A Blueprint for Building an Innovation Corridor
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A Blueprint for Building an Innovation Corridor

Report

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Executive Summary

The Innovation Corridor is a concept to create more broad-based growth across a geographic region by leveraging the innovation and placemaking assets of smaller cities and towns in conjunction with these same assets in an established relatively high-performing innovation hub. This Blueprint examines the potential for longer-term industry cluster growth along with people and place-based initiatives to offer ideas for policy makers and other champions to consider for expanding economic opportunity to help address uneven growth in the region.

Regional economic development in the United States followed a pattern of divergence after the 2008 financial crisis and Great Recession: Top-performing metro areas led rapid high-tech job and income growth, concentrating economic activity in areas with prominent and clustered innovation assets. This trend, defined using terms such as "winner take all," "winner take most," "superstar metro areas," or "knowledge-based affluence," has accelerated with the changing nature of the post–Great Recession economy, driven by the growth of knowledge sectors including software and bioscience, deindustrialization, shifting demographics, and concentration of highly skilled workers in cities. The 2020 coronavirus disease (COVID-19) pandemic and ensuing economic crisis has deeply exposed this divide: Knowledge workers with strong digital infrastructure and internet access are working safely from their homes, while workers in many industries risk job loss or illness.

North Carolina is no exception to this phenomenon: While the Raleigh–Durham–Chapel Hill area has thrived as a knowledge economy and Charlotte has grown as a financial center, much of the remainder of the state has seen stagnant or negative

economic growth since the Great Recession. This trend is not slowing, and over the next decade, urbanization, technology transformation, automation of manufacturing, growth of knowledge work, shifting racial and age demographics, low-wage service work, and global trade will all play a role in North Carolina's trajectory as it looks to rebuild from the 2020 pandemic and economic crisis.

The idea of the Innovation Corridor is to pilot a concept for regional development, focused on better linking a national innovation hub with small and medium-sized cities to generate broad-based, long-term economic growth. The goals of the Innovation Corridor include the following:

- Drive and expand growth in globally competitive industries.
- Create more job opportunities across a wider geography.
- Strategically coordinate research university and private-sector innovation assets.
- Launch North Carolina into the national and global innovation ranks.

The study region, spanning from Winston-Salem in the west through the Piedmont Triad, Research Triangle, and east to Greenville, provides a starting point for a geographic focus to build broader regions for innovation-driven economic growth. The region is diverse in its economic, research, cultural, and social characteristics and provides a test bed for pursuing a new vision for economic development. At the same time, it has potential to be better interconnected.

RTI examined the proposed Corridor in four phases: (1) a quantitative analysis of the region's economic and innovation trends, (2) a qualitative review of regional needs, (3) a market analysis of potential target industries, and (4) development of a Blueprint to improve quality of place, human capital, and industry. The work is not intended to diagnose the challenges of regional economic growth—these have been well documented—but to propose a course of action to use an innovation ecosystem approach to encourage more collaboration across regions and sectors and use targeted industry clusters as a driving force behind a regional vision.

ECONOMIC BACKGROUND

Over the decade after the 2008 recession, growth in the Corridor concentrated in the knowledge-intensive region between Raleigh, Durham, and Chapel Hill, with its research universities and knowledge assets, skilled human capital, and abundance of high-tech industries in and around Research Triangle Park. It has a rapidly emerging entrepreneurial ecosystem and established software and life science companies. At the same time, the furniture, textiles, tobacco, and financial firms that anchored the Piedmont Triad continued long-term job losses, and the eastern part of the state struggled as the footprint of small manufacturers declined.

The Corridor's population is growing quickly and is more educated and more diverse than a decade ago. People commute frequently across regions, but there is no single vision of how to coordinate or connect economic development activity. Each of the hubs of the region has a character defined by its unique history and assets. Winston-Salem and Greensboro have a historic base of manufacturers and headquarters, which are complemented by some of the nation's premiere historically black colleges and universities (HBCUs) and a vibrant arts scene. Economic development leaders in Rocky Mount are rethinking how to position the town as a place that can attract talent and grow with unique new places like Rocky Mount Mills, while addressing long-term challenges of deindustrialization and job loss.

Recently, economic development leadership in each of the hubs is noting a change in attitudes around innovation and entrepreneurship and how they fit into economic development. From Winston-Salem to Greenville, there have been collective efforts to support homegrown opportunities, make entrepreneurship more accessible, and make supportive efforts (networks, capital, services, spaces) more robust and better connected. Economic developers have recognized that innovation and entrepreneurship are critical components of the fabric of economic development and priorities that will support long-term growth in the region.

A BROAD VISION

We envision the Innovation Corridor as a public–private effort to build and strengthen innovation-focused economic growth

and address these challenges, which are unique neither to the Corridor nor to North Carolina. The Blueprint seeks to align existing organizations around strengthening components of an innovation ecosystem: improving human capital, broadband internet, and culture oriented toward growth. This involves

- a new mindset of growth, emphasis on quality of place, public–private partnership for place-based development, and new narratives about the possibilities for transformation;
- collaboration among major research universities, smaller public and private universities, and private-sector actors to bring new research to the market;
- improved access to capital, including for entrepreneurs that fall outside the spaces that are typically funded (business-to-business software, life sciences);
- aligning the vision of public agencies across the different political boundaries of the Corridor and understanding the mutual benefit of working collaboratively.

Although much of the research and development (R&D) and entrepreneurial activity is occurring in the Raleigh–Durham–Chapel Hill area, the region does not lack assets for strengthening the innovation ecosystem across the Corridor, with at least 282 organizations supporting the ecosystem including incubators, accelerators, government agencies, higher education, university research centers, funders, support organizations, and events. These assets are currently in place, but alignment requires a driving force to motivate actors to come to the table.

