which will be discussed in greater detail below, is one of the greatest sources of industry demand. This demand is likely to grow as challenges emerge in the energy infrastructure. For instance, aging nuclear plants represent one of the most significant challenges facing the nuclear sector both regionally and nationally. Because very few new nuclear plants have been constructed in recent years, currently operating plants are kept in service for 60 to 80 years – well beyond their initially expected lifecycle. The region is still grappling with the question of how to ensure that these older facilities continue to meet regulatory standards. One possible solution is to retrofit older plants with new digital technology, representing a potential growth opportunity for the nuclear industry. Similarly, increased integration of smart grid technology might create greater opportunities for electronics companies like General Microcircuits that make printed circuit boards for a variety of applications in the energy industry.

Beyond the electric power generation, transmission, and distribution industry, additional demand may emerge from natural gas distribution. Natural gas distribution currently has a low but growing employment concentration in the region. Piedmont Natural Gas in Charlotte represents one of the most important regional companies in this industry, supplying more than 1 million residential, industrial, and commercial customers.14

Electric power generation, transmission, and distribution

The energy utility sector is one of the Greater Charlotte region’s most prominent industries. Represented by electric power generation, transmission, and distribution, this industry provides a vital starting point for understanding the wider array of industries in the energy sector’s value-chain of suppliers and customers (see Figure 12). The electric power generation, transmission, and distribution industry is a specialization for the Greater Charlotte region, providing 30 percent more jobs locally than might be expected based on national employment numbers.

The industry directly employs thousands of workers throughout the region in over 60 establishments. Duke Energy, one of the region’s largest, employs almost 8,000 workers. With 7.2 million electric consumers in the region, the company is also the country’s largest private electric power company. In

addition to Duke Energy, the industry includes several rural electric cooperatives like Union Power, Lynches River, and York Electric. Over the past four years, the distribution industry grew 1.9 percent annually between 2010 and 2014. This growth occurred at a time when the industry declined nationally.

**Supplier opportunities**

Energy resources like coal, oil and gas represent key inputs for the industry, but these resources are not present in the region. As a result, they are gaps that are not likely to be filled. Rail transportation is an important mode of transportation for these resources, but also has a low employment concentration in the region.

The electric power generation, transmission, and distribution industry has a few strong opportunities in the Greater Charlotte region, especially in the manufacturing sector. As noted above, the turbine and turbine generator set units manufacturing industry is projected to grow and already has both high employment and a high regional employment concentration (due to companies like Siemens Energy). Totalizing fluid meters and counting devices manufacturing, represented by companies like Vision Metering in York County, has a high and growing employment concentration, while aircraft engine and engine parts manufacturing currently has a low but growing employment concentration.
On the services side, the construction industry plays an important role in the region’s electric power industry. The region’s construction industry accounts for about 56,000 jobs and is important for building homes and facilities that comprise the industry’s customer base. With that said, construction focused on building utility systems employs 5,300 workers, or about ten percent of the region’s total construction workforce. This industry has also grown significantly over the past four years, having added over 2,000 jobs since 2010. Another service industry that shows some growth potential is the miscellaneous professional, scientific, and technical services industry. This industry has a relatively low employment concentration, but has grown from 775 jobs to over 900 jobs since 2010. As the Greater Charlotte region continues to establish itself as an energy leader, this is one area that might likely to continue to grow.

**Market opportunities**

Nationally, the electric power generation, transmission, and distribution industry’s closest forward linkages are with extremely energy-intensive industries, like mining or aluminum manufacturing. These industries are largely not present in the region, nor are they likely to be in the future. With that said, manufacturers are important customers and users of electric power, and the region’s large and significant manufacturing sector provide a strong customer base. In order to support and grow this customer base, Duke Energy has a Site Readiness Program that works to evaluate and improve industrial sites in the counties Duke Energy serves in North Carolina and South Carolina.  

**Heavy duty truck manufacturing**

As noted earlier, transportation equipment manufacturing is one of the Greater Charlotte region’s most prominent advanced manufacturing industries. However, the region’s industry is characterized by parts manufacturers and the specialized shops that support motor sports rather than by large automotive assemblers. This is not to say that the region lacks significant OEMs, as it is home to Daimler Trucks North America which employs thousands of workers at their plants in Rowan and Gaston counties. As a result, we focus our analysis on heavy duty truck manufacturing and its key linked industries. Figure 13 diagrams these key linkages.

**Supplier opportunities**

Heavy duty truck manufacturing has a strong supplier base in the region, with several clear strengths and emerging opportunities. The region specializes in heavy duty truck manufacturing and motor vehicle parts manufacturing, which both have high employment concentrations, high employment, and high recent employment regional growth rates in the region. Motor vehicle parts manufacturing stands out as one of the heavy duty truck manufacturing industry’s largest backward linkages. Motor vehicle part manufacturers account for roughly 7,600 jobs around the region, and the industry is 60 percent more

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concentrated in the region than it is nationally. Since the recession, the industry has also been a source of regional growth, as it has added jobs at an annual rate of 4.3 percent—a rate somewhat slower than the national rate of 6.4 percent during the same period. In spite of this, the industry is projected to grow over the rest of the decade, while nationally it is expected to shed jobs.

Regional manufacturers produce a wide array of motor vehicle components. For instance, Wix Filtration Products of Gaston County and Champion Laboratories of York County make filters. Cataler North America of Lincoln County makes catalytic converters for companies like Toyota. Meritor and Performance Friction of York County make brake pads and systems. There are also other companies like NGK Ceramics of Mooresville and Magna Composites of Salisbury that manufacture non-metallic parts and components for use in motor vehicles. These parts suppliers feed into many different supply chains, not just those driven by heavy duty trucks manufacturing. That said, the range of parts manufacturers demonstrates the importance of transportation equipment to the region’s manufacturing landscape.

Several other regional industries also stand out. Tire manufacturing is another industry that is concentrated within the region and is a key backward linkage for the heavy duty trucks manufacturing value chain. The industry employs about 700 people in the region, and is represented in the region by companies such as Continental Tire in Fort Mill, SC and Michelin in Norwood, NC. Employment declined
slightly between 2010 and 2014, but this industry is expected to grow as the Singapore-based tire manufacturer Giti Tire is planning to build a new tire plant in Chester County, SC.

Two other backwardly linked industries supply several of the value chains analyzed in this report. For instance, speed changer, industrial high-speed drive, and gear manufacturing, and mechanical power transmission equipment is closely linked as suppliers not only for heavy duty truck manufacturing, but also for motor and generator, turbine and turbine set units, and ball and roller bearing manufacturing. This industry now accounts for almost 600 jobs, and has a high regional employment concentration. The other backwardly linked industry that supplies multiple core industries is totalizing fluid meters and counting devices manufacturing, which also is a closely linked supplier to the electric power generation, transmission and distribution industry. The industry employs 300 people, but grew regionally when it declined nationally.

Other component part manufacturing industries that are currently strong and growing in the region include other engine equipment manufacturing; motor vehicle body manufacturing; and air conditioning, refrigeration, and heating equipment manufacturing, represented in the region by companies such as Wix Filtration and GKN Driveline in Catawba, NC.

**Market opportunities**

Demand for heavy duty trucks is national and global in scope. Among the forward linked industries, the only industry with both a high employment concentration and high and growing employment is the heavy duty truck manufacturing industry itself. Other manufacturing assembly industries with a presence in the region include motor vehicle body, construction machinery, and travel trailer and camper manufacturing. These industries currently have a moderate but growing regional employment concentration, suggesting some potential for growth.

Heavy duty truck manufacturing also has market opportunities within some service industries. The automotive repair and maintenance and retail trade industries currently have moderate regional employment concentrations, with employment projected to grow. Increased demand for goods and services will increase the demand for heavy duty trucks.

**Aircraft parts and auxiliary equipment manufacturing**

The aircraft parts and auxiliary equipment manufacturing industry is a relatively small industry regionally, but it is representative of many of the firms that participate in the defense and aerospace market. Firms in these markets are often asked to produce sophisticated and relatively low volume products for very demanding customers. These activities often involve precision machining, use of innovative materials, and rapid prototyping.

Within the Greater Charlotte region, the most prominent aircraft parts manufacturer is Curtiss-Wright Controls. Curtiss-Wright Controls makes motion-controls for commercial and military aircraft (including Boeing), and currently employs roughly 400 people at its facilities in Cleveland and Gaston counties. UTC
Aerospace Systems (formerly Goodrich Corporation) is another major representative of the aerospace industry in the region, with about 500 employees at regional locations in Charlotte and Monroe, NC. With UTC Aerospace and other aerospace companies, Union County is home to the largest concentration of aerospace firms in North Carolina. It is also home to ATI Allvac that manufactures alloys and specialty steels for the aerospace industry. As shown in Figure 14, the industry is supplied by an array of backwardly linked industries, but due to the specialized nature of its equipment there are relatively few local industries generating market demand.

**Supplier opportunities**

The backwardly linked industries that supply the aircraft parts manufacturing industry often draw upon many of the region’s competitive strengths. For instance, precision metalworking is required for industries such as forging and stamping, and platework and fabricated structural product manufacturing. Forging and stamping is an industry that supplies many area manufacturers. As noted earlier, this industry has grown rapidly over the past four years and now has over 1,000 jobs in the region. For these activities, aerospace firms are able to draw on local machine shops and other suppliers to motor sports, an industry that also produces specialized equipment for coatings and forgings.

*Figure 14: Aircraft parts and auxiliary equipment manufacturing value chain*
The fabricated structural product manufacturing industry has added almost 500 additional jobs since 2010. By growing at a rate of 6.9 percent annually, the industry grew more than twice as quickly in the region as it did nationwide. Firms in this industry include SteelFab in Mecklenburg County, New South Fabricators in Lincoln County, and Supermetal Southern in York County. Turned product and screw, nut, and bolt manufacturing is another industry that requires precision metalworking and supplies multiple target industries. This industry is small and not highly concentrated, with only 265 regional jobs. With that said, it grew faster regionally than it did nationally over the past four years.

The aircraft parts manufacturing industry also buys from industries involved with advanced materials. The industry with the greatest regional presence is other plastics product manufacturing, which employs almost 2,800 workers. This industry has added over 600 jobs since 2010 and is becoming more concentrated regionally. Carbon and graphite product manufacturing is also a supplier industry for primary battery manufacturing, but lacks specialized companies to meet the local demand. While employment data may show a dearth of activity for this industry in the Greater Charlotte region, regional capacity may be found in a number of high end shops, like Fibreworks Composites in Mooresville, that support the motor sports industry.

Two other relatively large industries that are likely to supply aircraft parts manufacturing industry are hardware manufacturing (875 jobs) and communication and energy wire and cable manufacturing (1,870 jobs). Both of these industries are highly concentrated but have lost jobs since 2010.

**Market opportunities**

The aircraft parts and auxiliary equipment manufacturing industry has four primary industries that serve as customers to this sector. Firms in this industry sell to other firms in the industry as pieces are assembled before being ultimately shipped to an OEM. The aircraft engine and engine parts manufacturing industry also buys from this industry. Within the Greater Charlotte region, Turbomeca Manufacturing in Union County was the most significant firm in the aircraft engine manufacturing industry. This French-owned firm made helicopter turbine engines out of its Monroe facility. In late 2014, however, the firm announced it would be closing this facility, costing the region over 100 jobs.

Beyond these two industries, there are two other sources of demand that can affect the fortunes of the aircraft parts manufacturing industry. Air transportation can provide demand, as airlines buy parts for the maintenance and repair of the fleet of airplanes. Not surprisingly, this is a large and growing industry within the region. Charlotte Douglas International Airport’s role as a hub for American Airlines generates a lot of demand for parts manufacturers, although many are not local to the region.

Another primary source of demand for aircraft parts manufacturing comes from OEMs like Boeing or Airbus. The aircraft manufacturing industry is actually located in other regions such as Seattle and Wichita as well as in Charleston, SC, where Boeing will be manufacturing the 787 Dreamliner aircraft. The largest local parts manufacturer, Curtiss Wright Controls is already part of the Boeing supply chain, and its recent expansion was due to winning a Boeing contract. However, entering these supply chains
can be exceedingly difficult for firms that are not already in them. The industry’s quality and timing demands often exceed the capacity of many smaller firms. For instance, the certifications required by OEMs and larger suppliers are often more difficult to attain than those required in the automotive or marine industries. Moreover, these contracts require long lead times and, as a result, firms must prove stable. This means that established companies are more likely than start-up companies to compete as a link in these aircraft production supply chains.

**Ball and roller bearing manufacturing**

The Greater Charlotte region is also home to a number of precision metalworking firms that make parts and components that are essential to the manufacturing process. These firms often produce products that feed into multiple value chains, from aerospace to automotive to energy.

The highly specialized nature of high precision manufacturing represents a strong potential area for local growth in the region. Suppliers of high precision manufacturing of custom parts often needs to be located in close physical proximity to manufacturing plants in order to facilitate communications, which is why so many metals and castings for U.S. companies are produced domestically. Because many large firms in the region, like Siemens, require precision metallurgy, they require their small local suppliers to certify that they meet their quality specifications. Some of the region’s stakeholders have expressed that there is not enough local capacity in custom metalworking, machine shops, and tooling to meet demand.

Ball and roller bearing manufacturing is one of the region’s essential metalworking industries. The industry has become even more concentrated in the region in recent years, growing locally even though the industry declined nationally. The industry’s local employment is comprised of several different companies, including Schaeffler Group in Fort Mill, SC, Timken Company in Charlotte, NC, and American Roller Bearing Company in Hickory, NC.

The industry has an unusually high employment concentration within the Greater Charlotte region. In 2014, the industry accounted for over 3,000 jobs in the region. These jobs represent over 10 percent of the industry’s total US employment. Figure 15 shows the industry’s closest backward and forward linkages.

**Supplier opportunities**

The ball and roller bearing manufacturing industry draws on many of the same supplier industries that the motor and generator manufacturing industry uses. Just like the motor and generator manufacturing industry, this industry buys from ferrous metal foundries, which has a modest but growing presence in the region. Other common supplier industries include forging and stamping; other engine equipment manufacturing; and speed changer, industrial high-speed drive, and gear manufacturing, and mechanical power transmission equipment. These industries have above average employment concentrations and have added employment since 2010. As noted earlier, industries like forging and stamping supply...
several “core industries” discussed in this report and are therefore vital to the region’s manufacturing ecosystem.

Beyond these similar backward linkages, the ball and roller bearing manufacturing industry is also closely linked to machine shops and tool and die manufacturers. Even though machine shops employ vastly more people (2,575 jobs) than tool and die manufacturers (325 jobs), they are somewhat similar in that they are often smaller shops. Both industries average about 10 jobs per establishment. As a result, growing these industries is likely to rely on entrepreneurial support programs to help new start-ups instead of actively recruiting new firms to relocate to the region.

Two other backward linkages worth mentioning include fluid power process machinery and abrasive product manufacturing. Both of these industries experienced slight employment declines between 2010 and 2014. However, they did so during a time when these industries grew nationally. Both industries have fewer than 400 jobs and much of that employment is generated by a limited number of firms.

**Market opportunities**

The ball and roller bearing manufacturing industry’s forward linkages also overlap with the motor and generator manufacturing industry. Both “core industries” have close forward linkages with air and gas...
compressor manufacturing, power-driven hand tool manufacturing, and rolling mill and other metalworking machinery manufacturing. Moreover, firms in both industries are closely linked to other firms in their respective industries. Two industries—speed changer, industrial high-speed drive, and gear manufacturing, and mechanical power transmission equipment and fluid power process machinery—both buy from and sell to the ball and roller bearing manufacturing industry.

This overlap demonstrates the significance of this industry as a core component of the region’s advanced manufacturing sector. Moreover, the forward linkages show the extent to which ball and roller bearings are vital inputs into machinery manufacturing. Among the industry’s closest forward linkages are industrial machinery manufacturing, packaging machinery manufacturing, rolling mill and other metalworking machinery manufacturing, metal cutting and forming machine tool manufacturing, and fluid power process machinery manufacturing. As a result, growth in all aspects of the manufacturing sector is likely to generate additional demand for the ball and roller bearing manufacturing industry. Therefore, the region’s ability to produce high quality products will be key to it maintaining its competitive position in this industry.

**Truck transportation**

With the Greater Charlotte region’s strategic location between the northeast and southeast parts of the country, it has emerged as a major transportation and distribution center. In addition to its location at the intersection of three major interstate highways (I-40, I-77, and I-85), the region is one of the country’s busiest rail and air hubs, and home to the Charlotte Inland Terminal, which provides linkages to port facilities in Wilmington, NC. Due to these regional advantages, there are 64 freight forwarding and 20 air cargo companies currently located in the region.

Although the logistics industry encompasses many different transportation and warehousing and distribution industry sectors in the Greater Charlotte region, we selected truck transportation as a starting point for understanding the wider array of industries in the value-chain of supplier and market opportunities (see Figure 16). Truck transportation employs over 16,000 workers spread among over 1,000 small establishments in the region. This includes companies like YRC Freight and Southeastern Freight Lines in Charlotte, which contribute hundreds of jobs to the regional economy. The industry did experience a slow rate of growth between 2010 and 2014, but employment is projected to drop slightly by 2020, despite projected national gains. The industry has a relatively strong regional employment concentration, as it is 33 percent more concentrated in the Greater Charlotte region than it is for the nation as a whole.

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Supplier opportunities

Nationally, most closely linked supplier industries for the truck transportation industry are to be found in other service industries, especially transportation and distribution industries. For instance, two of the prominent backward industries are truck and rail transportation, the latter of which employs almost 800 regional workers. The region has particularly strong and growing employment concentrations in industries such as warehousing and storage, which employed 8,900 regional workers in 2014, and couriers and messengers, which employed 5,000. Several major companies have selected the Greater Charlotte region for their key warehousing and distribution centers, including Metrolina Greenhouses, Harris Teeter, Lowes, Global Express, Cologistics, Amazon, Dillards, Aldi, Carolina Beverage, and Electrolux.¹⁷

The truck transportation industry also has close backward linkages to several other business services. The employment services industry has a strong and growing employment concentration, while the

insurance carrier industry has a low and declining employment concentration. Among manufacturing industries, there are backward linkages to industries such as tire manufacturing, motor vehicle parts manufacturing, and wood container and pallet manufacturing. As noted during the discussion of heavy duty truck manufacturing, the region has a strong presence in both the tire manufacturing and motor vehicle parts manufacturing industries. Regionally, wood container and pallet manufacturing represents another strong manufacturing industry. Between 2010 and 2014, this industry grew from 800 workers to 920 workers. It is also 73 percent more concentrated in the region than it is nationally.

**Market opportunities**

Nationally, many of the truck transportation industry’s closest forward linkages are related to the movement of heavy materials. Mining-related industries like stone mining and quarrying and non-metallic mineral mining and quarrying purchase significant truck transportation services; the former accounts for about 500 regional jobs, and the latter has virtually no regional presence.