Our Blueprint proposes an industry cluster-focused approach that is flexible, collaborative, and focused on industry clusters for the future. We believe this is the best way to focus efforts to build a next generation of economic growth in North Carolina, and a prototype for other places to pursue. In this case, the Blueprint focuses on potential clusters that have economic, talent, and innovation assets in the region such as human capital, anchor industries or research institutes, incubators and accelerators, research output, intellectual property, and others, and pairs them with national and global trends. These clusters have applications across the value chain in the region, with the opportunity for early stage R&D, prototyping and development, production, manufacturing, services, and logistics, which will

bring new economic opportunity to diverse places. The following table describes some of these industry clusters:

Industry Title	Definition	Vision	Areas for Action
Agtech	Life science, digital tech, and other tech to improve or disrupt the agricultural sector	Become a global leader in developing, adopting, and integrating high-impact agtech applications, propelling a modern golden age of agriculture in NC	▪ Build on the momentum of the private sector to grow the livestock waste-to-energy subsector ▪ Invest in ag biotech start-ups and scale-ups ▪ Incentivize farmers to adopt technology for improved farm productivity
Biohealth	Pharmaceuticals, medical devices, diagnostics, and other applications of biotechnology, engineering, and health technology	Establish a leading biohealth epicenter in the United States, utilizing all the assets in the ecosystem including universities, hospitals, health centers, private companies, and pharmaceutical manufacturers	▪ Build out a full ecosystem of small-, medium-, and large-scale companies ▪ Expand small-scale manufacturers
Power Electronics for Transportation	Application of high-capacity, wide-bandgap technology for the electric vehicle industry	Position NC as "electric motown" for the next generation of transportation technology	▪ Retain and attract key innovative companies ▪ Invest in skill development ▪ Establish an open silicon carbide foundry
Defense Innovation	Application of new technologies and processes to meet national security needs and enable technical superiority for the U.S. Department of Defense (DOD), with a focus on human performance, data science/artificial intelligence, cybersecurity, and others	As the defense industry is disrupted through innovation initiatives and structural changes, position NC as a place for nontraditional innovation to capture an increased share of DOD spending in emerging areas of R&D, products, and services	▪ Coordinate among defense-related actors in the state ▪ Establish a defense innovation hub with connection to NC bases ▪ Certify companies for cybersecurity

Source: RTI International.

It will be important to combine these efforts to foster industry cluster growth with people- and place-based efforts. We lay out 10 important areas for stakeholders to consider, ranging from enhancing quality K–12 education, cultivating natural open

areas, and incorporating the arts in placemaking efforts. Together, these efforts can help this region and North Carolina better shape narratives about renewed growth and development and make progress toward longer-term economic development and job creation. This Blueprint is a first step. To advance the ideas put forth, the region must identify champions, organizational capacity, and resources to scale for each one. This is no small feat, but we now live under a new sense of urgency to address economic inequality. It is an opportune time to organize and test ideas that set the path for more balanced growth across the region.

1 Introduction and Purpose

1.1 WHY INVEST IN AN INNOVATION CORRIDOR?

Over the past decade, divergence has defined regional economic growth in the United States. While top-performing metro areas have led rapid high-tech job and income growth, the remaining regions have stagnated or seen declines in economic output, jobs, wages, and population. North Carolina is no exception to this phenomenon; while the Raleigh–Durham–Chapel Hill area has thrived as a knowledge economy, and Charlotte has grown as a financial center, much of the remainder of the state has seen stagnant or negative economic growth. This trend is not slowing, and over the next decade, urbanization, technology transformation, automation of manufacturing, growth of knowledge work, shifting racial and age demographics, low-wage service work, and global trade will all play a role in North Carolina's trajectory. Now, because of the effects of coronavirus disease (COVID-19), the divide is wider than ever. Knowledge workers in locations with strong digital infrastructure and internet access can work safely from their homes, leaving front-line workers in food service at risk from job loss or illness.

Nationally, metro areas with prominent and clustered innovation assets and talent are experiencing high shares of economic growth that become self-perpetuating. This trend, defined using terms such as "winner take all," "winner take most," "superstar metro areas," or "knowledge-based affluence," has accelerated with the changing nature of the

post–Great Recession economy, driven by the growth of knowledge sectors including software and bioscience, deindustrialization, shifting demographics, and concentration of highly skilled workers in cities. Academic publications[1] and policy reporting from the Brookings Institution,[2] *The New York Times*,[3] the W. E. Upjohn Institute for Employment Research, and others illustrate this shift, showing how high-tech job growth, patenting, and gross domestic product (GDP) growth are increasingly concentrated in the top innovative cities in the United States.

As ***Figure 1.1*** shows, five metro areas in the United States have gained the largest share of jobs in the innovation sector from 2005 to 2017. They are shown in dark blue and include San Francisco, Seattle, San Jose, Boston, and San Diego. These five metro areas experienced 90% of the growth in the U.S. innovation sector over this 12-year period.[4,5,6] Capturing shares of innovation jobs is important because for every 1 innovation job created, 5 additional jobs in local nontradable, or local support sectors (e.g., education, health, construction, food and beverage), are created.[7] At the same time, traditional manufacturing industries in medium-sized cities have shed jobs and output, leaving large regions of the country without the economic vibrancy they once had.

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[1] Balland, P.-A., Jara-Figueroa, C., Petralia, S. G., Steijn, M. P. A., Rigby, D. L., & Hidalgo, C. A. (2020). Complex economic activities concentrate in large cities. *Nature Human Behaviour, 4*, 248–254. https://doi.org/10.1038/s41562-019-0803-3

[2] Atkinson, R. D., Muro, M., & Whiton, J. (2019). *The case for growth centers: How to spread tech innovation across America*. Brookings Institution. https://www.brookings.edu/research/growth-centers-how-to-spread-tech-innovation-across-america/

[3] Porter, E. (2020, January 27). A $100 million bet that vacationland can be a tech hub, too. *The New York Times*. https://www.nytimes.com/2020/01/27/business/economy/portland-maine-economy.html?searchResultPosition=1

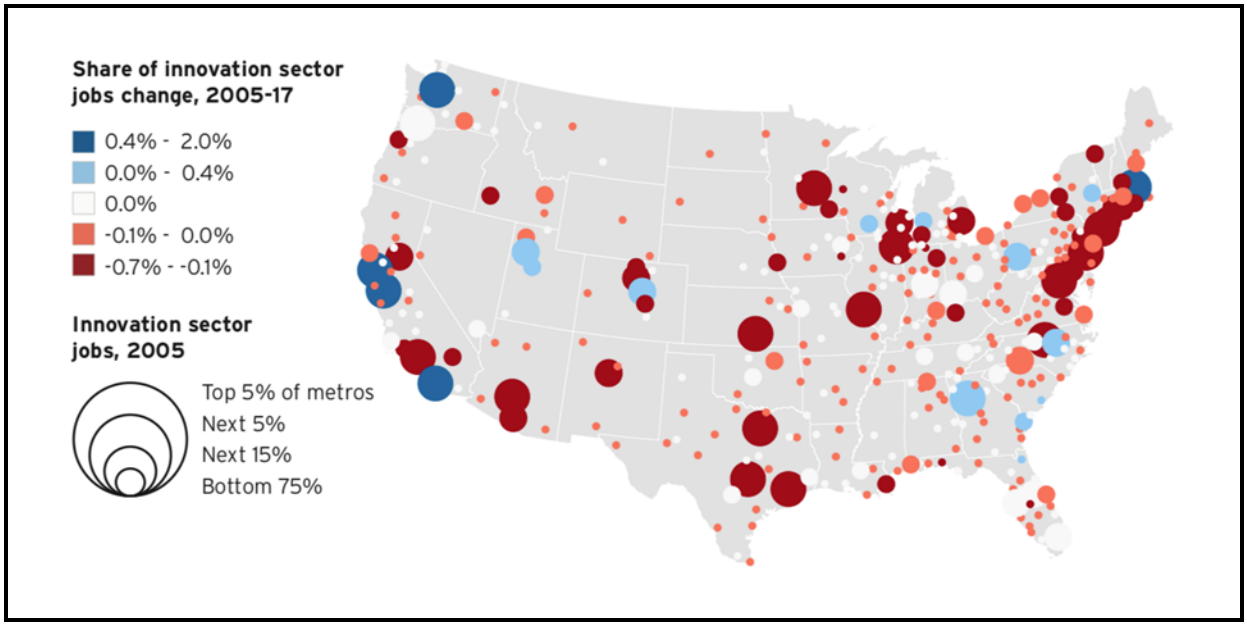
[4] See footnote 2.

[5] The Brookings Institution defines innovation industries as a subset of advanced industries that include the 13 most STEM- and R&D-intensive industry sectors.

[6] Raleigh is ranked seventh in the country, with an increase of 12,238 innovation jobs from 2005 to 2017. Other Corridor metros in the Brookings analysis include Winston-Salem, with an increase of 1,239 innovation jobs; Greensboro, with an increase of 626 innovation jobs; and Durham–Chapel Hill, with a decrease of 5,741 innovation jobs.

[7] Moretti, E. (2012). *The new geography of jobs*. Houghton Mifflin Harcourt.

Figure 1.1. Metros, by Change in Share of Total Innovation Sector Jobs: 2005–2017



Source: Brookings Institution, Information Technology and Innovation Foundation. Analysis of Emsi data.

Compounding this challenge is that workers are less likely to migrate to high-growth areas: Only 3.6% of Americans moved across counties in 2017, compared with 6.1% in 1990.[8] Increasingly restrictive housing costs in fast-growth metros bring challenges of opportunity and of displacement, as low-income residents are pushed out, and those wishing to find work are unable to afford to live in places with high-wage job growth. Research by Raj Chetty[9] of Stanford University shows that North Carolina has some of the cities and counties with the poorest economic mobility in the country. In places like Greensboro and Winston-Salem, the likelihood of a low-income child reaching the top income quartile is less than 5%, nearly half the national figure of 10%.

[8] McKinsey Global Institute. (2019, July). *The future of work in America: People and places, today and tomorrow*. https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Future%20of%20Organizations/The%20future%20of%20work%20in%20America%20People%20and%20places%20today%20and%20tomorrow/MGI-The-Future-of-Work-in-America-Report-July-2019.ashx

[9] Chetty, R. (2015, June 1). *The impacts of neighborhoods on economic opportunity: New evidence and policy lessons*. Presented to Brookings Institution. https://www.brookings.edu/wp-content/uploads/2015/06/Brookings-slides-for-web.pdf

This prompts a call to action to refresh approaches to the practice of regional economic development in a time of deepening regional divisions, and to proactively work towards a more integrated, intentional, regional approach to broad-based economic growth.

Experts have little doubt that this trend will continue and potentially grow more pronounced. In its report on *The Future of Work in America*, McKinsey & Company predicts that over the next decade, the 25 metro areas that led post-recession growth in the United States could capture 60% of the new job growth, whereas the fortunes of rural areas and cities that fall behind are uncertain. Additionally, these trends offer little in terms of addressing challenges of affordable housing and gentrification. High-quality jobs, with living wages, benefits, consistent hours, and potential for growth, require higher education and are increasingly out of reach for people from low-income backgrounds.[10] This leaves a large portion of the workforce with limited options in vulnerable industries such as restaurants, retail, and hospitality, sectors that have proven to be even more vulnerable to issues related to COVID-19.

Despite an abundance of research from national think tanks and thought leaders documenting these growing trends, there is no consensus on how to address these challenges at a local or regional level. Further, there is limited research that documents successful pilot solutions that can be implemented and scaled at local or regional levels to ensure more broad-based development across geographies. We believe this prompts a call to action to refresh approaches to the practice of regional economic development in a time of deepening regional divisions and to proactively work toward a more integrated, intentional, regional approach to broad-based economic growth.

1.2 WHAT IS THE INNOVATION CORRIDOR?

The Innovation Corridor is a concept for regional development focused on better linking a national innovation hub with small to medium-sized cities to generate more broad-based, long-term economic growth.