The other large area that purchases significant truck transportation services are those manufacturing activities related to building and construction materials. Of these industries, ready-mix concrete manufacturing has the largest regional employment. This industry employs about 800 regional workers at firms like Ready Mixed Concrete and Thomas Concrete Industries, which have multiple regional locations. Other building and construction related manufacturing industries that purchase extensive truck transportation services include cut stone and stone product manufacturing, ground or treated mineral and earth manufacturing, and lime and gypsum product manufacturing. With the exception of cut stone and stone product manufacturing, these industries have negligible regional employment suggesting that the stone and construction-related trucking are key elements of the region’s concentration in transportation, combined with the region’s role as a regional consumer products transportation hub.

**Overlapping linked industries present potential economic development targets**

While each of the value chains discussed above have their unique elements, a number of the linked industries are common to multiple value chains. The industries where these value chains intersect represent potential opportunities for the Greater Charlotte region to strengthen its manufacturing ecosystem. They not only benefit from the growth of the region’s target industries, but they also represent opportunities to tighten the region’s linkages with industries in other regions. If these supplier companies are not selling to multiple markets, then there may be opportunities for them to find new markets and support additional growth.

This section synthesizes some of the findings from the analysis above, by focusing on the industries that participate in multiple value chains. Figure 17 lists those overlapping industries. In the following section, we explore whether they are strengths or emerging opportunities in the region’s manufacturing ecosystem.
These linked industries are foundational elements of the Greater Charlotte region’s manufacturing ecosystem. Through our analysis we have identified roughly ten industries that have higher than average regional employment concentration and that support multiple ‘core’ industries. As noted earlier, for instance, tire manufacturing and motor vehicle parts manufacturing are both important components of the truck transportation and heavy duty truck manufacturing value chains.

However, among all these linked industries, the speed changer, industrial high-speed drive, gear manufacturing, and mechanical power transmission equipment industry is closely linked to five different core industries. Not only does it purchase from the ball and roller bearing industry, but it also sells into

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18 Several of the ‘core’ industries examined above buy from and sell to multiple industries, often themselves. We have excluded those industries from this section because they were discussed at length above.
multiple value chains, including heavy duty truck manufacturing, motor and generator manufacturing, ball and roller bearing manufacturing, and turbine and turbine generator set units manufacturing. Nationwide, this industry has grown 3 percent annually between 2010 and 2014, and this growth has been even quicker in the Greater Charlotte region (4.9 percent annually). Regional employment is now at roughly 600 jobs, up from 500 in 2010. Key regional companies in the industry include Boston Gear in Mecklenburg County and Oiles America Corporation in Cabarrus County. This equipment is vital for the production and use of all forms of industrial and transportation equipment.

Fluid power process machinery is another industry with multiple linkages. Nationally, this industry buys from and sells to the ball and roller bearing manufacturing industry and is also a close supplier industry for the turbine and turbine set manufacturing industry. Within the region, notable companies in this industry include Stabilus in Gaston County and Parker Hannifin in Mecklenburg County. Parker Hannifin manufactures power conversion systems for use in energy storage systems. Parker Hannifin’s Charlotte-based facilities produced and installed equipment that was used in support of the 2014 Winter Olympics in Sochi.

Several other of these linked industries merit mention. For instance, air and gas compressor manufacturers are likely to purchase from motor and generator manufacturers and ball and roller bearing manufacturers. Within the region, this industry is primarily represented by Ingersoll Rand in Davidson. Metal valve manufacturing is an important linked industry for the energy industry, as it supplies the turbine industry and sells to the primary battery manufacturing industry. It employs approximately 1,650 people throughout the region at companies like Red Valve in Gaston County and Mueller Systems in Rowan County.

**Emerging opportunities**

The linked industries described above show indications of regional strength, and supply and buy from multiple core industries. There are also a number of these linked industries that are not highly concentrated in the region but show growth potential. Growing and expanding these industries will be a vital part of the growing the region’s manufacturing ecosystem.

Among these emerging industries, forging and stamping is most closely integrated with five of the region’s core industries. It now accounts for over 1,000 jobs in the region, up from 600 in 2010. This growth has occurred in a range of activities, including iron and steel forging, powder metallurgy part manufacturing, and metal crown, closure and other metal stamping.

The industry is particularly important to energy value chains, and nationally it is an important supplier to all four energy industries examined in this report. The precision production processes that this industry brings to its production process are vital for the energy industry. For instance, Siemens needs precision castings because if anything does not meet the necessary specifications, the equipment will wear out faster and need to be replaced as bearings go out of alignment. The forging and casting industry is also a supplier for the aircraft parts manufacturing industry, which, like the energy industry, has demanding
standards for its component parts. The capacity to do this kind of work comes from extensive training and experience, some of which is provided by the companies themselves. This kind of capacity can also be found in some of the smaller firms supporting the motorsports industry. That said, several companies indicated that this kind of metalworking capacity does not exist at the scale the region’s companies demand within a day’s drive of Charlotte. Growing this demand will be vital to growing the region’s core industries.

The turned product and screw, nut, and bolt manufacturing industries represents another linked industry likely to supply both aircraft parts and equipment, as well as the motor and generator manufacturing industries. Within the region, this industry has a small, stable employment base (265 jobs), but is not particularly concentrated in the region. Ferrous metal foundries—which provide raw material for the turbine and turbine generator set units and ball and roller bearing manufacturing industries—have a similar profile with a modest employment base (440 jobs in 2014) and low regional concentration relative to the region.

By contrast, the totalizing fluid meters and counting devices manufacturing industry—which is linked to both the heavy duty truck manufacturing and electric power, generation, transmission and distribution industries—has grown rapidly and become more concentrated in the region. This industry is represented in the region by companies like Vision Metering in York County. Industry employment has almost doubled between 2010 and 2014, and the industry now accounts for over 280 jobs. With this growth, it is now more than three times more concentrated in the Greater Charlotte region than it is nationally.

Many of the industries discussed above are likely to supply the region’s target industries; power-driven hand tools manufacturers are more likely to buy from these target industries. It is an industry that appears as a key customer for three of the target industries—motor and generator manufacturers, ball and roller bearing manufacturers, and primary battery manufacturers. Currently regional employment within the power-driven hand tool manufacturing industry remains relatively small with fewer than 300 jobs, many of which are at Robert Bosch Tool Corporation in Lincoln County. However, the industry has grown over the past four years. Given the presence of these key inputs, tool manufacturing may represent a potential regional economic development target.

As regional economic developers undertake recruitment efforts to support the region’s manufacturing sector, it will be important to understand the current manufacturing ecosystem and how new OEMs can take advantage of the existing base of small manufacturers as suppliers to companies looking to invest in the region. Clearly, the region is well positioned to support companies that require precision machined parts for a variety of manufactured products: aircraft, truck, turbine, and batteries. Using this new understanding of the capacity of the region’s many small manufacturers will help reinforce the case to attract and grow companies in the sectors.
Many assets and resources strengthen the region’s manufacturing ecosystem

While manufacturing companies may comprise the core elements of the region’s manufacturing ecosystem, many other assets shape that ecosystem. For instance, the region’s educational institutions, support service providers, research centers, and infrastructure help make the Greater Charlotte region a fertile environment for manufacturing. Many of these assets were described in detail in the region’s CEDS document. This section will reference those insights and build upon them by examining the key assets that most directly support the region’s manufacturing sector. We will begin by discussing the region’s educational institutions and their student output that provide talent for local companies. We then highlight a number of the region’s other vital support services for the industry. We then conclude by considering how key elements of the region’s transportation system also support growth in the region’s manufacturing sector.

Regional educational institutions develop manufacturing talent

The region’s 10 community colleges and UNC-Charlotte are crucial institutions for meeting the region’s manufacturing workforce needs. The region’s educational institutions are identified in Figure 18. The extent to which these institutions—and the region’s other public and private education and training providers—align with the needs of the region’s employers was discussed in greater detail in the study.

Figure 18: Educational institutions in the Greater Charlotte region
prepared by Council for Adult and Experiential Learning (CAEL) as part of the region CEDS. Our goal here is to build on this analysis by looking at completer data to show how the region’s higher educational institutions are producing graduates for the region’s manufacturers.

Engineering graduates are a vital piece of the manufacturing talent pipeline, and the “Create It” component of the ‘Create it, make it, move it’ mantra that emerged from the regional CEDS. Manufacturers tend to recruit bachelor’s level graduates from their broad geographic region (e.g., the Southeast), and graduate level engineers nationally or even internationally. That said, local engineering talent is easier to find and retain and as a result, UNC Charlotte plays a vital role in training engineers for the region’s manufacturers while area community colleges are vital in providing many of the technicians required for production activities.

Furthermore, many local companies seek to enhance the skills of their existing workforce so access to engineering programs can be a vital part of these companies’ talent development goals. Figure 19 shows that the Greater Charlotte region had roughly 300 students graduated with 4-year engineering degrees and another 150 graduated with 4-year engineering technology degrees in 2013; all but 15 of them graduated from UNC-Charlotte. UNC-Charlotte was also responsible for the 116 graduate level engineers. Mechanical engineering was the most common degree, followed by civil and electrical engineering.

While the demand for engineers is met through a mix of local and non-local talent, the demand for production and skills trades workers tends to be far more local in nature, and they are key to the ‘Make It’ component of the ‘Create it, make it, move it’ mantra. Therefore, this is an area where the region’s community and technical colleges play a particularly vital role in supporting the regional manufacturing sector. The CAEL analysis of the education and training offerings relevant to the advanced manufacturing sector showed that there were 210 program offerings throughout the region, and of these 166 were pre-associate level certificates. These programs—particularly in areas such as computer integrated machining, electrical and industrial systems technology, and welding—are important for

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19 This report Jobs, Workforce and Education Alignment Strategy for the Greater Charlotte Region is available here: http://www.centralinaedc.org/documents/WorkforceEducationAlignmentReport12-6.pdf
responding to the more pressing immediate manufacturer needs in automotive, aerospace, or energy-related manufacturing.

In 2013, 725 students completed either certificates or associates degrees in engineering, engineering technology and precision production. Figure 20 shows how many people completed an associate’s degree and/or certificate programs that most directly pertain to advanced manufacturing. This includes graduates from programs in precision production (e.g., welding, machine shop technology, CNC Machinist Technology), engineering technology (e.g., applied engineering, Computer Aided Design), and engineering (predominantly 4-year and advanced degrees, and discussed in more detail below).

In 2013, Central Piedmont Community College had the largest number of graduates with an associate’s degree with 76 completers. This was followed by large private, for-profit institutions like ITT Tech’s two Charlotte campuses. Several colleges such as York Technical College, Stanly Community College, Catawba Valley Community College, and Gaston College all graduated between 35 to 40 students with degrees directly relevant to the manufacturing sector.

By contrast, several of the region’s other community colleges—Gaston College, Rowan-Cabarrus Community College, Northeastern Technical College, and Cleveland Community College—all have far more certificate completers than associates degree graduates. In these instances, the manufacturing

![Figure 20: Manufacturing-focused Bachelors & Graduate degrees](image)

<table>
<thead>
<tr>
<th>College</th>
<th>Associates Degree</th>
<th>Certificates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Piedmont CC</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>ITT Technical Institute-Charlotte South</td>
<td>59</td>
<td>57</td>
</tr>
<tr>
<td>York Tech. College</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>ITT Technical Institute-Charlotte North</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Stanly CC</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Catawba Valley CC</td>
<td>36</td>
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<tr>
<td>Gaston College</td>
<td>35</td>
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</tr>
<tr>
<td>Rowan-Cabarrus CC</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Northeastern Tech. College</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mitchell CC</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Cleveland CC</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

*Degrees in Engineering, Engineering Technologies, & Precision Production

Source: NCES IPEDS; EMSI

Manufacturing Associates Degrees and Certifications Completed (2013)
workforce may be relatively small, and employers want workers skilled up and in the workforce in a shorter period time than it takes to complete an associate’s degree. The focus of these certifications varies somewhat between colleges. For instance, Gaston College which had far more certification completers than any other college in the region was almost evenly split between completers with certificates in Welding and Machine Shop Technology. Rowan-Cabarrus Community College was similar. In other instances, this was not the case. Over three quarters of the certifications at Cleveland Community College were for welding.

It is important to note that the number of regional completers in these areas have changed over time, and all three show slightly different growth trends. As shown in Figure 21, completer trends for engineering students have generally followed larger economic trends with a general upward trajectory. Amongst engineering students, the region has almost doubled the number of engineering graduates. Between 2003 and 2013, the number of engineering students grew at an annual rate of 6.4 percent, which was faster than the national rate of 3.7 percent annually.

By contrast, completers in engineering technologies and precision production programs follow a more counter-cyclical trend. As a result, enrollment increases when the economy is poor and people need to build or strengthen skills and then decreases as the economy recovers and job opportunities are more available. This is a pattern consistent with community college enrollments nationwide, and these completers are often from associate’s degree and certificate programs. As shown in Figure 20, both program areas have grown over the past decade but enrollment spiked during the recession and has decreased since the recovery. Since precision production programs are typically shorter certification programs, the number of completers spiked in 2010, whereas engineering technologies degrees, which are typically 2-year degrees, peaked a year later in 2011.

The degrees considered in Figure 20 and Figure 21 are most directly relevant to manufacturing, but they are not the only fields of study producing qualified graduates. If we expand the programs to focus on a
broader set of Science, Technology, Engineering, and Math (STEM) curricula, we identify almost three times as many completers (3,460). Many of these graduates are at the institutions listed in Figures 18 and 19. Not surprisingly, many of them are graduating from the region’s largest institutions like UNC-Charlotte and CPCC. However, several other institutions do stand out with this broad set of programs. Most notably, the NASCAR Institute (a private, for-profit institution in Mooresville) had 745 graduates from its vehicle maintenance and repair program in 2013. This program actually takes longer than two years, and trains students with the maintenance needed for motor sports as well as general automotive repair.

Many STEM skills are often transferable to manufacturing in areas such as industrial maintenance, but they are obviously also critical skills for the region’s distribution and logistics industry. New programs are also coming online to further support the region’s ability to move products out of the region. Most notably, the new Central Piedmont Community College for Global Workforce and Logistics will offer programs on logistics and supply chain; logistics engineering, automation, and technology; and international business development, among others. In addition to its degree programs, it will also offer customized training for employers.

Additional training occurs through these institutions’ corporate colleges are also important resources for area manufacturers. By providing customized training for employers, college assets like York Technical College’s Center for Advanced Manufacturing can train workers in important areas like safety or lean manufacturing. This kind of non-degree training helps employers access important and immediate training needs for their incumbent workers.

It is important to note that often these kinds of industry training needs are quite specialized and as a result the cost of advanced equipment can be very significant. For public institutions, the cost per student to train workers in many of these manufacturing-related fields far exceeds the costs found in general education programs. Sustaining these programs requires a projection of a continuous need for workers. It cannot simply be a one-time need, especially if costs associated with the equipment on which workers will be trained cannot be offset in some way.

As a consequence, many associate’s degree programs focus on the foundational skills, but have difficulty consistently providing the applied skills that some companies now seek from their entry level workforce. Colleges have taken several different approaches to address these challenges. For instance, colleges actively seek direct involvement of companies to help keep the equipment state of the art as well as the production process techniques up to date. Articulation agreements between colleges can also avoid

\[\text{Engineering, Engineering Technologies and Engineering-Related Fields, Biological and Biomedical Sciences, Mathematics and Statistics, Physical Sciences, Science Technologies/Technicians, Mechanic and Repair Technologies/Technicians, Precision Production, and Transportation and Materials Moving.}\]

\[\text{http://www.uti.edu/campus-locations/mooresville-nc}\]

\[\text{http://www.cpcc.edu/global/logistics}\]
redundant investments in expensive programs and equipment. For instance, South Piedmont Community College has partnered with Central Piedmont Community College to allow their students to take advantage of the non-destructive testing (an in-demand area in the aerospace industry) at CPCC. Similarly, community college systems have invested in mobile labs that bring the equipment to students either at smaller colleges or at employer facilities.

**Apprenticeships**

Formal programs are not the only way in which manufacturers find and train workers. Increasingly regional manufacturers are using more structured, experiential learning approaches like apprenticeships. Apprenticeship programs have been gaining greater national attention in recent years, and the region is seen as a model for effective delivery of American apprenticeship programs. The impetus for many of these apprenticeship programs came from the region’s German manufacturers. Given that the apprenticeship model is standard practice in Germany, companies like Blum, Chiron, Daetwyler, and Pfaff Molds worked in partnership with Central Piedmont Community College (CPCC) to create an apprenticeship program that would work in the Greater Charlotte regional context.

To this end Apprenticeship 2000 was created in 1995. Apprenticeship 2000 is a four-year apprenticeship program that works to connect high school juniors and seniors with on-the-job training and a tuition stipend towards a technical degree at Central Piedmont Community College (CPCC). Over time it has also been expanded to dislocated workers and veterans. In addition to many of the initial German companies that participated, additional companies have joined as members of the Apprenticeship 2000 program, including Siemens, which is an associate member. Siemens also runs its own apprenticeship programs and in 2014 donated its product lifecycle management software, used by many other companies as well, to Central Piedmont Community College to train 40 degree-seeking students a year.

There are other apprenticeship programs outside of the more immediate Charlotte region. For instance, Northeastern Technical College partners with the Schaeffler Group, a German-based rolling and plain bearings manufacturer, to provide students with a 3.5-year apprenticeship program. Students commit to stay with INA for a minimum of 2 years after completing the apprenticeship program. Upon completion of the program, they graduate with an Associate Degree in Machine Tool Technology and a Journeyman’s License from the US Department of Labor.

Stanly Community College (SCC) and Chicago Tube and Iron developed a welding apprenticeship program that graduated its first class in 2013. In 2014, SCC opened the Advanced Manufacturing and Industrial Technology (AMIT) Center on the Albemarle campus. The Center offers training in industrial systems, welding, CNC/manual machining, auto repair, and HVAC. Rowan-Cabarrus Community College offers customized industry-specific trainings for local companies.
Manufacturing support services promote innovation and competitiveness

Workforce education and training is a significant need for manufacturers, but a healthy manufacturing ecosystem provides additional assistance in other areas. Within the Greater Charlotte region, assets are available to help manufacturers receive the technical support and business support they need to grow and become more competitive. Manufacturers are also able to leverage the research and innovation capacity of the research assets available at UNC-Charlotte and several other institutions. Combined these support services are important elements for ensuring the health of the region’s manufacturing sector.

Innovation assets

The University of North Carolina-Charlotte is perhaps the region’s most important innovation asset. It possesses a number of resources and programs that support the region’s manufacturing sector. Within the university two units that are specifically tasked with turning research into commercial products are the Charlotte Research Institute and the Office of Technology Transfer. The former provides a vehicle for creating university-industry partnerships and for connecting businesses to the university’s primary innovation assets. It has locations both on the UNC-Charlotte campus and at the North Carolina Research Campus in Kannapolis. The UNC-Charlotte Office of Technology Transfer works to make sure that innovative ideas developed at UNC-Charlotte find their way into the marketplace either through campus spinoff companies or licensed technologies.