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Goals of the Innovation Corridor

The goals of the Innovation Corridor are fourfold:

1. Drive and expand growth in globally competitive industries.

[10] Ross, M., Moore, K. A., Murphy, K., Bateman, N., DeMand, A., & Sacks, V. (2018, October). *Pathways to high-quality jobs for young adults*. Brookings Institution. https://www.brookings.edu/research/pathways-to-high-quality-jobs-for-young-adults/

2. Create more job opportunities across a wider geography.
3. Strategically coordinate research university and private-sector innovation assets.
4. Launch North Carolina into the national and global innovation ranks.

Rationale for Corridor Geography

To best create a Blueprint that leverages the dynamics of innovation-driven economies and generates more broad-based growth, RTI International selected a region for study in North Carolina that encompassed the state's research engine—Research Triangle Park (RTP)—and included regions with different economic and industry structures east and west of RTP. It is important to note that this region is hypothetical and was selected as a means to test development strategies that hold potential to broaden economic development opportunity across a wider geographic area around Raleigh–Durham–Chapel Hill. The approach to regional development that we present can be used across multiple regions and in combination with other existing regions. Certainly, there is neither a definitive Innovation Corridor in North Carolina nor is this a proposed region to demarcate where innovation economies can and cannot grow. The study region does, however, provide a starting a point for a geographic focus to build broader regions for innovation-driven economic growth.

The approach to regional development that we present can be used across multiple regions and in combination with other existing regions. Certainly, there is neither a definitive Innovation Corridor in North Carolina nor is this a proposed region to demarcate where innovation economies can and cannot grow. The study region does, however, provide a starting a point for a geographic focus to build broader regions for innovation-driven economic growth.

This geographic study region was selected for three main reasons:

1. Geographic proximity to RTP and surrounding research universities

   The metro areas of study in this Blueprint are roughly within 100 miles of RTP—a geographic central point of the state's primary research and innovation engine. This Blueprint emphasizes reviving and broadening the benefits of an existing and highly successful innovation hub around the RTP area across a wider geography.

2. Substate focus using combined statistical areas (CSAs)

   The study region is at a substate level to allow for more in-depth research focused on target industry clusters and innovation assets at a smaller geographic scale, yet it is a geography broad enough to bring a mix of industry structures and innovation assets to bear. We selected a study region of four CSAs to capture commuting sheds around major metropolitan and

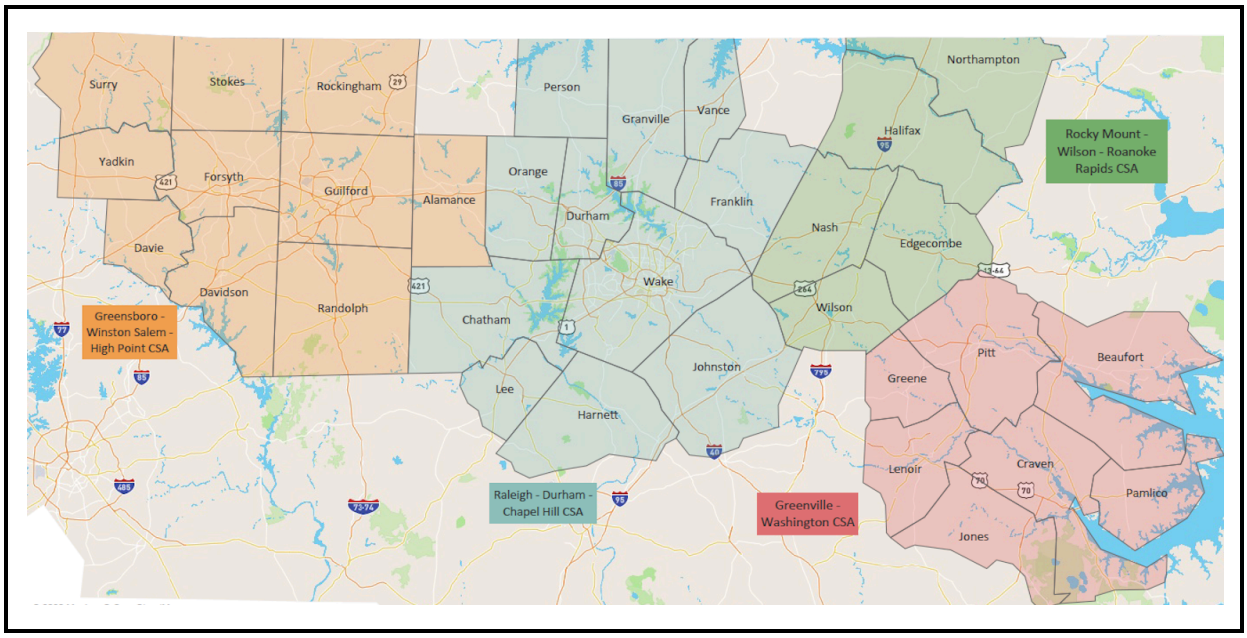
micropolitan areas in the approximate 100-mile proximity of RTP. We chose this approach to capture the diversity and mobility of people and industry in the region.[11]

3. Diversity

   The study region is diverse in its economic, research, cultural, and social characteristics. Selecting a region with highly distinguishable and different features provides a much stronger "test bed" for pursuing economic development approaches relevant to a variety of regional contexts.

For these three reasons, the Innovation Corridor is a continuous geographic region including the CSAs of Greensboro–Winston-Salem–High Point, Raleigh–Durham–Chapel Hill, Rocky Mount–Wilson–Roanoke Rapids, and Greenville–Washington (***Figure 1.2***). The Innovation Corridor approach focuses on ways to strengthen and connect areas with a critical mass (or potential for a critical mass) of people, business, or knowledge institutions for economic development.

Figure 1.2. Innovation Corridor Combined Statistical Areas (CSAs)



Source: U.S. Census Bureau, Office of Management and Budget. CSAs, 2015 definition.

[11] CSAs, as defined by the U.S. Office of Management and Budget, capture wide commuting sheds around major metropolitan and micropolitan areas.