The innovation underway at UNC-Charlotte often has direct applicability to the targeted industries. Several of these research centers target specific industries or technologies. For instance, the North Carolina Motor Sports and Automotive Research Center provides interdisciplinary training relating to both the business and engineering of motorsports. It allows students to be exposed to professionals within the motor sports industry, and an estimated 10 percent NASCAR engineers come from UNC Charlotte.

In addition to training engineers for motor sports, UNC-Charlotte also has several important applied research centers. For instance, the UNC-Charlotte Center for Precision Metrology provides a platform for academics and industry partners to collaborate on research, development, and integration of measuring technologies and their applications in the manufacturing process. It provides opportunities for R&D and application of new processes, as well as provides students exposure to advanced measuring equipment used by manufacturers. It is an interdisciplinary program, and students can choose tracks related to specific manufacturing processes or business applications. The UNC-Charlotte Center for

23 http://motorsports.uncc.edu/
24 http://cpm.uncc.edu/
Optoelectronics and Optocommunications is a similar program in that it engages industry partners in a combination of pure and applied research.\textsuperscript{25}

Another important research center is UNC-Charlotte’s Energy Production and Integration Center (EPIC).\textsuperscript{26} EPIC is part of the UNC-C’s William States Lee College of Engineering and was formed in part to help the region’s energy industry meet its pressing workforce needs. With support from many of the region’s leading energy companies (e.g., Duke Energy, Areva, Siemens), EPIC prepare students for many of the industry’s in-demand technical and engineering careers and engages those students in applied research and development.

Beyond the above centers that are actively involved in supporting the core industries discussed in this report, UNC-C’s influence on the region’s advanced economies extends further. For instance, it has several centers that train workers and undertake applied research related to the life sciences. These research centers include the Center for Bioinformatics, the Center for Biomedical Engineering and Science, and the Cancer Research Center.

In addition to UNC Charlotte, the region is home to other research institutions. Most notably, the North Carolina Research Campus in Kannapolis, North Carolina, is home to public-private research partnerships focusing on a range of topics within human health, genetics, nutrition, and agriculture. Research organizations have access to the resources of the UNC Charlotte Bioinformatics Services Division and the David H. Murdock Research Institute. Research efforts are being undertaken on behalf of private partners like General Mills and Monsanto, and other North Carolina-based universities like NC State, UNC-Chapel Hill and Duke University.

It should also be noted that the assets available to the region’s manufacturers are not just located within the region. For instance, not only does North Carolina State University train many of the state’s engineers, but it also has several key assets that can be brought to bear in support the region’s key manufacturers. For instance, the North Carolina Clean Energy Technology Center\textsuperscript{27} has resources and expertise that can inform the region’s energy companies. In the future, the establishment of the Next Generation Power Electronics Manufacturing Innovation Institute at North Carolina State University will represent a powerful applied research tool that will help both North Carolina and US manufacturers more generally.

Similarly, Clemson University is an important manufacturing asset in South Carolina. It not only trains many South Carolina engineers, but also houses the Clemson University International Center for Automotive Research (CU-ICAR), a nationally recognized leader in automotive manufacturing. CU-ICAR is an advanced technology research campus based in Greenville, SC. Over the past 10 years, CU-ICAR has

\textsuperscript{25} http://opticscenter.uncc.edu/

\textsuperscript{26} http://epic.uncc.edu/

\textsuperscript{27} http://nccleantech.ncsu.edu/
built partnerships between academics, private industry, and government organizations to facilitate applied research and testing facilitates that can support the region’s automotive sector. Also, through its master’s and doctoral programs, CU-ICAR also helps meet some of the automotive industry’s critical workforce needs.

**Technical support providers**

Regional manufacturers have access to two technical support networks. First, the Small Business Technology and Development Center (SBTDC) at UNC Charlotte helps small- and medium-sized companies to develop and implement strategies, develop accounting systems, identify financing sources, develop marketing plans for existing or new products, and develop business performance management systems. The SBTDC can also help companies with their pursuit of government contracts, an important consideration for manufacturers looking to enter defense and aerospace. The SBTDC is a part of a statewide network funded by the state and the US Small Business Administration.

For more technical assistance, manufacturers can seek the assistance of the North Carolina State University Industrial Extension Service (IES) in North Carolina and the South Carolina Manufacturing Extension Partnership (SC MEP) in South Carolina. These two centers are part of the National Institute for Standards and Technology (NIST) Hollings Manufacturing Extension Partnership (MEP). Both have representatives based in the region. Field engineers from these organizations have historically worked with manufacturers to implement lean and quality goals, but the program’s ultimate purpose is to address the entire set of challenges facing manufacturers. The national NIST MEP program has implemented a strategy of encouraging IES and its counterparts in other states to work with companies on growing their revenues—not just on turning around troubled firms or helping companies reduce their costs through lean management principles. This approach involves providing services associated not only with continuous improvement (such as lean and quality), but also with workforce development, energy efficiency, sustainability, technology acceleration, and supplier development. Firms pay for these services. The fee is partially subsidized by federal and state funding to support industrial extension activities.

In addition to these statewide organizations, the region also has access to several other technical service providers. For instance, the Manufacturing Solutions Center based at Catawba Valley Community College in Hickory offers product and prototype testing services for manufacturers. It also offers other technical assistance, such as improving the manufacturing production process, but additionally helps manufacturers with more business-oriented assistance, such as accurately pricing products. Another

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28 http://www.sbtdc.org/offices/uncc/
29 http://www.ies.ncsu.edu/
30 http://www.scmep.org/
31 http://www.manufacturingsolutionscenter.org/
regional technical support organization is the Polymers Center of Excellence (PCE) in Charlotte. PCE is a nonprofit organization that partners with NSCU IES, UNC-Charlotte, and NC State. Its mission is to help manufacturers design, develop, and test plastic parts and plastics-related manufacturing processes. PCE’s facilities house a laboratory for plastics testing and molding trials. It also holds classes on plastics for engineers, technicians, and operators.32

Industry support groups and networks

In additional to these technical support services, the Greater Charlotte region also has several institutions and initiatives that promote and advocate on behalf of the region’s manufacturers and often specific segments of the region’s manufacturing sector. For instance, the CEO Roundtable for Carolinas’ Advanced Manufacturing Companies organizes events for regional manufacturers, particularly the region’s German manufacturers. Through this group American and German business leaders discuss vocational education and skills development, and work to support many of the region’s apprenticeship programs.

There are also a number of industry support groups and networks that work toward the advancement of specific industries. For instance, E4 Carolinas is an industry-led trade association created to promote the energy sector in both North and South Carolina. The name E4 is meant to signify the crucial parts of their work: Energy, Economy, Environment, and Efficiency. Through its work, E4 Carolinas plays a growing role in connecting energy-related business to the resources available through research and educational institutions, economic development organizations, and local and state government. Making and strengthening these connections is an important step toward creating a more dynamic ecosystem for the Carolina’s energy sectors.

Similarly, the North Carolina Aerospace Alliance provides a venue for engaging aviation industry leaders in peer discussions and learning. It is particularly beneficial for smaller firms who are in aviation supply chains or want to enter these supply chains. Many small firms struggle with business development, and the Aerospace Alliance provides these smaller firms with opportunities to interact with larger companies. It also educates smaller firms about procurement strategies and the importance of industry certifications.

Beyond these industry specific groups, the region is also home to a number of entrepreneurial support groups. These groups are not necessarily specific to manufacturing, but are important resources for people looking to start new enterprises. For instance, Business Innovation & Growth (BIG) is a membership nonprofit that builds a network of entrepreneurs and growth-oriented companies. Queen City Forward in Charlotte connects entrepreneurs with business ideas that address the triple-bottom-line of people, planet, and profit. The hub sponsors a social innovation accelerator for social mission-based start-ups, a competition for entrepreneurs, and an accelerator program for college-age

32 http://www.polymers-center.org/index.htm
entrepreneurs. Charlotte is home to an Inception Micro Angel Fund, which is a member-managed capital fund to provide angel funding for scalable start-up companies, as well as a number of start-ups and investors on Angel List. UNC-Charlotte’s Ventureprise runs a business plan competition and provides resources for early-stage companies.

The region’s county and regional economic development and planning organizations also play an important role in supporting the region’s manufacturing. They not only market and promote the region to potential manufacturers, but can also be important conveners for bringing key stakeholders together to address regional challenges facing manufacturers and other industries. They also play important roles in securing resources to support manufacturing activities, and in addressing the infrastructure concerns (e.g., access roads, water, wastewater, etc.) of many manufacturers. The region’s workforce development boards and community colleges are also key stakeholders in addressing regional challenges and are often more effective when working collaboratively. For instance, the Charlotte Regional Workforce Development Partnership of nine community and technical colleges ensures that companies receive the customized training they need.

**Transportation infrastructure eases access to inputs and markets**

A foundational piece of the region’s manufacturing ecosystem, the region’s multi-modal transportation network provides area companies with the ability to efficiently convey raw materials and component parts into the region, and similarly ship completed products out to customers located all over the world. The Greater Charlotte region is well-served by highways, rail, and air, providing companies in the region with world-class access to freight transportation services and a distinct competitive advantage that helps explain The Greater Charlotte region’s role as a center for advanced manufacturing activities.

To build on the region’s freight infrastructure strengths, the Centralina Council of Governments and its regional partners in the Greater Charlotte Bi-State Region are currently working to develop “FLOW (Freight, Logistics, Opportunity and Workforce)”, a regional freight mobility plan. This study will provide an assessment of current freight infrastructure, freight movement, and freight-oriented land uses in the region, and strategies for addressing regional mobility gaps.

33 [http://queencityforward.org/](http://queencityforward.org/)
35 [https://angel.co/charlotte](https://angel.co/charlotte)
As shown in Figure 22, the region’s transportation infrastructure has many assets, including one of the nation’s busiest international airports and three interstate highways (I-77, I-85, and I-40), providing direct access to the Midwestern heartland and the Charleston port, major metropolitan areas to the southwest and northeast, as well as direct linkages to the west. It is also a central location to a large number of freight rail lines. In order to support overall freight operations, the region provides more than 60 freight forwarders, custom house brokers, and professional international service providers. This section will briefly discuss these key transportation assets and their importance for manufacturers.

**Ground transportation**

Ground transportation is the primary means by which manufactured goods are shipped in and out of the Greater Charlotte region. In 2007, the modes of freight transportation that moved the most goods out of the Greater Charlotte region in terms of tonnage were truck (85 percent), parcel (9 percent), air (1 percent), and rail (1 percent). For all modes of freight transportation the highest number of commodities in terms of value that were exported from the Greater Charlotte region were grains,
alcohol, and tobacco products; base metal and machinery; furniture, mixed freight and miscellaneous manufactured products; and electronic, motorized vehicles, and precision instruments.  

The main highways serving the Greater Charlotte region are I-77 and I-85, which provide linkages to the Northeast, Southwest, and Midwest parts of the country. The region is linked to the port of Wilmington and the West Coast by the nearby I-40 highway. Due to its central location, the region has become a major trucking center, with more than 300 trucking firms operating in the area. The availability of regional intermodal connections means that the region serves as an important “break-bulk” point for freight service, meaning goods are frequently transferred from one mode of transport to another.

In addition to the extensive interstate highway network, the Greater Charlotte region benefits from a strategic location within the consolidated rail system of Norfolk Southern and CSX Transportation. Both railroads have major operations in the area that link the region to 43,200 track miles of rail in 23 states, the District of Columbia, and Canada. Norfolk Southern and CSX Transportation are further connected to the region through two short-line railways, Lancaster and Chester Railroad and Aberdeen Carolina and Western Railway. Overall, approximately 600 trains run through the region weekly.

The region’s central location and large number of warehousing centers have helped it grow into one of the nation’s most prominent logistics and distribution locations. As noted, both the truck transportation and warehousing storage industries have high and growing employment concentrations in the region. These industries are vital for helping Regional manufacturers quickly receive and dispatch goods across the nation.

The transportation assets are key location factors in determining where industrial and distribution activities actually take places. Figure 23 shows the location of the region’s industrial parks. These industrial sites are all located either along interstate highways, major transportation arteries like US 321, or with nearby access to rail infrastructure. Maintaining, ready, flexible industrial sites with good transportation access contribute to the region’s manufacturing sector has the capacity to grow and expand.

**Air transportation**

Charlotte Douglas International Airport is the region’s primary hub for air transportation, but its emphasis is on passenger movement rather than air freight. As a passenger transportation center, Charlotte Douglas ranks eighth in the nation and the 25th largest in the world, with over 21 million enplanements in 2013. The airport averages 700 daily flights to around 144 airports, domestic and international.

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38 U.S. Bureau of Transportation Statistics - 2007 Commodity Flow Survey


The ability to easily get to the region from anywhere in the world is an important consideration for many firms in making site location decisions. As an air freight hub, Charlotte tends to rank much lower because it tends to move low weight, high value products. According to the U.S. Bureau of Transportation Statistics, the total landed weight at Charlotte ranked it at the 64th busiest U.S. airport, trailing Greensboro, Raleigh, and Columbia. Another source, Airports Council International of North America (ACI-NA), ranked Charlotte as 35th largest in total cargo (including, loaded freight, unloaded freight, and mail metric tons) in 2013. The ACI-NA

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42 U.S. Bureau Transportation, Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports, Calendar Year 2013.

measure reflects Charlotte’s role as a hub for small package express, air courier, commercial passenger carrier, and large freight forwarder services. Currently the airport is served by 20 cargo airlines, as well as on-site air cargo facilities operated by UPS, FedEx, Emory Worldwide, and DHL.44 This capacity is another important feature for manufacturers, as it gives them another option for quickly moving their products—particularly more specialized, small batch products—out to their customers.

In order to better link freight transportation in the region, Charlotte Douglas is currently working with Norfolk Southern Railroad to develop a new 200-acre intermodal port facility that will combine rail, air, and truck facilities adjacent to the airport’s third parallel runway, which was completed in 2009. This new intermodal yard will replace the existing 40-acre intermodal facility in Uptown Charlotte. Once completed, the facility is expected to generate $7.6 billion in regional economic development over the next 20 years. In 2012, Norfolk Southern and the City of Charlotte signed a lease agreement for the property that allowed Norfolk Southern to begin construction of the facility.45

Hickory Regional Airport in Catawba County serves as a general aviation airport and is not currently served by a commercial airline. For the 12-month period ending July 31, 2013, the airport had 40,504 aircraft operations, an average of 111 per day.4647 By comparison, during this period Charlotte Douglas had 553,487 aircraft operations, an average of 1,515 per day.

Other regional airports in the Greater Charlotte region include Concord Regional Airport in Cabarrus County, Charlotte-Monroe Executive Airport in Union County, Gastonia Municipal Airport in Gaston County, Rowan County Airport in Rowan County, and Bryant Field Airpark in York County. The Concord Regional Airport is particularly important for the motor sports industry, as it is the airport used by many of the race teams. It is also an important facility for the smaller, specialized shops that make custom parts because it allows them to get their parts to customers in a very tight timeframe. Rowan County Airport also qualifies as part of North Carolina Certified Sites, a statewide inventory of industrial sites selected and scrutinized through a rigorous prequalification process to ensure they are “shovel ready” for immediate development.48

As a national airport hub, the Greater Charlotte region has advantages both for its ability to efficiently move air cargo and passengers, but also for the potential development of its burgeoning aerospace manufacturing industry. In particular, employment growth in the Aircraft Parts and Auxiliary Equipment

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Manufacturing industry suggest that it is an emerging opportunity for the region. Building on the
presence of manufacturers like Curtiss-Wright Controls and UTC Aerospace could provide a foundation
for expansion in the region’s air transportation and related manufacturing cluster.

**Water transportation**

Although the Greater Charlotte region is inland, it is located within a short distance of a number of
major port facilities, including the Ports of Wilmington, NC, Morehead, NC, Charleston, SC, Savannah,
GA, and Jacksonville, FL. The port range of Wilmington, Charleston, Savannah, and Jacksonville grew by
306,424 TEU (Twenty-foot Equivalent Unit) from 2011 to 2013, of which Charleston, SC, captured
220,018 TEU.49

The Port of Wilmington, NC, the state’s busiest port, is located approximately 200 miles from Charlotte.
In 2010, the port ranked 17th highest nationally for amount of containerized cargo exports.50 The NC
Ports Authority operates an inland terminal in Charlotte, which links the city to the port through rail and
“Sprint Truck Service”.51 The Charlotte Inland Terminal also links the port to the I-85 and I-77
distribution corridors. It provides professional, neutral container yard operations to container carriers,
and serves as a staging area for empty and loaded containers. CSX Intermodal’s National Gateway
Project connects Wilmington to the rail intermodal transportation network.52

The Port of Charleston, SC, is located approximately the same distance from Charlotte as the Port of
Wilmington and is connected to Charlotte via Norfolk Southern and CSX. This port is one of the busiest
container ports along the Southeast and Gulf coasts and ranked 9th nationally for total amount of
containerized cargo exports in 2010. In 2012, the port ranked 33rd nationally in terms of overall
tonnage.53 The Port of Morehead City, NC, handles both break-bulk and bulk cargo and ranks second
nationally in rubber imports.54 It is connected to Charlotte through Norfolk Southern and direct highway
access.

The region’s close proximity to port facilities is vital for several industries in the region, especially
manufacturers that import and export a large share of their goods internationally. With so many
foreign-owned manufacturers in the region, easy access to shipping both to and from Europe or Asia can
serve as a vital competitive advantage. In particular, regional industries like heavy duty truck
manufacturing and motor and generator manufacturing depend on component parts from a number of
overseas suppliers across the globe.

terminal/
53 U.S. Bureau of Transportation Statistics - National Transportation Statistics (Updated January 2015)
Conclusion

The Greater Charlotte region’s manufacturing sector was once dominated by low-skill, low-wage textiles and furniture manufacturing. The Greater Charlotte region’s manufacturing is now characterized by knowledge-intensive, advanced manufacturing industries that rely on a tradition of metalworking and precision manufacturing and an ability to create and make new products and move them to markets worldwide. In order to better understand these trends, this report places a magnifying glass on several regionally important manufacturing clusters. It examined the value chains that drive them, and brings greater understanding about their respective buying and selling relationships. The report serves several purposes:

First, it articulates manufacturing’s foundational role in the region’s economy and how it contributes to both employment and GDP growth, allowing regional stakeholders to define the need for manufacturing support to:

1) Develop new technologies;
2) Enhance the talent pipeline;
3) Find new market opportunities;
4) Provide vital transportation and communications infrastructure;
5) Reduce burdens for operating production facilities in the region.

Second, the report provides analysis and mapping of key regional core value chains that highlight strategic inter-industry linkage to inform economic developers in their efforts to support, service, and grow manufacturing clusters. The analysis and data will help practitioners target their attention and focus on:

1) Customer - Supplier value chains and relationships;
2) Spin off effects and gap identification of industries within networks;
3) Multi-sector linkage and Inter-industry expansion and growth opportunities;
4) Recruitment message supported by defined data on market opportunities and sector stability for both expansions and prospects.

The analysis presented in this study yielded several key findings, presented here below;

- **Advanced, mass customizing industries drive the regional manufacturing sector’s growth.**
  
  Energy, Automotive and Machinery manufacturing are all key components in this growth cycle characterized by intensive R&D and a high concentration of STEM workers. These industries contribute to a regional manufacturing “Supercluster”, and efforts that build these will likely involve expanding existing value chain strengths and filling the value chain gaps. Economic development efforts that focus on the region’s targeted industries’ direct suppliers and
customers offer the most promising strategy for creating more jobs and growing prosperity in the Greater Charlotte region, taking advantage of the broad applications of an array of manufacturing equipment and consumer products produced that are integral to many OEM value chains.

**The Greater Charlotte Region is a key supplier of energy-related parts and equipment.** Related product and service opportunities—not only for Duke Energy but also for other energy providers—could represent the next generation of manufacturing in the region. The manufacturing of motors, generators, batteries, and turbine production cross link and highly integrate the region’s capacity for precision metalworking. These skills are vital for many other industries, most notably aerospace-related activities, which have grown dramatically in nearby Greensboro and Charleston.

**The Greater Charlotte region has an important role in multiple transportation equipment value chains.** As a center for commercial vehicle production and auto parts, transportation manufacturing relies on key OEMs like Daimler Trucks and bus manufacturing (e.g., Thomasville in nearby regions) but also suggests that the after-market auto parts manufacturing industry continues to represent a key opportunity. Changes in composite and lightweight materials may ultimately transform the vehicle parts manufacturing sector. The region must access the innovations occurring as a result of automotive R&D and NASCAR prototype testing. This will allow efficient transfer of knowledge to area manufacturers to ensure that they stay ahead of the technology curve.

**Industries that buy from, and sell to, many of the region’s targeted industries represent important multi-sector value chain participation in the region’s overall manufacturing ecosystem. They offer the greatest potential for new markets expansion and for local diversification.** Industries of note:

- **Transmission, drives and gear manufacturing** and **engine equipment manufacturing** are two industries that make products that transform kinetic energy into useful machines that create, move, or make things and are closely related to the region’s energy industries as well as making transportation and energy equipment.

- **Forging and stamping** feeds into multiple local value chains and reflects the critical role that precision metal working plays in many of the region’s target manufacturing industries. This industry grew faster in the region than elsewhere, and utilizes unique regional talents that are a foundation to the future as a national manufacturing center.

**Local linkages are important, but value chain connections that extend beyond the region are also vital to growth.** Local firms rely on larger area companies as customers, but many also supply their products well beyond the Greater Charlotte region to national and global markets.
The presence of so many German firms in the area suggest that the area is a **vital source for machining** for these firms as they service the **U.S. automotive and industrial machinery markets**.

Regional firms seeking entry into the lucrative **aviation and aerospace market** may need to look north on I-85 to partners and customers in the Piedmont Triad region where an aviation cluster is emerging (based of aircraft component manufacturing with Timko and Triumph Actuation Systems).

Firms expanding reach into **automotive-related activities**, can look south down I-85 to Upstate South Carolina and beyond into northern Georgia and Alabama where the world’s major auto manufacturers like BMW, Honda, and Kia have established major assembly plants.

**A strong regional manufacturing ecosystem ensures that firms remain competitive and stay on top of technological advances.** Metalworking will remain vital to the region’s manufacturers for years to come, however the movement toward new and different materials is a trend for which area manufacturers need to pay attention. “Light weighting” is clearly a trend aimed at developing lighter, stronger materials through use of composites. Preparing companies and their workers for these technologies will require companies to engage with the region’s sources of innovation and real world problem-solving at UNC Charlotte, North Carolina State or Clemson University that are leaders in innovation. Success will also involve working closely with technical assistance support services such as the North Carolina State Industrial Extension Service (MEP) and the UNCC Small Business and Technology Development Center as well as other knowledge sharing resources like E4 Carolinas to deploy these innovations in companies.

In summary, these findings and resulting data support industry and economic development practitioner understanding of the spin-off effects from working with suppliers or customers in certain industries and how their success can benefit other industries. The process of identifying specific companies within each of these value chains and understanding inter-industry linkage can enhance the foundation for supplier-customer matchmaking as well as provide more targeted business recruitment focus and incentives rationale. The results not only benefit the company receiving assistance directly, but also strengthen the cluster of related suppliers and customers within the region.

*With the [Key Value Chains for the Greater Charlotte Region’s Investing in Manufacturing Communities Partnership Report](#), economic developers can better tell the story to prospective new companies exploring the region as a potential future location as well as investment consideration by existing industries. The Charlotte Region’s manufacturing ecosystem is dynamic and innovative – with a strong foundation anchored in advanced technologies and advanced manufacturing. These competencies secure the Greater Charlotte region’s economic prosperity and leading position in the global economy.*
Appendices

Appendix A: Advanced industries in Greater Charlotte regional counties

Appendix A provides data on the advanced industry employment found in each county within the Greater Charlotte region. These advanced industries—identified by researchers at the Washington, D.C. based Brookings Institution—are characterized by intensive Research and Development (R&D) activities and a high concentration of Science, Technology, Engineering and Mathematics (STEM) workers. In total, the Brookings Institution researchers identified 50 advanced industries within the US economy; 35 of these industries belong to the manufacturing sector.

The 2012 Prosperity for Greater Charlotte report, encompassing the 2012-2017 Comprehensive Economic Development Strategy (“CEDS”) reports for the two EDA-designated Economic Development Districts in Greater Charlotte, and the regional Jobs, Workforce, and Education Alignment Study, identified Advanced Manufacturing as the region’s core competency for supporting five of the region’s six targeted industry clusters, effectively forming an Advanced Manufacturing “Super-Cluster”.

As stated in the CEDS, the region’s core competencies in Advanced Manufacturing, Engineering, and Information Technology are embedded in the region’s six Targeted Industry Clusters (Aerospace, Automotive, Biopharmaceuticals, Logistics, and Energy). The innovative technology used by Advanced Industries production and market delivery systems are used to enhance both more established traditional industry supply chains and more newly developed supply chains within the Greater Charlotte region.

Industries must meet two specific criteria to be considered an ‘Advanced Industry’: 1) Its share of R&D spending per worker must fall in the 80th or higher percentile of all industries thereby exceeding $450 per worker, and 2) Its share of workers that whose occupations require a high degree of STEM knowledge must also be above the national average (21 percent of all workers).

These Advanced Industries are defined using 4-digit NAICS level data.
region. Figure 24 contains a detailed matrix indicating the specific niche industries within the six major industries targeted by the region.

These six clusters form the basis for the industries chosen as core industries in this report. The Energy cluster is represented by four of the value chains, while the Aerospace, Automotive and Logistics industry clusters are each represented by one value chain. The Metalworking value chain represents more of a “target competency”, rather than a “target industry”. The value chains in this report are interrelated both because they represent similar industries, and because they utilize similar advanced manufacturing competencies. Of the 107 industries that appear as backward or forwardly linked industries within the 8 value chains, 52 are classified as Advanced Industries. This demonstrates the important role that these Advanced Industries play in the current and future growth of the region’s targeted clusters and their associated value chains.

The following lists provide a snapshot of the current state of the Advanced Industry economy at the individual county level. For each county, the consulting team collected data on each industry’s total employment in 2010 and 2014, employment change for this period, regional employment annual growth rate, national employment annual growth rate, regional employment concentration, and average wages. These lists highlight how each county’s current employment fits within this Advanced Industries framework.
## Greater Charlotte region

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<td>Petroleum and Coal Products Manufacturing</td>
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<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>2.4%</strong></td>
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## Alexander County, NC

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<td>2111</td>
<td>Oil and Gas Extraction</td>
<td>0</td>
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<tr>
<td>2122</td>
<td>Metal Ore Mining</td>
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## Anson County, NC

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## Catawba County, NC

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<tr>
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<td>Architectural, Engineering, and Related Services</td>
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<td>Medical and Diagnostic Laboratories</td>
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<tr>
<td>2122</td>
<td>Metal Ore Mining</td>
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<td>32</td>
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<td>53</td>
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<td>105</td>
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<td></td>
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</tr>
<tr>
<td>3253</td>
<td>Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.1%</td>
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<td>$0</td>
</tr>
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<td>Pharmaceutical and Medicine Manufacturing</td>
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<td>Other Chemical Product and Preparation Manufacturing</td>
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<td>151</td>
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<td>Clay Product and Refractory Manufacturing</td>
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<td>-0.7%</td>
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<td>$0</td>
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<tr>
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<td>Other Nonmetallic Mineral Product Manufacturing</td>
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<td>23</td>
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<td>Iron and Steel Mills and Ferroalloy Manufacturing</td>
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<td>0.0%</td>
<td>1.5%</td>
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<td>Alumina and Aluminum Production and Processing</td>
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<tr>
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<td>Agriculture, Construction, and Mining Machinery Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
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<tr>
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<td>Industrial Machinery Manufacturing</td>
<td>17</td>
<td>0</td>
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<td>$0</td>
</tr>
<tr>
<td>3333</td>
<td>Commercial and Service Industry Machinery Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-1.7%</td>
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</tr>
<tr>
<td>3336</td>
<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
<td>155</td>
<td>143</td>
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<td>-1.9%</td>
<td>2.6%</td>
<td>2.89</td>
<td>$62,415</td>
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<tr>
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<td>Other General Purpose Machinery Manufacturing</td>
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<tr>
<td>3341</td>
<td>Computer and Peripheral Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
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<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3342</td>
<td>Communications Equipment Manufacturing</td>
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<td>0.03</td>
<td>$0</td>
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<tr>
<td>3343</td>
<td>Audio and Video Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.8%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>-0.3%</td>
<td>0.01</td>
<td>$0</td>
</tr>
<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
<td>0</td>
<td>21</td>
<td>21</td>
<td>0.0%</td>
<td>-1.4%</td>
<td>0.11</td>
<td>$42,476</td>
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<tr>
<td>3346</td>
<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
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<td>$0</td>
</tr>
<tr>
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<td>Electric Lighting Equipment Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
<td>0.2%</td>
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<td>$0</td>
</tr>
<tr>
<td>3352</td>
<td>Household Appliance Manufacturing</td>
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<td>0.0%</td>
<td>-0.4%</td>
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<td>$0</td>
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<tr>
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<td>0.0%</td>
<td>2.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3359</td>
<td>Other Electrical Equipment and Component Manufacturing</td>
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<tr>
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<td>Motor Vehicle Manufacturing</td>
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<td>0.0%</td>
<td>6.0%</td>
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<td>$0</td>
</tr>
<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>0</td>
<td>66</td>
<td>66</td>
<td>0.0%</td>
<td>5.9%</td>
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<td>Motor Vehicle Parts Manufacturing</td>
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<td>0</td>
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<td>$0</td>
</tr>
<tr>
<td>3365</td>
<td>Railroad Rolling Stock Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
<td>8.9%</td>
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<td>$0</td>
</tr>
<tr>
<td>3366</td>
<td>Ship and Boat Building</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
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<tr>
<td>3369</td>
<td>Other Transportation Equipment Manufacturing</td>
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<tr>
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<td>54</td>
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<tr>
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<td>Other Miscellaneous Manufacturing</td>
<td>197</td>
<td>258</td>
<td>62</td>
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<tr>
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<td>Cable and Other Subscription Programming</td>
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<td>-100.0%</td>
<td>4.2%</td>
<td>$0</td>
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<tr>
<td>5172</td>
<td>Wireless Telecommunications Carriers (except Satellite)</td>
<td>54</td>
<td>29</td>
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<td>-14.3%</td>
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<tr>
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<td>14</td>
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<td>$0</td>
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<tr>
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<td>230</td>
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<td>2111</td>
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<td>0</td>
<td>0.0%</td>
<td>7.4%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>2122</td>
<td>Metal Ore Mining</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>7.0%</td>
<td>0.00</td>
<td>$0</td>
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<td>Electric Power Generation, Transmission and Distribution</td>
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<td>0.0%</td>
<td>0.5%</td>
<td>0.52</td>
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<td>Basic Chemical Manufacturing</td>
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<td>0.6%</td>
<td>6.18</td>
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<td>-42</td>
<td>-16.7%</td>
<td>0.6%</td>
<td>7.14</td>
<td>$63,038</td>
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<td>Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing</td>
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<td>-47</td>
<td>-26.8%</td>
<td>1.1%</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3259</td>
<td>Other Chemical Product and Preparation Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.3%</td>
<td>0.12</td>
<td>$0</td>
</tr>
<tr>
<td>3271</td>
<td>Clay Product and Refractory Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.7%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3279</td>
<td>Other Nonmetallic Mineral Product Manufacturing</td>
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<td>3.2%</td>
<td>54.05</td>
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<td>Iron and Steel Mills and Ferroalloy Manufacturing</td>
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<td>0</td>
<td>0.0%</td>
<td>1.5%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3313</td>
<td>Alumina and Aluminum Production and Processing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.7%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3315</td>
<td>Foundries</td>
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<td>36</td>
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<td>0.0%</td>
<td>3.1%</td>
<td>4.78</td>
<td>$41,596</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>5.7%</td>
<td>0.51</td>
<td>$0</td>
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<tr>
<td>3332</td>
<td>Industrial Machinery Manufacturing</td>
<td>13</td>
<td>16</td>
<td>3</td>
<td>5.0%</td>
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<td>3333</td>
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<tr>
<td>3336</td>
<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
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<tr>
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<td>Other General Purpose Machinery Manufacturing</td>
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<td>0</td>
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<td>$0</td>
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<tr>
<td>3341</td>
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<tr>
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<td>$0</td>
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<tr>
<td>3343</td>
<td>Audio and Video Equipment Manufacturing</td>
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<td>-0.8%</td>
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<td>$0</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>-0.3%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>-1.4%</td>
<td>0.00</td>
<td>$0</td>
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<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
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<tr>
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<tr>
<td>3352</td>
<td>Household Appliance Manufacturing</td>
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<td>3353</td>
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<td>2.0%</td>
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<tr>
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<td>Other Electrical Equipment and Component Manufacturing</td>
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<td>$0</td>
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<tr>
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<td>Motor Vehicle Manufacturing</td>
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<td>6.0%</td>
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<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
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<td>0</td>
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<tr>
<td>3363</td>
<td>Motor Vehicle Parts Manufacturing</td>
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<td>Aerospace Product and Parts Manufacturing</td>
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<td>$0</td>
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<tr>
<td>3365</td>
<td>Railroad Rolling Stock Manufacturing</td>
<td>0</td>
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<td>0.0%</td>
<td>8.9%</td>
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<td>$0</td>
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<tr>
<td>3366</td>
<td>Ship and Boat Building</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
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<td>$0</td>
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<tr>
<td>3369</td>
<td>Other Transportation Equipment Manufacturing</td>
<td>0</td>
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<td>0.0%</td>
<td>-0.4%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>3391</td>
<td>Medical Equipment and Supplies Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
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<td>Change</td>
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<td>EBITDA</td>
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<tr>
<td>5152</td>
<td>Cable and Other Subscription Programming</td>
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<td>0.0%</td>
<td>-4.2%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>5172</td>
<td>Wireless Telecommunications Carriers (except Satellite)</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-2.4%</td>
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<td>$0</td>
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<tr>
<td>5174</td>
<td>Satellite Telecommunications</td>
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<td>-5.1%</td>
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<td>$0</td>
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<tr>
<td>5179</td>
<td>Other Telecommunications</td>
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<td>87</td>
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<td>-9.7%</td>
<td>18.01</td>
<td>$58,567</td>
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<td>5182</td>
<td>Data Processing, Hosting, and Related Services</td>
<td>0</td>
<td>13</td>
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<td>2.6%</td>
<td>0.81</td>
<td>$91,684</td>
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<tr>
<td>5191</td>
<td>Other Information Services</td>
<td>0</td>
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<td>0.0%</td>
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<td>$0</td>
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<tr>
<td>5413</td>
<td>Architectural, Engineering, and Related Services</td>
<td>24</td>
<td>38</td>
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<tr>
<td>5415</td>
<td>Computer Systems Design and Related Services</td>
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<td>0.0%</td>
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<tr>
<td>5416</td>
<td>Management, Scientific, and Technical Consulting Services</td>
<td>15</td>
<td>10</td>
<td>-7.9%</td>
<td>5.0%</td>
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<td>5417</td>
<td>Scientific Research and Development Services</td>
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<td>$0</td>
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<tr>
<td>6215</td>
<td>Medical and Diagnostic Laboratories</td>
<td>0</td>
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<td>0.0%</td>
<td>2.1%</td>
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<td>$0</td>
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<td></td>
<td>605</td>
<td>602</td>
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<td>0.80</td>
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</tr>
<tr>
<td>2111</td>
<td>Oil and Gas Extraction</td>
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<td>0</td>
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<td>0.0%</td>
<td>7.4%</td>
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<tr>
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<td>Metal Ore Mining</td>
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<td>0</td>
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<td>0.0%</td>
<td>7.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>2211</td>
<td>Electric Power Generation, Transmission and Distribution</td>
<td>39</td>
<td>27</td>
<td>-12</td>
<td>-8.4%</td>
<td>-0.4%</td>
<td>0.68</td>
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<td>Petroleum and Coal Products Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
<td>0.5%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
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<td>Basic Chemical Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>0.6%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>3252</td>
<td>Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.6%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3253</td>
<td>Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.1%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>3254</td>
<td>Pharmaceutical and Medicine Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.00</td>
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<tr>
<td>3259</td>
<td>Other Chemical Product and Preparation Manufacturing</td>
<td>20</td>
<td>23</td>
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<td>-0.3%</td>
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<td>Clay Product and Refractory Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
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<td>$0</td>
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<tr>
<td>3279</td>
<td>Other Nonmetallic Mineral Product Manufacturing</td>
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<td>0</td>
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<td>3.2%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>3311</td>
<td>Iron and Steel Mills and Ferroalloy Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.5%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>3313</td>
<td>Alumina and Aluminum Production and Processing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>1.7%</td>
<td>0.00</td>
<td>$0</td>
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<td>$0</td>
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<tr>
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<td>Agriculture, Construction, and Mining Machinery Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
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<td>$0</td>
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<tr>
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<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3333</td>
<td>Commercial and Service Industry Machinery Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-1.7%</td>
<td>0.00</td>
<td>$0</td>
</tr>
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<td>-----------------------------------------------</td>
</tr>
<tr>
<td>3336</td>
<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.6%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3339</td>
<td>Other General Purpose Machinery Manufacturing</td>
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<td>0.0%</td>
<td>3.8%</td>
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<tr>
<td>3341</td>
<td>Computer and Peripheral Equipment Manufacturing</td>
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<td>0</td>
<td>0.0%</td>
<td>0.5%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3342</td>
<td>Communications Equipment Manufacturing</td>
<td>0</td>
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<td>0</td>
<td>0.0%</td>
<td>-4.3%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3343</td>
<td>Audio and Video Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.8%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.3%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
<td>0</td>
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<td>0.0%</td>
<td>-1.4%</td>
<td>0.23</td>
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<tr>
<td>3346</td>
<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>-7.2%</td>
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<td>$0</td>
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<tr>
<td>3351</td>
<td>Electric Lighting Equipment Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
<td>0.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3352</td>
<td>Household Appliance Manufacturing</td>
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<td>292</td>
<td>36</td>
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<td>-0.4%</td>
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<td>2.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3359</td>
<td>Other Electrical Equipment and Component Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.8%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3361</td>
<td>Motor Vehicle Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>6.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>5.9%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3363</td>
<td>Motor Vehicle Parts Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>6.4%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
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<td>Aerospace Product and Parts Manufacturing</td>
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<td>$0</td>
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<tr>
<td>3365</td>
<td>Railroad Rolling Stock Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>8.9%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3366</td>
<td>Ship and Boat Building</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
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</tr>
<tr>
<td>3369</td>
<td>Other Transportation Equipment Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
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## Iredell County, NC