There are other excellent viable approaches for creating regional innovation strategies. For example, a study by the Office of Science, Technology & Innovation in the North Carolina Department of Commerce has identified eight locales that are research intensive and have the most economic leverage to achieve statewide economic gains in innovation.[12] In that study, cities such as Charlotte, Wilmington, and Asheville are included as additional locations prime for fostering more statewide growth. Brookings and the Information Technology and Innovation Foundation offer clear criteria for policy makers to consider when determining new innovation hubs in which to invest across the country, including traits such as strong pre-K–16 science, technology, engineering, and mathematics (STEM) worker supply chains; population centers of more than 500,000 people; high levels of university research and development (R&D) spending; and demonstrated commitments for high regional collaboration.[13]

1.3 STUDY ORIGINS

The Innovation Corridor concept originated with a group of business leaders in North Carolina called the Executive Leadership Group (ELG). Under the management of The Results Company, the ELG devised a concept for a public–private initiative to generate greater economic development by harnessing higher productivity in research discoveries, product creation, and company formation across a region surrounding RTP. This effort was envisioned to attract and stimulate innovative minds across a wider geography to ultimately become a key growth center for knowledge-based jobs. Thus, the concept of a "Knowledge Corridor" was created.

RTI's research builds on the Knowledge Corridor concept to more broadly embrace the regional innovation ecosystem, industry cluster growth, and place-based development strategies. As a result, the research evolved to include more

[12] Office of Science, Technology & Innovation. (2019). *Tracking Innovation: North Carolina innovation index* (page iii). North Carolina Department of Commerce. https://files.nc.gov/nccommerce/documents/files/Tracking_Innovation_NC_Innovation_Index_2019.pdf

[13] See pages 60–61. We did not fully consider the Brookings and ITIF criteria because this Blueprint focuses on regional development approaches for an *existing but expanded* innovation hub, not a new hub.

aspects relevant to innovation, expanding the focus from knowledge institutions. The research of this Blueprint also evolved from the Knowledge Corridor concept by laying out ideas for a wide range of stakeholders to consider including champions in the business, government, higher-education, and non-profit community.

1.4 STUDY APPROACH

This approach is designed in a way that can be replicated, adapted, or scaled across different types of geographies. The Innovation Corridor, and the approach to inform it, can also be a test bed for approaches that seek to cultivate a shared vision that encompasses bolstering local assets, strengthening emerging competitive industries, accentuating quality of place, and linking people to economic opportunity.

The Innovation Corridor study includes four phases of research to foster idea development for transformative growth in North Carolina over the next few decades.

- **Phase 1**: *Innovation and Economic Analysis*. RTI completed an in-depth data analysis of the current state and recent performance of the state economy and Innovation Corridor economies. Analyzing 13 data sources and 56 indicators, RTI developed economic and innovation profiles for the Corridor and the four economic hubs: Greensboro–Winston-Salem–High Point, Raleigh–Durham–Chapel Hill, Rocky Mount–Wilson–Roanoke Rapids, and Greenville–Washington. See ***Appendix B*** for a detailed look at these profiles.
- **Phase 2**: *Qualitative Review of Regional Needs.* RTI conducted exploratory interviews with 23 regional and statewide stakeholders to ground Phase 1 findings, identify emerging and cross-cutting innovation trends, and refine the research outcomes. Section 2 outlines the findings from Phases 1 and 2.
- **Phase 3**: *Targeted Industry and Market Analysis.* RTI explored clusters with high potential for innovation-driven growth, local assets, and economic opportunity. The team analyzed the market size potential and capabilities required for growth of 4 industry sectors and interviewed 34 industry leaders in the area. The clusters include agtech, biohealth, power electronics for transportation, and defense innovation. See ***Appendix C*** for a detailed look at each cluster.

Across the phases of research, RTI conducted 89 interviews across the Corridor, gaining perspectives from multiple economic development professionals, entrepreneurs, innovation and higher-education leaders, and business and industry leaders.

- Across the phases of research, RTI conducted 89 interviews across the Corridor, gaining perspectives from multiple economic development professionals, entrepreneurs, innovation and higher-education leaders, and business and industry leaders.
- **Phase 4**: *Blueprint Development.* RTI conducted an additional 32 targeted interviews with community, university, entrepreneurship, innovation, and economic development–related stakeholders in each economic hub. The team gleaned insights on requirements to enhance quality of place to attract business and talent and support for innovation-driven economic development strategies. See Sections 3 and 4 for the Innovation Corridor Blueprint.

Across the phases of research, RTI conducted 89 interviews across the Corridor, gaining perspectives from multiple economic development professionals, entrepreneurs, innovation and higher-education leaders, and business and industry leaders. See ***Appendix A*** for the full list of people interviewed.

1.5 GUIDING PRINCIPLES

Through these phases of research, RTI sought to understand how an Innovation Corridor Blueprint could add to the economic development landscape and ways in which RTI's technical expertise in innovation and economic development could be best leveraged to benefit the region today. Several factors led to the end result of this Blueprint:

- Recent national-level research has done an excellent job of describing the problem of uneven growth, its underlying factors, and implications of this kind of growth if left unattended. However, this macro-level research neither presents ideas at the state, regional, and local levels, nor does it include examples of how places are testing ideas to refocus economic development for more broad-based, innovation-driven growth. Thus, the Blueprint aims to create an approach that can be tested, replicated, and scaled to any geography with a critical mass of innovation assets, people, and business and industry ripe for economic growth by adopting new ideas, technologies, and approaches.

This Blueprint is designed to highlight how innovation ecosystem approaches to economic development can be used across wider regions for long-term economic development.

- Economic development is a wide-ranging practice, touching on closely related fields such as workforce development, health and human services, and city and regional planning. Further, in economic development, practitioners concentrate on similarly sweeping areas such as rural development, entrepreneurship, and business recruitment and retention. RTI recognizes that there are many ways to foster and promote economic development and many closely adjacent practice areas that are critical to consider. This Blueprint is designed to highlight how *innovation ecosystem* approaches to economic development can be used across wider regions for long-term economic development. This Blueprint is tailored to the development of "hubs" in the Corridor that have, or could have, a critical mass in people and innovation assets. The ideas presented in this Blueprint are meant be considered *in conjunction with* other development efforts.
- The regions and localities across North Carolina command a portfolio of economic development activities and investments used across the state to help grow, attract, and retain business and industry. Various institutions, including the Economic Development Partnership of North Carolina; the North Carolina Department of Commerce; and local city, county, and regional economic development programs, form a wide-ranging array of initiatives. Moreover, a growing number of organizations are supporting entrepreneurs, start-ups, and talent and workforce development in the state, ranging from NC IDEA (https://ncidea.org) to myFutureNC. Our interviews revealed that a missing link in regional economic development **is a unified vison for economic development with ways to encourage more collaboration across sectors[14] and political boundaries in order to scale existing efforts**. Stakeholders are wary of creating new organizations that duplicate existing efforts. Therefore, the Blueprint focuses on setting a vision and seeding ideas for a range of organizations, emphasizing a single focus rather than a new organization or institution.
- We recognize that the organizations and people engaged in economic development every day are in a strong position to offer specific recommendations to decision makers in policy and practice. Thus, this Blueprint is *not*

[14] In this report, *sectors* refers to broad economic activities such as health care or manufacturing, whereas *industries* refers to specific classifications, such as dental offices or paper product manufacturing.

intended as a conclusive document or strategic plan with definitive solutions or recommendations. Instead, it is a pre-planning effort to **set out regional cross-cutting ideas for building stronger ecosystems for growth** that individual entities may not have time or resources to consider given the daily and weekly commitments of their organization.

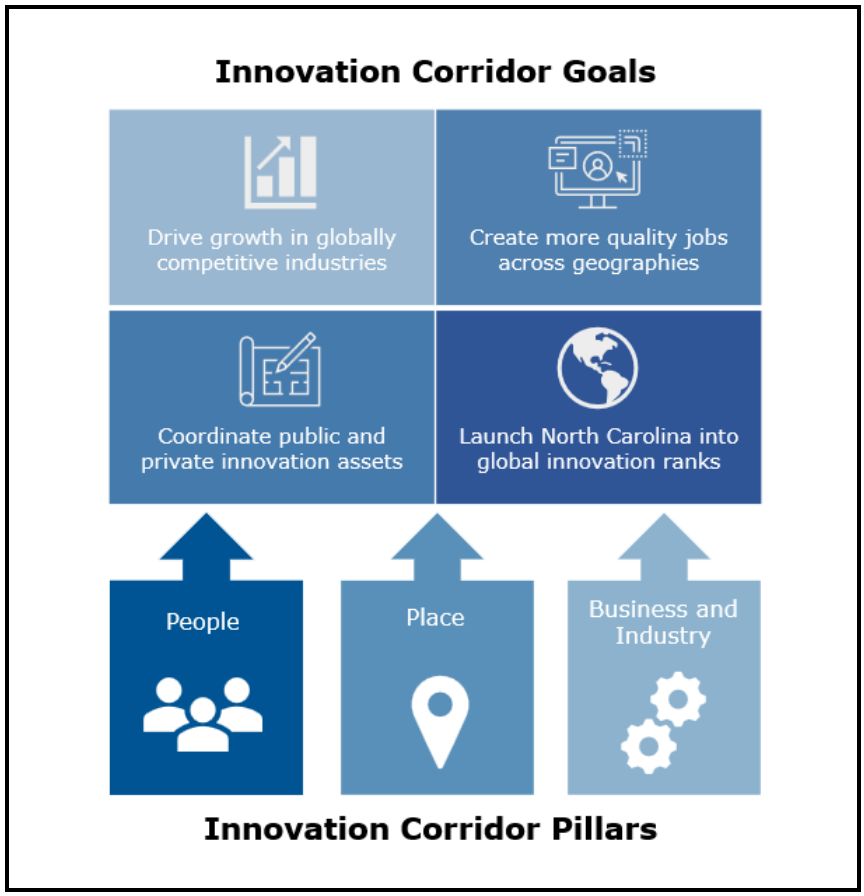
- In RTI's experience working on strategic plans and economic development evaluations across the United States and in other countries, we observe that stakeholders in places with broader and more diverse geographies tend to collaborate more readily and advance development strategies more effectively if they incorporate an industry cluster focus. Thus, the Blueprint **includes target industry clusters as a central point for creating a regional vision for innovation-driven growth**. These industries are not meant to be definitive but are intended to demonstrate the kinds of potential cross-cutting clusters to focus on that can ignite more broad-based transformative growth.

With these principles in mind, the Blueprint is structured on three pillars as the foundation for growth in an innovation Corridor: people, place, and industry.

- **People**: talent that contributes to the workforce and to value creation through innovation and entrepreneurship. Networks and organizations foster an individual's access to participate in the innovation economy.
- **Place**: place-based characteristics, culture, and infrastructure that attract talent and business, and support inclusive innovation ecosystem development.
- **Industry**: businesses that grow, expand, and thrive in globally competitive industries, creating jobs and accessing local supply chains.

Figure 1.3 illustrates the pillars that support an innovation Corridor and how building these pillars leads to reaching the Corridor's overall development goals.

Figure 1.3. Goals and Pillars for the Innovation Corridor



Source: RTI International.

The Blueprint is structured as follows: Section 2 describes the current status of the Innovation Corridor using publicly available data of social, economic, and innovation-related measures. Section 3 describes the building blocks for the Innovation Corridor using an innovation ecosystem lens. We incorporate a high-level review of each building block based on research and interviews. Finally, Section 4 is the Blueprint that provides starting points for industry sectors that show promise for future sustained growth across a wider economic geography. We also offer 10 ways to begin to focus investments in people and places important to the Corridor's development.

1.6 ABOUT RTI INTERNATIONAL

RTI International is an independent, nonprofit research institute dedicated to improving the human condition. Our staff provide research, development, and technical services to government and commercial clients worldwide. RTI was founded as the anchor institute of RTP, a transformative investment that leveraged the knowledge assets and set the course for economic development in the state in the second half of the 20th century. As the anchor institute of RTP, recently celebrating our 60th anniversary, RTI's Executive Leadership requested a study by RTI's economic development and innovation practice to explore ideas for innovation-driven, transformative, and broad-based economic growth that could guide the upcoming decades of economic transformation in North Carolina.