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<td>-1.7%</td>
<td>0.06</td>
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</tr>
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</tr>
<tr>
<td>3336</td>
<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
<td>99</td>
<td>111</td>
<td>11</td>
<td>2.8%</td>
<td>2.6%</td>
<td>2.23</td>
<td>$86,793</td>
</tr>
<tr>
<td>3339</td>
<td>Other General Purpose Machinery Manufacturing</td>
<td>174</td>
<td>219</td>
<td>45</td>
<td>5.9%</td>
<td>3.8%</td>
<td>1.70</td>
<td>$54,330</td>
</tr>
<tr>
<td>3341</td>
<td>Computer and Peripheral Equipment Manufacturing</td>
<td>0</td>
<td>201</td>
<td>201</td>
<td>0.0%</td>
<td>0.5%</td>
<td>2.52</td>
<td>$64,483</td>
</tr>
<tr>
<td>3342</td>
<td>Communications Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-4.3%</td>
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<td>$0</td>
</tr>
<tr>
<td>3343</td>
<td>Audio and Video Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.8%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
<td>98</td>
<td>0</td>
<td>-98</td>
<td>-100.0%</td>
<td>-0.3%</td>
<td>0.05</td>
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<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
<td>74</td>
<td>33</td>
<td>-41</td>
<td>-18.3%</td>
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<td>$18,958</td>
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<tr>
<td>3346</td>
<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-7.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3351</td>
<td>Electric Lighting Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3352</td>
<td>Household Appliance Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.4%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3353</td>
<td>Electrical Equipment Manufacturing</td>
<td>408</td>
<td>325</td>
<td>-83</td>
<td>-5.5%</td>
<td>2.0%</td>
<td>4.56</td>
<td>$43,887</td>
</tr>
<tr>
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<td>Other Electrical Equipment and Component Manufacturing</td>
<td>52</td>
<td>189</td>
<td>137</td>
<td>38.1%</td>
<td>1.8%</td>
<td>3.03</td>
<td>$74,277</td>
</tr>
<tr>
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<td>Motor Vehicle Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>6.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>5.9%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3363</td>
<td>Motor Vehicle Parts Manufacturing</td>
<td>541</td>
<td>977</td>
<td>435</td>
<td>15.9%</td>
<td>6.4%</td>
<td>3.74</td>
<td>$47,998</td>
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<tr>
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<td>Aerospace Product and Parts Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.7%</td>
<td>0.04</td>
<td>$0</td>
</tr>
<tr>
<td>3365</td>
<td>Railroad Rolling Stock Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>8.9%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3366</td>
<td>Ship and Boat Building</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.2%</td>
<td>0.01</td>
<td>$0</td>
</tr>
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</tr>
<tr>
<td>3369</td>
<td>Other Transportation Equipment Manufacturing</td>
<td>220</td>
<td>255</td>
<td>35</td>
<td>3.8%</td>
<td>-0.4%</td>
<td>15.94</td>
<td>$66,938</td>
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<tr>
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<td>Medical Equipment and Supplies Manufacturing</td>
<td>238</td>
<td>154</td>
<td>-85</td>
<td>-10.4%</td>
<td>0.3%</td>
<td>1.02</td>
<td>$51,712</td>
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<tr>
<td>3399</td>
<td>Other Miscellaneous Manufacturing</td>
<td>116</td>
<td>228</td>
<td>112</td>
<td>18.4%</td>
<td>0.8%</td>
<td>1.70</td>
<td>$118,597</td>
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<td>5112</td>
<td>Software Publishers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>4.1%</td>
<td>0.03</td>
<td>$0</td>
</tr>
<tr>
<td>5152</td>
<td>Cable and Other Subscription Programming</td>
<td>18</td>
<td>0</td>
<td>-18</td>
<td>-100.0%</td>
<td>-4.2%</td>
<td>0.04</td>
<td>$0</td>
</tr>
<tr>
<td>5172</td>
<td>Wireless Telecommunications Carriers (except Satellite)</td>
<td>52</td>
<td>70</td>
<td>18</td>
<td>7.8%</td>
<td>-2.4%</td>
<td>0.91</td>
<td>$60,609</td>
</tr>
<tr>
<td>5174</td>
<td>Satellite Telecommunications</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-5.1%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>5179</td>
<td>Other Telecommunications</td>
<td>0</td>
<td>17</td>
<td>17</td>
<td>0.0%</td>
<td>-9.7%</td>
<td>0.44</td>
<td>$40,417</td>
</tr>
<tr>
<td>5182</td>
<td>Data Processing, Hosting, and Related Services</td>
<td>17</td>
<td>0</td>
<td>-17</td>
<td>-100.0%</td>
<td>2.6%</td>
<td>0.02</td>
<td>$0</td>
</tr>
<tr>
<td>5191</td>
<td>Other Information Services</td>
<td>32</td>
<td>35</td>
<td>2</td>
<td>1.8%</td>
<td>10.3%</td>
<td>0.34</td>
<td>$21,660</td>
</tr>
<tr>
<td>5413</td>
<td>Architectural, Engineering, and Related Services</td>
<td>274</td>
<td>449</td>
<td>175</td>
<td>13.1%</td>
<td>2.0%</td>
<td>0.66</td>
<td>$73,682</td>
</tr>
<tr>
<td>5415</td>
<td>Computer Systems Design and Related Services</td>
<td>131</td>
<td>209</td>
<td>78</td>
<td>12.5%</td>
<td>5.1%</td>
<td>0.24</td>
<td>$78,019</td>
</tr>
<tr>
<td>5416</td>
<td>Management, Scientific, and Technical Consulting Services</td>
<td>281</td>
<td>697</td>
<td>416</td>
<td>25.5%</td>
<td>5.0%</td>
<td>1.15</td>
<td>$62,092</td>
</tr>
<tr>
<td>5417</td>
<td>Scientific Research and Development Services</td>
<td>13</td>
<td>16</td>
<td>4</td>
<td>6.9%</td>
<td>0.8%</td>
<td>0.05</td>
<td>$72,816</td>
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<tr>
<td>6215</td>
<td>Medical and Diagnostic Laboratories</td>
<td>24</td>
<td>28</td>
<td>4</td>
<td>3.7%</td>
<td>2.1%</td>
<td>0.23</td>
<td>$101,171</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>4,203</td>
<td>5,612</td>
<td>1,409</td>
<td>7.5%</td>
<td>2.4%</td>
<td>0.91</td>
<td>$60,292</td>
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</tr>
<tr>
<td>2111</td>
<td>Oil and Gas Extraction</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>7.4%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>2122</td>
<td>Metal Ore Mining</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>7.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>2211</td>
<td>Electric Power Generation, Transmission and Distribution</td>
<td>87</td>
<td>50</td>
<td>-37</td>
<td>-13.0%</td>
<td>-0.4%</td>
<td>0.86</td>
<td>$86,508</td>
</tr>
<tr>
<td>3241</td>
<td>Petroleum and Coal Products Manufacturing</td>
<td>29</td>
<td>19</td>
<td>-10</td>
<td>-10.0%</td>
<td>0.5%</td>
<td>1.10</td>
<td>$41,634</td>
</tr>
<tr>
<td>3251</td>
<td>Basic Chemical Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.6%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3252</td>
<td>Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.6%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3253</td>
<td>Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.1%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3254</td>
<td>Pharmaceutical and Medicine Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.01</td>
<td>$0</td>
</tr>
<tr>
<td>3259</td>
<td>Other Chemical Product and Preparation Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.3%</td>
<td>0.71</td>
<td>$0</td>
</tr>
<tr>
<td>3271</td>
<td>Clay Product and Refractory Manufacturing</td>
<td>21</td>
<td>21</td>
<td>0</td>
<td>0.1%</td>
<td>-0.7%</td>
<td>3.62</td>
<td>$49,977</td>
</tr>
<tr>
<td>3279</td>
<td>Other Nonmetallic Mineral Product Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>3.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3311</td>
<td>Iron and Steel Mills and Ferroalloy Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.5%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3313</td>
<td>Alumina and Aluminum Production and Processing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.7%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3315</td>
<td>Foundries</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>3.1%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3331</td>
<td>Agriculture, Construction, and Mining Machinery Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>5.7%</td>
<td>0.24</td>
<td>$0</td>
</tr>
<tr>
<td>3332</td>
<td>Industrial Machinery Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.6%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3333</td>
<td>Commercial and Service Industry Machinery Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-1.7%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
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<td>------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>3336</td>
<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.6%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3339</td>
<td>Other General Purpose Machinery Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>3.8%</td>
<td>0.03</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3341</td>
<td>Computer and Peripheral Equipment Manufacturing</td>
<td>14</td>
<td>151</td>
<td>136</td>
<td>79.8%</td>
<td>0.5%</td>
<td>6.22</td>
<td>$98,972</td>
</tr>
<tr>
<td>3342</td>
<td>Communications Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-4.3%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3343</td>
<td>Audio and Video Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.8%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.3%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
<td>0</td>
<td>104</td>
<td>104</td>
<td>0.0%</td>
<td>-1.4%</td>
<td>1.80</td>
<td>$65,413</td>
</tr>
<tr>
<td>3346</td>
<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-7.2%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3351</td>
<td>Electric Lighting Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.2%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3352</td>
<td>Household Appliance Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.4%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3353</td>
<td>Electrical Equipment Manufacturing</td>
<td>46</td>
<td>118</td>
<td>72</td>
<td>26.6%</td>
<td>2.0%</td>
<td>5.41</td>
<td>$60,518</td>
</tr>
<tr>
<td>3359</td>
<td>Other Electrical Equipment and Component Manufacturing</td>
<td>468</td>
<td>744</td>
<td>276</td>
<td>12.3%</td>
<td>1.8%</td>
<td>39.22</td>
<td>$50,143</td>
</tr>
<tr>
<td>3361</td>
<td>Motor Vehicle Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>6.0%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>5.9%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3363</td>
<td>Motor Vehicle Parts Manufacturing</td>
<td>0</td>
<td>143</td>
<td>143</td>
<td>0.0%</td>
<td>6.4%</td>
<td>1.80</td>
<td>$50,099</td>
</tr>
<tr>
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<td>Aerospace Product and Parts Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.7%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3365</td>
<td>Railroad Rolling Stock Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>8.9%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>3366</td>
<td>Ship and Boat Building</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.2%</td>
<td>0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------</td>
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<td>-------------------------</td>
<td>----------------</td>
<td>------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>3369</td>
<td>Other Transportation Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.4%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3391</td>
<td>Medical Equipment and Supplies Manufacturing</td>
<td>0</td>
<td>238</td>
<td>238</td>
<td>0.0%</td>
<td>0.3%</td>
<td>5.17</td>
<td>$30,693</td>
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<td>119</td>
<td>7</td>
<td>1.5%</td>
<td>0.8%</td>
<td>2.91</td>
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<td>4.1%</td>
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<td>$0</td>
</tr>
<tr>
<td>5152</td>
<td>Cable and Other Subscription Programming</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-4.2%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
<td>5172</td>
<td>Wireless Telecommunications Carriers (except Satellite)</td>
<td>0</td>
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<td>0.0%</td>
<td>-2.4%</td>
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<td>$0</td>
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<tr>
<td>5174</td>
<td>Satellite Telecommunications</td>
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<td>-5.1%</td>
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<td>$0</td>
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<tr>
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</tr>
<tr>
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<td>Medical and Diagnostic Laboratories</td>
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<td>0.0%</td>
<td>2.1%</td>
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<td><strong>2.4%</strong></td>
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<td><strong>$59,641</strong></td>
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<tr>
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<td>Metal Ore Mining</td>
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<td>$0</td>
</tr>
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<td>$0</td>
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<td>3252</td>
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<td>136</td>
<td>72</td>
<td>-63</td>
<td>-14.5%</td>
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<td>$23,581</td>
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<td>1.1%</td>
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<td>$0</td>
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<tr>
<td>3254</td>
<td>Pharmaceutical and Medicine Manufacturing</td>
<td>220</td>
<td>273</td>
<td>54</td>
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<td>0.1%</td>
<td>6.23</td>
<td>$63,909</td>
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<tr>
<td>3259</td>
<td>Other Chemical Product and Preparation Manufacturing</td>
<td>52</td>
<td>160</td>
<td>108</td>
<td>32.2%</td>
<td>-0.3%</td>
<td>12.31</td>
<td>$54,891</td>
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<tr>
<td>3271</td>
<td>Clay Product and Refractory Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>-0.7%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3279</td>
<td>Other Nonmetallic Mineral Product Manufacturing</td>
<td>0</td>
<td>11</td>
<td>11</td>
<td>0.0%</td>
<td>3.2%</td>
<td>0.93</td>
<td>$71,145</td>
</tr>
<tr>
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<td>Iron and Steel Mills and Ferroalloy Manufacturing</td>
<td>39</td>
<td>136</td>
<td>97</td>
<td>36.4%</td>
<td>1.5%</td>
<td>9.52</td>
<td>$62,255</td>
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<td>Alumina and Aluminum Production and Processing</td>
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<td>0</td>
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</tr>
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<td>3.1%</td>
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<td>$0</td>
</tr>
<tr>
<td>3331</td>
<td>Agriculture, Construction, and Mining Machinery Manufacturing</td>
<td>155</td>
<td>141</td>
<td>-15</td>
<td>-2.4%</td>
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<td>Industrial Machinery Manufacturing</td>
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<tr>
<td>3333</td>
<td>Commercial and Service Industry Machinery Manufacturing</td>
<td>0</td>
<td>15</td>
<td>15</td>
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<td>$51,413</td>
</tr>
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</tr>
<tr>
<td>3336</td>
<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
<td>35</td>
<td>109</td>
<td>74</td>
<td>32.8%</td>
<td>2.6%</td>
<td>6.91</td>
<td>$68,279</td>
</tr>
<tr>
<td>3339</td>
<td>Other General Purpose Machinery Manufacturing</td>
<td>29</td>
<td>97</td>
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<td>35.1%</td>
<td>3.8%</td>
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<tr>
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<td>Computer and Peripheral Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.5%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
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<td>Communications Equipment Manufacturing</td>
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<td>-4.3%</td>
<td>8.61</td>
<td>$38,334</td>
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<tr>
<td>3343</td>
<td>Audio and Video Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.8%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>-0.3%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
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<td>57</td>
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<td>44.6%</td>
<td>-1.4%</td>
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<tr>
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<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
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<td>0</td>
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<td>0.0%</td>
<td>-7.2%</td>
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</tr>
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<td>$0</td>
</tr>
<tr>
<td>3352</td>
<td>Household Appliance Manufacturing</td>
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<td>-0.4%</td>
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<td>$0</td>
</tr>
<tr>
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<td>2.0%</td>
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</tr>
<tr>
<td>3359</td>
<td>Other Electrical Equipment and Component Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>1.8%</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>3361</td>
<td>Motor Vehicle Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>6.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
<td>5.9%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3363</td>
<td>Motor Vehicle Parts Manufacturing</td>
<td>152</td>
<td>257</td>
<td>105</td>
<td>14.1%</td>
<td>6.4%</td>
<td>3.09</td>
<td>$49,819</td>
</tr>
<tr>
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<td>Aerospace Product and Parts Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
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<td>$0</td>
</tr>
<tr>
<td>3365</td>
<td>Railroad Rolling Stock Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
<td>8.9%</td>
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<td>$0</td>
</tr>
<tr>
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<td>Ship and Boat Building</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.2%</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
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</tr>
<tr>
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<td>Other Transportation Equipment Manufacturing</td>
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<td>0.00</td>
<td>$0</td>
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<tr>
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<td>4.1%</td>
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</tr>
<tr>
<td>5152</td>
<td>Cable and Other Subscription Programming</td>
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<td>Wireless Telecommunications Carriers (except Satellite)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-2.4%</td>
<td>0.31</td>
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</tr>
<tr>
<td>5174</td>
<td>Satellite Telecommunications</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-5.1%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
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<td>0.0%</td>
<td>2.6%</td>
<td>0.00</td>
<td>$0</td>
</tr>
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<td>0</td>
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<td>10.3%</td>
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</tr>
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<td>Architectural, Engineering, and Related Services</td>
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<td>2.0%</td>
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<td>0</td>
<td>0.0%</td>
<td>0.8%</td>
<td>0.04</td>
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</tr>
<tr>
<td>6215</td>
<td>Medical and Diagnostic Laboratories</td>
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<td>0</td>
<td>-11</td>
<td>-100.0%</td>
<td>2.1%</td>
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</tr>
<tr>
<td>2111</td>
<td>Oil and Gas Extraction</td>
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<td>0</td>
<td>0.0%</td>
<td>7.4%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>2122</td>
<td>Metal Ore Mining</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>7.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
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<td>1.1%</td>
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<td>0</td>
<td>0.0%</td>
<td>0.5%</td>
<td>0.00</td>
<td>$0</td>
</tr>
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<td>0.6%</td>
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<td>-</td>
<td>-12</td>
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<td>1.1%</td>
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## Rowan County, NC