2 Current Status of the Innovation Corridor

The Innovation Corridor represents, on a regional scale, many of the statewide and national trends of innovation-based economic growth, along with the challenges of deindustrialization, rural disinvestment, and inequality of opportunity.

North Carolina's slow recovery from the Great Recession of 2008 followed the long-term decline of the textile, furniture, and tobacco industries in the late 20th century. Urban centers grew as hubs of knowledge and high-tech services, while the economies of medium-sized and rural areas stagnated as automation and outsourcing of basic manufacturing, demographic shifts, foreign trade, and low-wage service work displaced traditional industries. In the decade after the Great Recession, North Carolina's economy grew more slowly than the nation's, despite above-average population growth. The state moved from 10th to 9th nationally in population, driven by high rates of in-migration to major metro areas, but the state's GDP dropped from 9th to 11th nationally.[15]

The proposed Innovation Corridor (shown in ***Figure 1.2***), spanning from Winston-Salem through the Piedmont Triad, the Research Triangle (Raleigh–Durham–Chapel Hill), and east to Greenville, is a diverse economic region with nearly 4.4 million residents and $218 billion in economic output. It contains many of North Carolina's most important knowledge economy assets

[15] This data point suggests multiple policy questions worth exploration, including these: Has North Carolina's per-person productivity level decreased? Are in-migrants to metro areas working disproportionately in low-productivity jobs? Is North Carolina home to low-productivity jobs, does the state not have enough highly skilled workers, or both?

The proposed Innovation Corridor is a diverse economic region with nearly 4.4 million residents and $218 billion in economic output. It contains many of North Carolina's most important knowledge economy assets including R1 research universities, historically black colleges and universities (HBCUs), nationally recognized medical schools and health centers, 49 institutions of higher education including community colleges, incubators and accelerators, research facilities, and advanced manufacturing sites.

including R1 research universities,[16] historically black colleges and universities (HBCUs), nationally recognized medical schools and health centers, 49 institutions of higher education including community colleges, incubators and accelerators, research facilities, and advanced manufacturing sites. The Innovation Corridor represents, on a regional scale, many of the statewide and national trends of innovation-based economic growth, along with the challenges of deindustrialization, rural disinvestment, and inequality of opportunity. Unlike other metros such as Atlanta, Charlotte, or Chicago, it does not have a single center; economic activity and population are distributed across a multicentric region.

The Corridor's economic past and present tell a story of people, place, and industry. Its people form the base of human capital for industries of the future, its places attract and foster new activity, and its business and industry generate the economic output. All three pillars are mutually reinforcing, and their success depends on cross-cutting economic development policy and practice.

We describe the status of the Innovation Corridor in terms of its people, places, and business and industry to provide a foundation for building a vision and Blueprint for its future. ***Appendix B***, a standalone data report, contains a detailed social, economic, and innovation analysis.

2.1 PEOPLE

The Innovation Corridor's population is growing quickly and is becoming more diverse: The population has grown by 10% since 2010 with a high level of in-migration from U.S. rural and nonmetropolitan areas and from large cities including New York and the District of Columbia, as well as international migration. The Corridor is growing across all age cohorts, and its population is increasingly older because of demographic shifts and increasing life expectancy: In 2018, 15% of the population was older than 65, up from 12% in 2010. People's economic well-being, by some measures, is moving in a positive direction since the 2008 recession: 43% of Corridor residents had a

[16] R1 universities are classified as having very high research activity by the Carnegie Classification of Institutions of Higher Education (https://carnegieclassifications.iu.edu/classification_descriptions/basic.php).

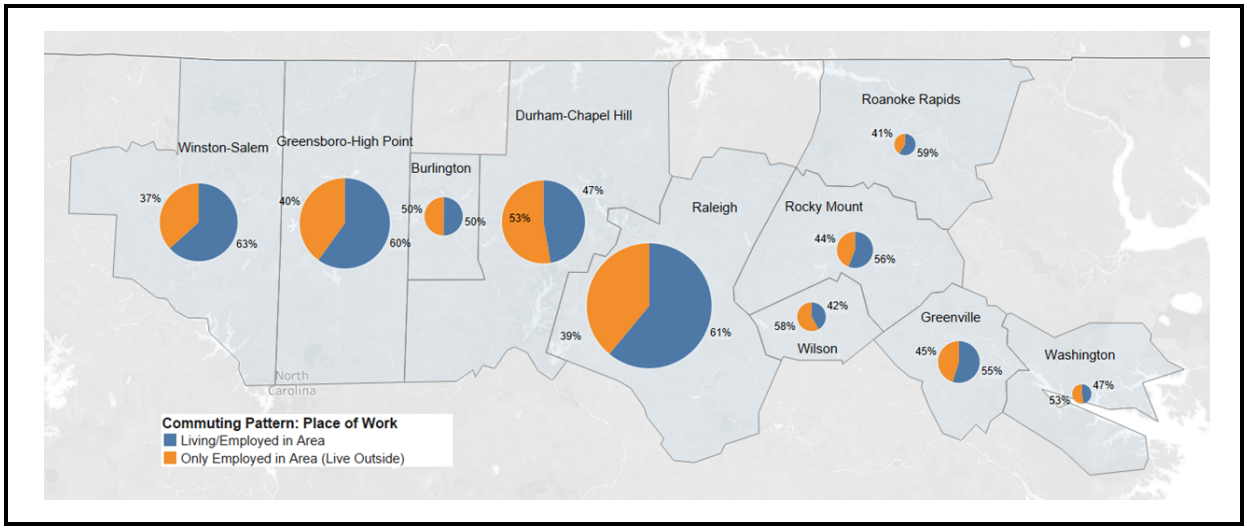
postsecondary degree (associate's or higher) in 2018, a jump from 38% in 2010. Unemployment dropped from 10% in 2010 to below 4% at the end of 2019.[17] Opportunities have still been uneven:

- The region is increasingly urban: 2.2 million people live in the Raleigh–Durham–Chapel Hill metro areas, which saw a 19% increase in jobs over the decade after the recession.
- Poverty is declining but uneven: The poverty rate stood at 15% in 2018, with a distinct divide across metro areas. While the Raleigh–Durham–Chapel Hill metros had a 12% poverty rate, Greenville had a 25% poverty rate.
- Median household income across much of the Corridor is below the U.S. median household income. The median household income in Rocky Mount was slightly above $41,000 in 2018, compared with a national average of $63,000. Raleigh–Durham–Chapel Hill had the highest median household income at $65,000.