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<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>68</td>
<td>21</td>
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<tr>
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<td>Motor Vehicle Parts Manufacturing</td>
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<td>Aerospace Product and Parts Manufacturing</td>
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<td>Railroad Rolling Stock Manufacturing</td>
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<td>$0</td>
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<td>Ship and Boat Building</td>
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<tr>
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<td>Other Transportation Equipment Manufacturing</td>
<td>18</td>
<td>19</td>
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<td>Medical Equipment and Supplies Manufacturing</td>
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<td>11</td>
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<td>Cable and Other Subscription Programming</td>
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<tr>
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<td>Architectural, Engineering, and Related Services</td>
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<td>2111</td>
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<td>Metal Ore Mining</td>
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<td>$0</td>
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<td>Electric Power Generation, Transmission and Distribution</td>
<td>44</td>
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<td>Petroleum and Coal Products Manufacturing</td>
<td>0</td>
<td>0</td>
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<td>0.0%</td>
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<td>$0</td>
</tr>
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<td>$0</td>
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<td>Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.6%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
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<td>Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing</td>
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<td>0</td>
<td>0</td>
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<td>1.1%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
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<td>0.1%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
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<td>Other Chemical Product and Preparation Manufacturing</td>
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<td>0</td>
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<td>0.0%</td>
<td>-0.3%</td>
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<td>$0</td>
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<td>0</td>
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<td>0.0%</td>
<td>-0.7%</td>
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<td>Other Nonmetallic Mineral Product Manufacturing</td>
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<td>17</td>
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<td>3.2%</td>
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<td>Iron and Steel Mills and Ferroalloy Manufacturing</td>
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<td>0.0%</td>
<td>1.5%</td>
<td>0.00</td>
<td>$0</td>
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<tr>
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<td>Alumina and Aluminum Production and Processing</td>
<td>53</td>
<td>0</td>
<td>-53</td>
<td>-100.0%</td>
<td>1.7%</td>
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</tr>
<tr>
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<td>0.0%</td>
<td>3.1%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3331</td>
<td>Agriculture, Construction, and Mining Machinery Manufacturing</td>
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<td>0.0%</td>
<td>5.7%</td>
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<tr>
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<td>-100.0%</td>
<td>2.6%</td>
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<td>$0</td>
</tr>
<tr>
<td>3333</td>
<td>Commercial and Service Industry Machinery Manufacturing</td>
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<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-1.7%</td>
<td>0.00</td>
<td>$0</td>
</tr>
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</tr>
<tr>
<td>3336</td>
<td>Engine, Turbine, and Power Transmission Equipment Manufacturing</td>
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<td>0</td>
<td>0.0%</td>
<td>2.6%</td>
<td>0.01</td>
<td>$0</td>
<td>$0</td>
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<tr>
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<td>Other General Purpose Machinery Manufacturing</td>
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<td>87</td>
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<td>0</td>
<td>0.0%</td>
<td>0.5%</td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
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<td>Communications Equipment Manufacturing</td>
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<td>$0</td>
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<tr>
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<td>Audio and Video Equipment Manufacturing</td>
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<td>0</td>
<td>0.0%</td>
<td>-0.8%</td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
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<td>0</td>
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<td>-0.3%</td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
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<td>0.0%</td>
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<td>0.00</td>
<td>$0</td>
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<tr>
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<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
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<td>0.0%</td>
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<td>Other Electrical Equipment and Component Manufacturing</td>
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<td>161</td>
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<tr>
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<td>Motor Vehicle Manufacturing</td>
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<td>6.0%</td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>0</td>
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<td>5.9%</td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
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<tr>
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<td>54</td>
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<td>8.9%</td>
<td>0.00</td>
<td>$0</td>
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<td>3366</td>
<td>Ship and Boat Building</td>
<td>0</td>
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<td>0.0%</td>
<td>2.2%</td>
<td>0.00</td>
<td>$0</td>
<td>$0</td>
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<td>-0.4%</td>
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<td>$0</td>
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<tr>
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<td>Cable and Other Subscription Programming</td>
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<td>0.0%</td>
<td>-4.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>5172</td>
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<td>-5.1%</td>
<td>0.00</td>
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<td>$0</td>
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<td>0</td>
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<td>2.6%</td>
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<td>$0</td>
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<tr>
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<td>5.1%</td>
<td>0.05</td>
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<td>5.0%</td>
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</tr>
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### York County, SC

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<td>0.0%</td>
<td>-0.8%</td>
<td>1.06</td>
<td>$29,591</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and Other Electronic Component Manufacturing</td>
<td>22</td>
<td>12</td>
<td>-10</td>
<td>-13.3%</td>
<td>-0.3%</td>
<td>0.06</td>
<td>$21,878</td>
</tr>
<tr>
<td>3345</td>
<td>Navigational, Measuring, Electromedical, and Control Instruments Manufacturing</td>
<td>223</td>
<td>211</td>
<td>-12</td>
<td>-1.4%</td>
<td>-1.4%</td>
<td>0.93</td>
<td>$31,387</td>
</tr>
<tr>
<td>3346</td>
<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-7.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3351</td>
<td>Electric Lighting Equipment Manufacturing</td>
<td>151</td>
<td>179</td>
<td>28</td>
<td>4.4%</td>
<td>0.2%</td>
<td>6.65</td>
<td>$51,812</td>
</tr>
<tr>
<td>3352</td>
<td>Household Appliance Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.4%</td>
<td>0.10</td>
<td>$0</td>
</tr>
<tr>
<td>3353</td>
<td>Electrical Equipment Manufacturing</td>
<td>112</td>
<td>147</td>
<td>35</td>
<td>7.1%</td>
<td>2.0%</td>
<td>1.72</td>
<td>$36,655</td>
</tr>
<tr>
<td>3359</td>
<td>Other Electrical Equipment and Component Manufacturing</td>
<td>129</td>
<td>583</td>
<td>454</td>
<td>45.8%</td>
<td>1.8%</td>
<td>7.80</td>
<td>$54,872</td>
</tr>
<tr>
<td>3361</td>
<td>Motor Vehicle Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>6.0%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3362</td>
<td>Motor Vehicle Body and Trailer Manufacturing</td>
<td>114</td>
<td>320</td>
<td>206</td>
<td>29.5%</td>
<td>5.9%</td>
<td>3.95</td>
<td>$107,280</td>
</tr>
<tr>
<td>3363</td>
<td>Motor Vehicle Parts Manufacturing</td>
<td>1,342</td>
<td>1,120</td>
<td>-222</td>
<td>-4.4%</td>
<td>6.4%</td>
<td>3.57</td>
<td>$41,434</td>
</tr>
<tr>
<td>3364</td>
<td>Aerospace Product and Parts Manufacturing</td>
<td>0</td>
<td>217</td>
<td>217</td>
<td>0.0%</td>
<td>0.7%</td>
<td>0.75</td>
<td>$102,220</td>
</tr>
<tr>
<td>3365</td>
<td>Railroad Rolling Stock Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>8.9%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>3366</td>
<td>Ship and Boat Building</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>2.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>--------------------</td>
<td>----------------------------</td>
<td>---------------------</td>
<td>-----------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>3369</td>
<td>Other Transportation Equipment Manufacturing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-0.4%</td>
<td>0.02</td>
<td>$0</td>
</tr>
<tr>
<td>3391</td>
<td>Medical Equipment and Supplies Manufacturing</td>
<td>234</td>
<td>243</td>
<td>9</td>
<td>1.0%</td>
<td>0.3%</td>
<td>1.34</td>
<td>$41,816</td>
</tr>
<tr>
<td>3399</td>
<td>Other Miscellaneous Manufacturing</td>
<td>55</td>
<td>145</td>
<td>90</td>
<td>27.4%</td>
<td>0.8%</td>
<td>0.90</td>
<td>$37,586</td>
</tr>
<tr>
<td>5112</td>
<td>Software Publishers</td>
<td>54</td>
<td>177</td>
<td>123</td>
<td>34.7%</td>
<td>4.1%</td>
<td>0.98</td>
<td>$307,195</td>
</tr>
<tr>
<td>5152</td>
<td>Cable and Other Subscription Programming</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-4.2%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>5172</td>
<td>Wireless Telecommunications Carriers (except Satellite)</td>
<td>42</td>
<td>75</td>
<td>33</td>
<td>15.6%</td>
<td>-2.4%</td>
<td>0.82</td>
<td>$36,529</td>
</tr>
<tr>
<td>5174</td>
<td>Satellite Telecommunications</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>-5.1%</td>
<td>0.00</td>
<td>$0</td>
</tr>
<tr>
<td>5179</td>
<td>Other Telecommunications</td>
<td>29</td>
<td>21</td>
<td>-7</td>
<td>-7.0%</td>
<td>-9.7%</td>
<td>0.45</td>
<td>$55,788</td>
</tr>
<tr>
<td>5182</td>
<td>Data Processing, Hosting, and Related Services</td>
<td>63</td>
<td>203</td>
<td>141</td>
<td>34.3%</td>
<td>2.6%</td>
<td>1.28</td>
<td>$68,869</td>
</tr>
<tr>
<td>5191</td>
<td>Other Information Services</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>10.3%</td>
<td>0.08</td>
<td>$0</td>
</tr>
<tr>
<td>5413</td>
<td>Architectural, Engineering, and Related Services</td>
<td>683</td>
<td>603</td>
<td>-80</td>
<td>-3.1%</td>
<td>2.0%</td>
<td>0.74</td>
<td>$59,094</td>
</tr>
<tr>
<td>5415</td>
<td>Computer Systems Design and Related Services</td>
<td>156</td>
<td>252</td>
<td>96</td>
<td>12.7%</td>
<td>5.1%</td>
<td>0.24</td>
<td>$69,530</td>
</tr>
<tr>
<td>5416</td>
<td>Management, Scientific, and Technical Consulting Services</td>
<td>241</td>
<td>292</td>
<td>51</td>
<td>4.9%</td>
<td>5.0%</td>
<td>0.40</td>
<td>$79,003</td>
</tr>
<tr>
<td>5417</td>
<td>Scientific Research and Development Services</td>
<td>0</td>
<td>22</td>
<td>22</td>
<td>0.0%</td>
<td>0.8%</td>
<td>0.06</td>
<td>$39,263</td>
</tr>
<tr>
<td>6215</td>
<td>Medical and Diagnostic Laboratories</td>
<td>36</td>
<td>113</td>
<td>78</td>
<td>33.3%</td>
<td>2.1%</td>
<td>0.78</td>
<td>$49,981</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>6,120</strong></td>
<td><strong>7,652</strong></td>
<td><strong>1,532</strong></td>
<td><strong>5.7%</strong></td>
<td><strong>2.4%</strong></td>
<td><strong>1.04</strong></td>
<td><strong>$70,861</strong></td>
</tr>
</tbody>
</table>
Appendix B: Maps of targeted value chains

The following maps show the total number of companies from each value chain located in the Greater Charlotte region. The maps show patterns where the core and linked industries are located within the region. We have also included a map that depicts regional companies that are defined as an “Advanced Industry” by the Brookings Institution. Along with the companies, the maps also depict the region’s various economic development infrastructure assets.

The various maps portray the companies that are part of any industry that appears as a supplier or customer in the relevant value chain, or any industry designated as a Brookings Advanced Industry. Companies are identified as to where they appear in the value chain, according to the categories of supplier, customer, or both supplier and customer. Companies with multiple locations within the region will appear at each location.

The value chain maps included in this appendix are:

- Motor and generator manufacturing (NAICS 335312)
- Primary battery manufacturing (NAICS 335912)
- Turbine and turbine generator set units manufacturing (NAICS 333611)
- Electric power generation, transmission, and distribution (NAICS 2211)
- Heavy duty truck manufacturing (NAICS 33612)
- Aircraft parts and auxiliary equipment manufacturing (NAICS 336413)
- Ball and roller bearing manufacturing (NAICS 332991)
- Truck Transportation (NAICS 484)
- Brookings Advanced Industry

Due to the large volume of companies included, the maps do not show information about the individual companies. However, all companies included on the maps are listed in the Excel workbook that accompanies Appendix C and accessed at this Dropbox link; [Value Chains Company Database](#).
Centralina: Motor & Generator Manufacturing

- County Seats
- Linkages: Backward, Both, Forward
- Infrastructure: Airports, Inland Ports, Freight Rail, Interstate Highways

Source(s):
- Mecklenburg County Economic Development Office, 2014
- Charlotte Chamber of Commerce, 2014
- NC Department of Commerce
- Carports & Chain Link Fences Development Association, 2014
- Mooresville South Trade & Economic Development Corporation, 2014
- Rowan Works, 2014
- Stanly Economic Development Commission 2014
- Statesville Regional Development, 2014
- U.S. Census, 2014
Centralina: Other Aircraft Parts & Auxillary Equipment Manufacturing

- **County Seats**

**Linkages**
- Backward
- Both
- Forward

**Infrastructure**
- Airports
- Inland Ports
- Freight Rail
- Interstate Highways

Source(s):
- Mecklenburg County Economic Development Office, 2014
- Charlotte Chamber of Commerce, 2014
- NCEDC, 2014
- Gaston County Economic Development Commission, 2014
- Investing In Manufacturing Partnership, 2014
- Mecklenburg South inland Economic Development Corporation, 2014
- Faison Works, 2014
- NCEDC, 2014
- Mecklenburg Economic Development Commission 2014
- Shelby Regional Development, 2014
- U.S. Census, 2014
Appendix C: Value Chains Company Database

This spreadsheet provides a comprehensive inventory of the region’s companies in that are part of the value chain industries selected for this report, as well as every Brookings Advanced Industry. The list was assembled by first reviewing the core and linked industries associated with each value chain. The team then compiled a complete listing of all industries that appeared in the value chains, noting each as a core, backward linked, or forward linked industry. The team also added all industries from the full list of Brookings Institution’s Advanced Industries.

Upon completion of this task, the team reviewed relevant regional company lists assembled by various industry groups or economic development organizations, including:

- Charlotte Chamber of Commerce
- Charlotte Regional Partnership
- Rowan Works
- E4 Carolinas
- Statesville Regional Development
- Stanly County Economic Development Commission
- Gaston County Economic Development Commission
- Anson County Economic Development Office
- Lincoln Economic Development Association
- Mooresville South Iredell Economic Development Corporation

The team then used these lists to identify all companies that fell under the NAICS codes for the industries in the value chains and Advanced Industries. Location information and other company information was cross-referenced using the Reference USA business directory, a service of Infogroup. The information listed for each company in the list includes company name, web address, county, city, state, primary NAICS industry, and, where available, a general description of activities.

Although companies may participate in more than one value chain, each company only appears once on the list. Some core industries do not currently have a significant employment presence in the Greater Charlotte region, so only a few companies from those value chains will appear in the total company list. All locations are listed for companies with more than one location in the 16-county region.

Combined with the value chain diagrams, this regional company list can serve as the foundation for understanding the larger business-to-business relationships for the core industries of the Greater Charlotte region. Economic developers and businesses can use this list to start identifying the presence or absence of companies within the region’s core industries, and the companies that serve to support those core industries as suppliers and customers. A number of companies may serve multiple industries in the region. For example, the region’s many machine shops often supply larger companies representing a variety of different industry sectors, including aerospace and automotive manufacturing.
Identifying the actual companies that represent the industries within each value chain can help businesses find companies to fill gaps within their own supply chains. It can also help economic developers connect existing businesses within the region, and inform their business recruitment and business development efforts.

Due to the continuously changing make-up of businesses within a region, and the data limitations noted above, economic developers and other stakeholders can use this list as a foundation for these efforts, but utilize their own local knowledge of the Greater Charlotte region in order to further refine and expand upon this list.

Appendix C is an interactive and sortable database available upon request and can also be accessed at this Dropbox link; Value Chains Company Database. The full report and the database will also be posted and reside on the CHAMPION Alliance page of www.MindsThatManufacture.com.
Appendix D: County asset maps

The following maps show the total number of companies from all value chain located in each county. Because the maps portray companies from all value chains, the companies are designated according to the value chain in which they appear. If a company is part of an industry that often overlaps between multiple value chains, it is designated as “multiple”. Please see Appendix B for more specific geographic information about the companies that make up each individual value chain. Along with the companies, the maps also depict the region’s various economic development infrastructure assets.

Due to the large volume of companies included, the maps do not show information about the individual companies. However, all companies included on the maps are listed in the Excel workbook that accompanies Appendix C.

The county maps included in this Appendix are:

- Alexander County, NC
- Anson County, NC
- Cabarrus County, NC
- Catawba County, NC
- Chester County, SC
- Chesterfield County, SC
- Cleveland County, NC
- Gaston County, NC
- Iredell County, NC
- Lancaster County, SC
- Lincoln County, NC
- Mecklenburg County, NC
- Rowan County, NC
- Stanly County, NC
- Union County, NC
- York County, SC
Centralina: Anson County, North Carolina

Value Chains
- Multiple
- Ball and Roller Bearing
- Electric Power Generation
- Truck Transportation

Infrastructure
- Primary Roads
- Freight Rail
Centralina: Cabarrus County, North Carolina

Value Chains
- Multiple
- Ball and Roller Bearing
- Electric Power Generation
- Heavy Duty Trucking
- Motor Generators
- Other Aircraft Parts
- Primary Battery
- Truck Transportation

Infrastructure
- Airports
- Interstate Highways
- Primary Roads
- Freight Rail

Concord Regional Airport
Concord
CABARRUS

Source(s):
See Appendix
Centralina: Catawba County, North Carolina

Value Chains
- Multiple
- Ball and Roller Bearing
- Electric Power Generation
- Heavy Duty Trucking
- Other Aircraft Parts
- Primary Battery
- Truck Transportation

Infrastructure
- Airports
- Interstate Highways
- Primary Roads
- Freight Rail

Source(s):
See Appendix
Centralina: Chester County, South Carolina

**County Seat:**

**Linkages:**
- Multiple
- Ball and Roller Bearing
- Primary Battery
- Truck Transportation

**Infrastructure:**
- Interstate Highways
- Primary Roads
- Freight Rail

See Appendix
Centralina: Cleveland County, North Carolina

Value Chains
- Multiple
- Electric Power Generation
- Heavy Duty Trucking
- Primary Battery
- Truck Transportation

Infrastructure
- Interstate Highways
- Freight Rail
- Primary Roads
Centralina: Gaston County, North Carolina

- County Seat

Value Chains
- Multiple
- Ball and Roller Bearing
- Electric Power Generation
- Heavy Duty Trucking
- Motor Generation
- Other Aircraft Parts
- Primary Battery
- Truck Transportation
- Turbine Generator & Set Units

Infrastructure
- Airports
- Primary Roads
- Interstate Highways
- Freight Rail

Source(s):
Sea Apparatus

Scale:
0 3.5 7 14 Miles
Centralina: Iredell County, North Carolina

- County Seat

Value Chains
- Multiple
- Ball and Roller Bearing
- Electric Power Generation
- Heavy Duty Trucking
- Motor Generation
- Other Aircraft Parts
- Primary Battery
- Truck Transportation
- Turbine Generator & Set Units

Infrastructure
- Interstate Highways
- Freight Rail
- Primary Roads

Source(s): Sea Appands
Centralina: Lancaster County, South Carolina

**Linkages**
- Multiple
- Electric Power Generation
- Heavy Duty Trucking
- Primary Battery
- Truck Transportation
- Turbine Generator & Set Units

**Infrastructure**
- Primary Roads
- Freight Rail

Source: Sea Apparals
Centralina: Mecklenburg County, North Carolina

Value Chains:
- Multiple
- Rail and Roller Bearing
- Electric Power Generation
- Heavy Duty Trucking
- Motor Generation
- Other Aircraft Parts
- Primary Battery
- Truck Transportation
- Turbine Generator & Set Units

Infrastructure:
- Charlotte Inland Terminal
- Airports
- Interstate Highways
- Primary Roads
- Freight Rail

Sources:
Sea Apparatus
Centralina: Rowan County, North Carolina

Value Chains:
- Multiple
- Ball and Roller Bearing
- Electric Power Generation
- Heavy Duty Trucking
- Motor Generation
- Primary Battery
- Truck Transportation
- Turbine Generator & Set Units

Infrastructure:
- Airports
- Interstate Highways
- Primary Roads
- Freight Rail

Note: Source(s): Sea Apparate
Centralina: Stanly County, North Carolina

Value Chains
- Multiple
- Ball and Roller Bearing
- Electric Power Generation
- Heavy Duty Trucking
- Motor Generation
- Other Aircraft Parts
- Primary Battery
- Truck Transportation

Infrastructure
- Primary Roads
- Freight Rail

Source(s):
Sea Apparals
Appendix B: Manufacturing Education Asset Inventory Report
Manufacturing Education Asset Inventory Update

JUNE 2015
The following represents a refresh of programming relative to the Advanced Manufacturing sector Education Asset Inventory conducted for the Prosperity for Greater Charlotte Jobs, Workforce and Education Alignment Strategy for the Greater Charlotte Region. The data included in this report provides a current landscape of all the education programs, from Apprenticeship through Doctorate level offerings, in the 9 County Centralina Council of Governments region. This data was gathered via Institutional website information and detail provided within the most current school year (2014-2015) course catalogs.

The chart above provides an overview of the high level competencies addressed within the Higher Education programs offered across the Centralina COG geography and breakdowns those aspects of each program per county the institution is located. Detailed information is provided in the following Manufacturing Inventory relative to program offerings per credential, by program competency and type of institution. Further detail on the Apprenticeship programs, including their competency areas of focus, as well as related education and training, employer partners, program credentials provided and entry requirements is included at the end of this supplemental report.

<table>
<thead>
<tr>
<th>County</th>
<th>Manufacturing Program Competencies per County</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Advanced Manufacturing</td>
</tr>
<tr>
<td>Anson</td>
<td></td>
</tr>
<tr>
<td>Cabarrus</td>
<td></td>
</tr>
<tr>
<td>Gaston</td>
<td></td>
</tr>
<tr>
<td>Iredell</td>
<td></td>
</tr>
<tr>
<td>Lincoln</td>
<td></td>
</tr>
<tr>
<td>Mecklenburg</td>
<td></td>
</tr>
<tr>
<td>Rowan</td>
<td></td>
</tr>
<tr>
<td>Stanly</td>
<td></td>
</tr>
<tr>
<td>Union</td>
<td></td>
</tr>
</tbody>
</table>
The following plot chart includes detail of program availability, by each competency, of what type of credential (Certificate, Associate, Bachelor, etc.) is offered within each institution in the Centralina Council of Governments geography.

<table>
<thead>
<tr>
<th>Manufacturing Programs</th>
<th>Belmont Abbey College</th>
<th>Central Piedmont Community College</th>
<th>Davidson College</th>
<th>DeVry University North Carolina</th>
<th>Gaston College</th>
<th>ITT Technical Institute-Charlotte</th>
<th>Johnson C. Smith University</th>
<th>Mitchell Community College</th>
<th>Pfeiffer University</th>
<th>Rowan-Cabarrus Community College</th>
<th>South Piedmont Community College</th>
<th>Stanly Community College</th>
<th>University of North Carolina at Charlotte</th>
<th>University of Phoenix-Charlotte Campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning, Heating and Refrigeration Technology</td>
<td>A, C, C, Diploma</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>A, C</td>
<td>A, C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Architectural Technology</td>
<td>A, C</td>
<td>A, C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive Systems Technology</td>
<td>B</td>
<td>A, C, C, Diploma</td>
<td>A, C</td>
<td>A, C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil Engineering Technology</td>
<td>A, C</td>
<td>A, C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Construction Technology</td>
<td>A, C</td>
<td>A</td>
<td>A, C</td>
<td>B, M</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Drafting and Design Technology</td>
<td>A, C</td>
<td>A, C</td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>General Occupational Technology</td>
<td>A</td>
<td>A, C</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Industrial Systems Technology</td>
<td>A, C, C, Diploma</td>
<td>C</td>
<td>B</td>
<td>A, C</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Engineering Technology</td>
<td>C</td>
<td>C</td>
<td>A, C</td>
<td>A, C</td>
<td>A, C</td>
<td>B, M, D</td>
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<td>Welding Technology</td>
<td>C</td>
<td>A, C, C, Diploma</td>
<td>C</td>
<td>A, C</td>
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<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

Certificate, A = Associates, B = Bachelors, Diploma, PBC = Post Baccalaureate Certificate, M = Masters, GC = Graduate Certificate, D = Doctorate
The above chart shows the number and types of programs offered within Higher Education institutions across the 9 county Centralina COG Region, only Engineering Technology is not included. Full detail of this program breakdown by competency areas (engineering, industrial technology, welding, etc.) is provided in a table in the appendix of this Inventory.
The above chart shows the number and types of Engineering Technology programs offered within Higher Education institutions across the 9 county Centralina COG Region.

<table>
<thead>
<tr>
<th>Engineering Technology</th>
<th>Anson</th>
<th>Gaston</th>
<th>Iredell</th>
<th>Lincoln</th>
<th>Mecklenburg</th>
<th>Rowan</th>
<th>Stanly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>9</td>
<td>18</td>
<td>9</td>
<td>44</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>
The above chart provides further detail on the types of institutions (For Profit, Private and Public Colleges and Universities) along with the type and count of program areas supporting the Manufacturing Sector (excluding Engineering Technology) in the 9 county Centralina COG Region.
The above chart provides further detail on the types of institutions (For Profit, Private and Public Colleges and Universities) along with the type and count of Engineering Technology program areas supporting the Manufacturing Sector in the 9 county Centralina COG Region.
The chart above provides an overview of the total count of program area offerings (not including Engineering Technology) per Public College institutions. The institutions listed exist within the 9 country Centralina COG Region.
The chart above provides an overview of the total count of program area offerings (not including Engineering Technology) per all non-Public College institutions; including Private Colleges, Private and Public Universities and For Profit Institutions. The institutions listed exist within the 9 country Centralina COG Region.
The chart above provides an overview of the total count of Engineering Technology programs per all institutions. The institutions listed exist within the 9 country Centralina COG Region.
The above chart provides detail on the type of credential offered (everything except Certificates) within each program area (excluding Engineering Technology) at the institutions within the 9 county Centralina COG Region.
The above chart provides detail on the Certificate offerings within each program area (excluding Engineering Technology) at the institutions within the 9 county Centralina COG Region.

<table>
<thead>
<tr>
<th>Certificate Program</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning, Heating and Refrigeration Technology</td>
<td>33</td>
</tr>
<tr>
<td>Architectural Technology</td>
<td>5</td>
</tr>
<tr>
<td>Automotive Systems Technology</td>
<td>24</td>
</tr>
<tr>
<td>Civil Engineering Technology</td>
<td>4</td>
</tr>
<tr>
<td>Computer Engineering Technology</td>
<td>20</td>
</tr>
<tr>
<td>Construction Technology</td>
<td>10</td>
</tr>
<tr>
<td>General Occupational Technology</td>
<td>2</td>
</tr>
<tr>
<td>Industrial Systems Technology</td>
<td>32</td>
</tr>
<tr>
<td>Mechanical Engineering Technology</td>
<td>20</td>
</tr>
<tr>
<td>Welding Technology</td>
<td>29</td>
</tr>
</tbody>
</table>
The above chart provides detail on Engineering Technology offerings per degree type (Associate, Certificate, Bachelors, etc.) at the institutions within the 9 county Centralina COG Region.

<table>
<thead>
<tr>
<th>Engineering Technology</th>
<th>Associate</th>
<th>Bachelors</th>
<th>Certificate</th>
<th>Diploma</th>
<th>Doctorate</th>
<th>Masters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Technology</td>
<td>31</td>
<td>4</td>
<td>66</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
**Apprenticeship Program Overview and Detail**

The below overview provides the most recent detail relative to the various Apprenticeship programs across the 9 county Centralina COG region supporting Manufacturing businesses and developing the Manufacturing workforce pipeline. The chart includes detail on program participant eligibility, various hours of On-the-Job Training and Job-Related Instruction provided, credential received by program participant (the type of certification and Associate degree if applicable) and the long term job placement opportunity for program completers.

Data for this overview was gathered via program information provided through the Higher Education institutions that run the various Apprenticeship programs and in collaboration with M/H/R Services LLC. All of this information is current as of June 2015.

### Program / Driver:

**Apprenticeship 2000:**
 Employer Driven program established by Blum and Daetwyler in 1995. Once program functional, 6 other manufacturers joined it. Recently 3 left program.

- **Eligibility:** Minimum 2.5 GPA. Should have completed courses in Algebra 1&2, Geometry, Physics, Drafting, Computer application, Attendance
- **Hours of OJT and JRI:** 8000 hours / including 1,750 of job related instruction
- **Credential Received:** Journeyman’s Certificate for DOL Registered Job: AAS Degree in Mechatronics Engineering Technology
- **Long Term Job Placement:** Guaranteed employment after graduation at a predetermined starting annual wage, regardless of registered occupation.

**Apprenticeship Charlotte:**
 Community College centered encouraged by Siemens in addition to & then alternative to Apprenticeship 2000.

- **Eligibility:** Admission to CPCC is pathway for high school students to enter Apprenticeship Charlotte programs with employers. Graduation requirements depend on registered occupation and employer
- **Hours of OJT and JRI:** Up to 8000 hours / including 1,750 of job related instruction - depending on certification levels
- **Credential Received:** Journeyman’s Certificate for DOL Registered Job: AAS Degree in one of 8 Engineering Technology academic programs in which an AAS degree can be granted by CPCC.
- **Long Term Job Placement:** No promise of employment by CPCC; terms and conditions of employment vary depending on Employer Partner policies
<table>
<thead>
<tr>
<th>Program / Driver:</th>
<th>Eligibility</th>
<th>Hours of OJT and JRI</th>
<th>Credential Received</th>
<th>Long Term Job Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apprenticeship Catawba:</strong></td>
<td>Employer Driven program modeled after Apprenticeship 2000 and including former employer partner (Sarstedt)</td>
<td>Minimum 3.0 GPA Excellent math/technical skills good attendance record</td>
<td>8000 hours / including 1,750 of job related instruction</td>
<td>Journeyman Certificate for DOL Registered Job: AAS Degree in Mechatronics Engineering Technology OR Computer Integrated Machining Technology</td>
</tr>
<tr>
<td><strong>Apprenticeship 20/20:</strong></td>
<td>Employer Driven program modeled at first after Apprenticeship 2000, but changing to Community College driven program.</td>
<td>At 1st: Minimum 2.5 H.S. GPA Should have completed courses in Algebra 1&amp;2, etc. Now admitting apprenticeship candidates to Community College and enrolling in remedial math if necessary.</td>
<td>At 1st: 8000 hours / including 1,750 of job related instruction. Now developing other programs.</td>
<td>Journeyman’s Certificate for DOL Registered Job: AAS Degree in Mechatronics Engineering Technology OR in Industrial Systems Technology, depending on job</td>
</tr>
<tr>
<td><strong>Apprenticeship 321:</strong></td>
<td>Registered as single employer driven (STEAG Energy Services) program in 2013; becoming a community college driven multi-employer program 2015.</td>
<td>2013: STEAG hired community college students for first class of apprentices, then recruited high school grads in 2014. For new program, Gaston College to use WorkKeys and math competency tests for students.</td>
<td>2013: 2 jobs registered with NC DOL agency: 1) 4,000 OJT; 2) 6,000 OJT with related classes.</td>
<td>Journeyman’s Certificate for DOL Registered Jobs: As length of STEAG program not sufficient for apprentices to earn AAS degree, Gaston College awards certificate or diploma for directly related coursework and employer continues to sponsor willing students for AAS degree using tuition reimbursement program.</td>
</tr>
</tbody>
</table>
The following overview provides further detail per Apprenticeship program. This chart catalogs the various Skilled Trades developed per program, relevant Employer Partners, program service area per County within the Centralina COG Region, Community College partners and High School Systems (per county) where program participants are recruited into the program.

<table>
<thead>
<tr>
<th>Program / Driver:</th>
<th>Skilled Trades</th>
<th>Employer Partners</th>
<th>Counties</th>
<th>Community Colleges</th>
<th>Recruiting High School System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apprenticeship 2000:</strong></td>
<td>CNC Machinist</td>
<td>Ameritech, Blum, Chiron, Daetwyler, Pfaff Molds</td>
<td>Iredell, Lincoln, Mecklenburg</td>
<td>Central Piedmont Community College</td>
<td>Iredell, Lincoln, Mecklenburg</td>
</tr>
<tr>
<td></td>
<td>Welding Fabricator</td>
<td></td>
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<tr>
<td></td>
<td>Tool &amp; Die Maker</td>
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<tr>
<td></td>
<td>Machine Technician</td>
<td></td>
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<tr>
<td></td>
<td>Mold/Plastics Technician</td>
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<tr>
<td></td>
<td>Mechatronics Electrician</td>
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<tr>
<td></td>
<td>Mechatronics Technician</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>CNC Machinist</td>
<td>Bosch-Rexroth, HAWE Hydraulics, Daimler, Muratec, and Siemens</td>
<td>Mecklenburg and Others</td>
<td>Central Piedmont Community College</td>
<td>Charlotte-Mecklenburg System (CMS)</td>
</tr>
<tr>
<td><strong>Apprenticeship Charlotte:</strong></td>
<td>CNC Machinist</td>
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<tr>
<td></td>
<td>Welding Fabricator</td>
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<tr>
<td></td>
<td>Tool &amp; Die Maker</td>
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<td></td>
<td>Machine Technician</td>
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<td></td>
<td>Mold/Plastics Technician</td>
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<td></td>
<td>Mechatronics Electrician</td>
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<tr>
<td></td>
<td>Mechatronics Technician</td>
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<tr>
<td></td>
<td>Tool &amp; Die Maker</td>
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<tr>
<td></td>
<td>CNC Machinist</td>
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<td></td>
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</tr>
<tr>
<td><strong>Apprenticeship Catawba:</strong></td>
<td>Mechanical Maintenance Technician</td>
<td>Aptar, Continental, GKN, Sarstedt, Technibilt, Tenowo, ZF</td>
<td>Catawba, Lincoln</td>
<td>Catawba Valley Community College</td>
<td>Catawba, Lincoln</td>
</tr>
<tr>
<td></td>
<td>Electrical Maintenance</td>
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<tr>
<td></td>
<td>Technician</td>
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<tr>
<td></td>
<td>Mechatronics Technician</td>
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<tr>
<td></td>
<td>Tool &amp; Die Maker</td>
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<tr>
<td></td>
<td>CNC Machinist</td>
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<td></td>
</tr>
<tr>
<td><strong>Apprenticeship Catawba:</strong></td>
<td>Electrical Maintenance Technician</td>
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<tr>
<td></td>
<td>Technician</td>
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<tr>
<td></td>
<td>Mechatronics Technician</td>
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<tr>
<td></td>
<td>Tool &amp; Die Maker</td>
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<tr>
<td></td>
<td>CNC Machinist</td>
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</tr>
<tr>
<td>Program / Driver:</td>
<td>Skilled Trades</td>
<td>Employer Partners</td>
<td>Counties</td>
<td>Community Colleges</td>
<td>Recruiting High School System</td>
</tr>
<tr>
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<td>-------------------------------</td>
</tr>
<tr>
<td><strong>Apprenticeship 20/20:</strong> Employer Driven program modeled at first after Apprenticeship 2000, but changing to Community College driven program.</td>
<td>At 1st:CNC Machinist, Welding Fabricator, Tool &amp; Die Maker, Electrician, Mold/Plastics Technician, Maintenance Technician</td>
<td>At 1st: Greiner Bio-One, Safran Turbomeca, Vanguard Pai Lung were 3 employers who paid ($20,000) to start program with help of Golden Leaf grant. Now Greiner Bio-One is reportedly only company with apprentices.</td>
<td>Anson, Union</td>
<td>South Piedmont Community College</td>
<td>Anson, Union</td>
</tr>
<tr>
<td><strong>Apprenticeship 321:</strong> Registered as single employer driven (STEAG Energy Services) program in 2013; becoming a community college driven multi-employer program 2015.</td>
<td>STEAG initially registered 2 DOL recognized jobs: 1) Machinery Mechanic 2) Chemical Operator. Gaston College now registering at least 2 more jobs: 3) Multi-Machine Set Up Operator; 4) Tool Setter. If prospective Employer Partner with registered program (Daimler Trucks) joins Apprenticeship 321, it has 6 additional apprentices jobs registered with NCDOL.</td>
<td>As of May 2015: only STEAG Energy Services and Daimler Trucks have registered programs in Gaston County. By Fall 2015, expect 6 other companies in Gaston and Lincoln counties to join Apprenticeship 321 program</td>
<td>Gaston, Lincoln</td>
<td>Gaston Community College</td>
<td>Cleveland, Gaston, Lincoln</td>
</tr>
</tbody>
</table>

**NOTE:** Information regarding the status of Registered Apprenticeship programs for manufacturing sector employers in the North Carolina counties of the Charlotte Region was updated in collaboration with M/H/R Services LLC, a consulting firm also engaged by Centralina Council of Governments for overlapping purposes.
National Best Practices in Apprenticeship Programs Supporting the Manufacturing Sector

The Manufacturing sector have been an early adopter, and leading a reinvestment, in the American Apprenticeship model. The renaissance is even more prominent specifically in the Greater Charlotte region with many Manufacturing employers leading Apprenticeship development and sustainability to continue creating a talented workforce pipeline for the region. With constant evolution in the American Manufacturing sector and the need for highly skilled workers, Apprenticeship programs are great mechanisms to engage with a long-term talent pipeline, create an environment which contextualizes learning in a hands-on, industry-driven format and supports long term degree attainment for the workforce. The Greater Charlotte Region is currently enjoying several innovative approaches to Apprenticeship programs in the Manufacturing sector and is on a path to further cultivate and sustain these models for long term success – both for the workforce and the employer partners. To benefit future development of these programs this section provides an overview of Apprenticeship program best practices from examples at a National level.

Skill Development:

- **Focus on “Soft Skills” as much as the Technical “Hard Skills”** – “Soft Skills” are sometimes referred to as “Critical Skills”. Many programs have begun to have a heavier focus on these non-technical skills through the On-the-Job Training aspect of the Apprenticeship program. These skills include critical thinking, problem solving, collaboration, teamwork and communication skills. These are all critical for a successful workforce and by folding skill development on these areas into the technical skill sets also developed within an Apprenticeship model employers are positioned to create a well-rounded worker.

- **Incorporate Technical Learning with Skill Remediation** – Many Apprenticeship programs have had to overcome barriers of skill remediation particularly in the Math and Science fields. The State of Washington created the I-BEST model for learning (Integrated Basic Education and Skills Training) which is a nationally recognized model that quickly boosts students’ literacy and work skills and in some examples has been applied in the Apprenticeship or pre-Apprenticeship programs to create a larger applicant and program participant pool.

Partnership Development and Sustainability:

- **Build Multi-Employer Partnerships** – While the particular skill needs and proprietary functions across employers may vary greatly there are several successful Apprenticeship programs that work with several employers to identify foundational skill needs that will benefit the pipeline for the sector, as opposed to the employer themselves. These partnerships benefit the development of the workforce as a group and ensure that there are career opportunities on a more consistent basis due to multiple entry points across the group of employers alleviating the need for one employer to absorb all Apprenticeship graduates.
- **Nurture Partnership with Community Colleges** – Community Colleges are key partners in the success of Apprenticeship programs, as evidenced in all the models in the Greater Charlotte Region. Nationally there has been success across economy sectors by drawing upon the infrastructure for training opportunities that exists within a Community College Instruction or System. The Colleges can offer the Related Training and Instruction for many skilled trades that would benefit not just the Manufacturing Sector but other Industries core to the Greater Charlotte economy.

**Program Structure:**

- **Leverage National Training Resources and Input** – National partnerships have helped to sustain Apprenticeship programs and lessen the cost of training development for individual employer partners. Developing a Coalition of Industry from other Manufacturing sector employers across the country will provide key input on national trends and needs, at the foundational level, within the industry and the workforce pipeline. For example the Energy Providers Coalition for Education (EPCE) includes employers from all over the country who help to inform education curriculum at the Pre-Apprenticeship and Apprenticeship levels. This model creates a large network of industry leaders and increases collaboration among industry and education beyond the geographic area of where the business is located.

- **Include Placement Services and Follow Up for Program Graduates** – Programs have begun to invest in post-program services to ensure that the Apprentice completer has found employment (if not directly offered as a part of the Apprenticeship Program) and has been successful in their job placement (validating the learning that occurred during OJT and Related Training offered in the program). This creates a holistic feedback loop to both employer and education partner to continue modifying Apprenticeship program structure to ensure long term employability for their graduates.

- **Provide Financial Assistance to Students** – Supporting students tuition costs associated with the Apprenticeship program (either partial or full tuition payments or reimbursement) directly contributes to the success of program students and helps either supplement or eliminate the financial burden that Higher Education programs represent for many workers. Financial assistance can be provided for tuition, textbooks and fees.

**Apprenticeship Program Examples:**

- The following two programs are good examples of how Statewide and National partnerships have come together to support Apprenticeship programs. This information was gathered from their website information. The link to each website which contains contact information on program leadership is included in the overview.
Aerospace Joint Apprenticeship Committee (AJAC) – State of Washington Model

In 2008 the State of Washington funded the creation of the Aerospace Joint Apprenticeship Committee to serve as a state-wide sector partnership to develop Apprenticeship programs serving the number of various trades supporting the Aerospace industry throughout Washington.

AJAC is a statewide, nonprofit 501(c)(3) aerospace and advanced manufacturing registered apprenticeship program. It is the mission of AJAC that the training of apprentices shall be without discrimination based on race, sex, color, religion, national origin, age, disability, sexual orientation, veteran status or as otherwise specified by law.

AJAC and its advisory committee, comprised of employers and employees, have developed and implemented the following registered apprenticeship programs based on employer and industry need:

- Machinist (Aircraft-Oriented)
- Aircraft Mechanic Airframe
- Precision Metal Fabricator
- Tool and Die Maker
- Industrial Maintenance Mechanic
- Aircraft Interiors Assembly Mechanic (In Development)
- Composite Technician (In Development)

Apprenticeship combines supervised on-the-job training experience with college-level classroom instruction enabling:

- Employees to earn a living wage while they learn on-the-job from a mentor and attend class one night a week at a local community or technical college
- Employers to increase their workforce skills without disrupting production

AJAC's program offers:

- Employers across Washington State a proven method to capture these knowledge and skills
- Apprentices the tools necessary to learn and master these skills, advance in their career and become a master tradesperson
- Step by step process for employers to begin an apprenticeship
- Central guidance for employer mentors and apprentices

In addition to obtaining journey-level certification as a master tradesperson, AJAC's unique program sets the apprentice on a path towards an associate’s degree that can articulate into a four-year degree. Companies across Washington State who participate as registered Training Agents with AJAC can enroll current employees in an existing AJAC program. If a company has 15 or more employees that need training in one of AJAC's currently registered occupations, AJAC can create a new program exclusively for that company.

Energy Providers Coalition for Education (EPCE) – National Model

The Energy Providers Coalition for Education (EPCE) is a group of representatives from the energy industry that develops, sponsors, and promotes industry-driven, standardized, quality online learning programs to meet the workforce needs of the energy industry. EPCE is the premier source of online energy education, built to address the critical employment needs of the evolving utility industry.

EPCE members represent energy leaders across the country, from Washington State to Florida, who collaborate with accredited education providers to develop utility-specific solutions to education and training needs.

Since June 2000, EPCE has served as a national resource for online energy education programs that are:

- High Quality - interactive and instructor lead; offered by fully accredited leading institutions
- Industry Supported - designed by and for the industry to address workforce challenge faced by energy companies today
- Convenient - available online 24/7; study anytime, anywhere

In response to member need EPCE created an innovative blended learning approach to the typical Apprenticeship program. EPCE created and implemented an online program in Electric Power Technology courses to meet specific training needs within approved apprenticeship training programs. The EPCE sponsored online Electric Power Technology Education program, delivered by the Bismarck State College National Energy Center of Excellence, provides apprentices with a core set of skills and competencies as well as a foundation in electrical systems, transformers and electric components. EPCE developed and regularly maintains and updates coursework within the Apprenticeship programs through a national curriculum committee made up of representatives from major industry organizations.

Advantages of the Apprenticeship Programs:

- Apprentices have a foundation of knowledge from the online, industry specific courses, which allows the on-the-job instruction to go deeper into the subject matter
- After gaining more knowledge, apprentices are better prepared to step up to their responsibilities, show increased confidence, and be inquisitive and engaged
- The online courses allow for flexibility with the company apprenticeship schedule, allowing for 4, 8, 12 and 16 week offerings
- Apprentices receive college credit for the courses
- Upon completion of the apprenticeship program, apprentices are well on the way to obtaining an associate’s college degree
- The program increases the number of college graduates at the company
- The online courses are attractively priced when compared to other outsourced training options

More Information Can Be Found At: http://epceonline.org/apprenticeship-program
<table>
<thead>
<tr>
<th>School</th>
<th>Type of Institution</th>
<th>Program</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belmont Abbey College</td>
<td>Private College</td>
<td>Business Management</td>
<td>Bachelors</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Welding Technology</td>
<td>Certificate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Air Conditioning, Heating and Refrigeration Technology</td>
<td>Certificate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Air Conditioning, Heating and Refrigeration Technology</td>
<td>Certificate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Air Conditioning, Heating and Refrigeration Technology</td>
<td>Certificate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Electronics Engineering Technology</td>
<td>Certificate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Electronic Engineering Technology</td>
<td>Certificate</td>
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<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Electronic Engineering Technology</td>
<td>Certificate</td>
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<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Electronic Engineering Technology</td>
<td>Certificate</td>
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<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Architectural Technology</td>
<td>Certificate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Air Conditioning, Heating and Refrigeration Technology</td>
<td>Associate</td>
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<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Architectural Technology</td>
<td>Associate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Electronic Engineering Technology</td>
<td>Associate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Electronic Engineering Technology</td>
<td>Associate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Construction Technology</td>
<td>Associate</td>
</tr>
<tr>
<td>Central Piedmont Community College</td>
<td>Public College</td>
<td>Electronic Engineering Technology</td>
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Appendix C: Communications Plan for IMCP
Implementation Strategies and Objectives
Communications Plan for IMCP Implementation Strategies and Objectives

Marketing and communications support will focus primarily on Strategic Objective 3: Recruit greater industry participation in demand-based expansion of regional Advanced Manufacturing college attainment curriculums and monitored alignment of course offerings, training programs (Apprenticeships/Internships) including training resources for employers. While each of the four objectives are significant to achieving IMCP’s goals, this specific goal is especially achievable when paired with parallel efforts already underway at the State level.

Proposed tactics include:

- increase operational deployment of regional training, internship and apprenticeship collaborations, job placement, and industry sector partnerships through coalition activities;
- expand and invest in the Advanced Manufacturing Centers and training facilities within existing community college networks; and
- facilitate additional funding for manufacturing affiliated curriculum and degree programs;

Proposed indicators of success:

- percentage of growth in post-secondary credentials aligning with Advanced Manufacturing career pathways,
- increase number of new apprenticeship/internship programs,
- increase number of new apprentices/interns, and
- increase STEM based certificate and degree offerings.

The communications strategy is designed to develop a robust talent pipeline that will plug both the skills and interest gaps for advanced manufacturing careers among adults and students to meet the current and future needs of the Greater Charlotte Region’s Advanced Manufacturing employers.

Focus on Advanced Manufacturing Career Pathways

At the State level, career pathways have been targeted to become a key workforce tool to support workers’ transitions from education into and through the workforce. Pathways offer North Carolina and the region the best opportunity to increase the education, training, and learning opportunities for our current and emerging workforce.

Currently, an integrated team representing community colleges and the departments of commerce and public instruction are creating a framework by defining, developing, and implementing clear, concise, and comprehensive pathways that will be consistent across the state, yet reflect the economic needs of various regions. This framework combines best practices from the Pathways to Prosperity work supported by Jobs for the Future and the Harvard Graduate School of Education, research/concepts from the U.S. departments of labor and education, and ideas from around the country. The pathways will include “on- and
off-ramps” for citizens at different phases of their careers including students in high school, community college, or university; veterans; unemployed or dislocated workers; and underemployed individuals or those who want to advance their careers.

Career pathways are included in the strategic plans of the State Board of Community Colleges, the NCWorks Commission, and the Governor’s Education Cabinet. This consistent, focused effort will help individuals be ready for work in a shorter time period because they can follow a path that leads to success without duplication of effort and added cost. Companies benefit from participation by helping to create a pipeline of talent to meet their needs and validating program quality.

The IMCP manufacturing coalition and North Carolina can strengthen an already mutually beneficial relationship by developing an Advanced Manufacturing career pathway in parallel and in partnership with the region’s three workforce development boards (Centralina, Charlotte Works and Gaston). While the entities mentioned above work on multiple pathways in multiple sectors to be scaled across the state, the development and promotion of an Advanced Manufacturing career pathway by the IMCP manufacturing coalition and the workforce boards could likewise be broadened into a model for other areas.

Phase 1: Market Research

Given that the Advanced Manufacturing career pathway to be developed by the IMCP manufacturing coalition, the CEDC and the workforce development boards will focus on the region’s Advanced Manufacturing “hot jobs,” we must first determine a number of factors, including

- what those jobs are,
- the employers offering them,
- the verifiable skills and correspondent certifications and/or degrees,
- the current and projected professional development trajectories for each position,
- how many people to pull through the pipeline to fill the jobs, etc.

Phase I of the IMCP communications plan is to conduct extensive market research among the region’s advanced manufacturers, particularly the eight key value chains identified in this report, to gather the intelligence necessary both to define current demand and to forecast employer need (numbers of skilled workers, types of positions on the pathway).

This one-time, project-based assessment will necessarily include direct contact with key advanced manufacturing personnel (plant managers, apprenticeship coordinators, trainers, etc.). A vital component of this phase will be to develop and employ ongoing communications (e.g., quarterly meetings or newsletters, a private LinkedIn group or BaseCamp page, Twitter chats, etc.) to cultivate trusting, long-lasting, mutually beneficial relationships with these key personnel, who will also provide critical input during the latter phases of the communications strategy.
Phase 2: Career Pathway Development

Development of the Advanced Manufacturing career pathway can run concurrently with the proposed market research as positions and potential are uncovered.

To be completely effective in attracting the skilled talent required to fill the Advanced Manufacturing pipeline, the career pathway must be created, vetted and tested with multiple employers. Advanced manufacturers from across sectors and company sizes must come together to consider and recommend elements including:

- categories in demand (e.g., production, process development, quality assurance, maintenance, etc.);
- occupations in demand (e.g., welder, CNC machinist, assembler, etc.);
- progression up the pathway categories through education, experience or a combination;
- pathway “on- and off-ramps” for all career phases;
- curriculum development (K – 12, post-secondary, certifications, etc.);
- soft-skills training;
- standardized testing and achievement levels to validate skills attainment; etc.

Another significant activity in this phase will be the creation of the Charlotte Region Advanced Manufacturing Talent Guarantee (working title). Established, administered and tracked by the IMCP manufacturing coalition, the Guarantee will significantly reduce business uncertainty and ensure a steady and consistent pipeline of highly skilled workers into the region’s Advanced Manufacturing ecosystem. It will be the IMCP manufacturing coalition’s promise to employers (both existing and new) that the students and adults who are recruited, assessed, and trained into the Advanced Manufacturing pathway will meet or exceed their workforce needs.

The Guarantee’s specific parameters will include:

- being applicable only to employers filling jobs within the Advanced Manufacturing pathway;
- requiring close collaboration between employers and IMCP manufacturing coalition; and
- demanding accountability from employers (who will be required to share current retention levels, employee productivity numbers, employee satisfaction data, etc.).

Communication activities will be aimed at branding the IMCP manufacturing coalition, its Advanced Manufacturing career pathway, and the Charlotte Region Advanced Manufacturing Talent Guarantee, including retaining a branding agency to develop logos, taglines, fonts, style guides, etc.
Phase 3: Employer Engagement

Moving into the more purely communications-driven phases of the overall strategy, the current, smaller group of engaged employers will be equipped to partner with the IMCP manufacturing coalition to expand the circle of Advanced Manufacturing employers who are committed to embracing the career pathway and Charlotte Region Advanced Manufacturing Talent Guarantee.

Communications during this phase will be aimed at:
- raising awareness among the region’s Advanced Manufacturing ecosystem of these tools;
- educating employers about and promoting widespread participation in work-based learning opportunities for both students and adults;
- educating employers about and assisting with the creation of certified apprenticeship programs;
- recruiting active the IMCP manufacturing coalition members from within the ecosystem and key partners in the education and workforce systems; and
- continuing nurturing the relationships cultivated in Phase 1.

Potential tactics could include:
- regular electronic communications (e-newsletters, LinkedIn, Twitter, etc.);
- earned media outreach in targeted trade publications;
- paid advertising, both online and in print, in targeted trade publications;
- creating a speakers’ bureau to deliver presentations at targeted Advanced Manufacturing trade associations and relevant organizations (developing talking points, PowerPoint decks, collateral);
- using the existing Minds That Manufacture website or creating a new web presence to promote these tools and activities;
- developing a targeted social media outreach strategy; etc.

Phase 4: Talent engagement

Now that a clear Advanced Manufacturing pathway with its attendant training and advancement opportunities – together with an eager base of employers with open positions – is available, we must embark upon a creative outreach campaign to generate buzz and interest in Advanced Manufacturing as a viable, profitable, sustainable career.

The primary audiences for this campaign will be educators (teachers/instructors, guidance/career counselors, career development coordinators, etc.) in the K-12 and post-secondary systems, students, and parents. Secondary audiences will include community-based workforce development and youth organizations.

Training for educators about the career pathway and Charlotte Region Advanced Manufacturing Talent Guarantee will be developed, delivered, and supplemented with
ongoing communication from the IMCP manufacturing coalition and in partnership with the K – 12 and post-secondary systems (e.g., e-newsletters, social media, website, etc.).

Parent education and outreach will also be developed and executed in partnership with the school systems. Specific tools will be developed for use with parent-teacher organizations, media relations, parent blogs, etc.

Because career awareness requires a deeper dive into each individual job on the career pathway, an interactive version of the pathway will be developed and housed on either the Minds That Manufacture website or a newly created micro-site. When clicked, each job will be linked to a sub-page that houses the following elements:

- a professionally produced “day in the life” video of a young person who currently hold that role,
- a sample job description,
- the current numbers of openings and employers,
- current salary information,
- direct links to employers’ career sites/application instructions,
- a detailed description of the training required to earn the position (including curriculum, work-based learning opportunities, hours in the classroom/on the job, average cost, etc.), and
- links to regional training providers.

This career pathway webpage/site will be marketed to all three primary audiences, together with the existing Youth Business Connector website that connects employers and students for work-based learning opportunities.

The videos will be cross-posted on the Minds That Manufacture website (or other branded) YouTube and Vine channels that will become a cornerstone of a comprehensive social media campaign aimed at students. Other components may include a youth-oriented, Charlotte-region Advanced Manufacturing

- Facebook page,
- Twitter account,
- Tumblr,
- Instagram and Pinterest boards,
- Snapchat, etc.

Investment should also be made in developing a peer-education program with students who are preparing to enter the Advanced Manufacturing pathway, are somewhere on its continuum, or have recently graduated and entered the Advanced Manufacturing workforce. Elements of this program could include their participation in the social media campaign, media relations, and employer outreach.
Measurement of Communications Strategies

While the overall success of this education-focused IMCP strategic objective will be measured by the long-term indicators listed above, evaluation will be built into each phase of the communications strategy based on that phase's goal(s). For example, measures in Phase 1 could include not simply completion of the market research itself, but the number and quality of responses to information requests posed to individual employers within the Advanced Manufacturing ecosystem. Attendance at meetings, subscribes/unsubscribes/shares of the e-newsletter, and engagement (number of members, quality of discussion, etc.) in the proposed private social media group will also be tracked.

Other success measures could include:

- number of Advanced Manufacturing employers that actively use the career pathway;
- number of Advanced Manufacturing employers that hire employees who have been certified with the Charlotte Region Advanced Manufacturing Talent Guarantee;
- number of Talent Guarantee-certified employees hired;
- long-term status of the certified employees (wage growth, promotions, additional educational attainment, etc.);
- number of work-based learning opportunities resulting from the awareness campaign;
- number of new apprentices and apprenticeship programs created;
- number of speakers' bureau appearances and engagement that can be tracked directly back to them;
- increase in the number of members of the IMCP manufacturing coalition;
- number of educators trained to use the career pathway and Talent Guarantee;
- number of parents educated about Advanced Manufacturing careers in the Charlotte region and their engagement with the IMCP manufacturing coalition and its tools;
- number of students who enter the Advanced Manufacturing career pathway at the most elementary level;
- long-term status of those students (progression through the both the educational system and the pathway, wage growth, promotions, etc.); etc.

This recommendation assumes that common qualitative communications measures will be tracked (e.g., website traffic, number and sentiment of media mentions, number and sentiment of comments on social media channels, views of videos, e-newsletter click-through, etc.).