As measured by commuting patterns, the region's residents are highly mobile. In 2017, over 700,000 people (42% of primary jobs) in the Corridor lived in a different metro area than their place of work, as seen in ***Figure 2.1***. People are highly likely to live and work in different places, and there is no single center where people move: Although Raleigh is the largest recipient of inbound commuters, large numbers still commute to Durham–Chapel Hill, Greensboro, and Winston-Salem. This shows that people commute to multiple places for work and find housing in a mix of urban, suburban, and rural places.

[17] These data are from 2019 and do not capture the spike in unemployment claims in March 2020 as a result of the COVID-19 outbreak.

Figure 2.1. Commuting Patterns: Inflow of Workers Commuting to Their Primary Job: 2017

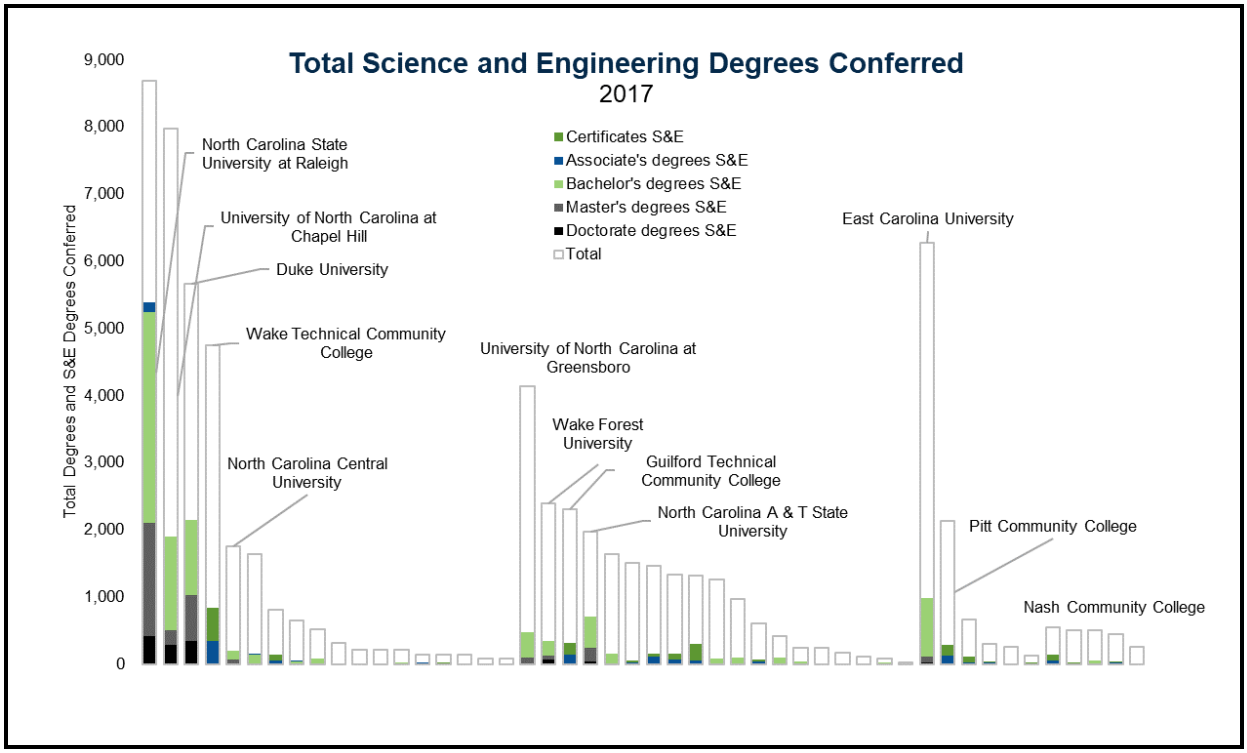


Source: U.S. Census Bureau, OnTheMap.

The region has not been immune to the economic divergence that has occurred on a statewide and national scale. Compared with the pre-recession peak in jobs in 2008, Raleigh–Durham–Chapel Hill saw a net gain of over 130,000 jobs and is home to over half of the jobs in the Corridor. The remaining regions have not recovered from pre-recession job numbers, with a net loss of 5,600 jobs over the same period, with the largest losses in the Rocky Mount area.

The Corridor's economic trajectory is closely tied to the base of human capital that drives a knowledge economy. STEM jobs make up 6.2% of jobs in North Carolina but are concentrated in the Raleigh–Durham–Chapel Hill area, with 72% of the STEM workers in the Corridor. The talent pipeline reflects that: Academic institutions across the Corridor are producing large numbers of graduates, but 70% of science and engineering degrees came from institutions based in Raleigh–Durham–Chapel Hill: North Carolina State University (NCSU), the University of North Carolina at Chapel Hill (UNC-CH), Duke University, and Wake Technical Community College contributed to a strong tech workforce in the region. ***Figure 2.2*** outlines the total degrees conferred and science and engineering degrees, by institution.

Figure 2.2. Science and Engineering Degrees Conferred: 2017



Source: U.S. Department of Education, Integrated Postsecondary Education Data System.

The region struggles with low levels of economic mobility, with sharp regional and racial divides in access to high-paying jobs. Children's access to economic opportunity in the region is highly dependent on their location and parents' income level. In research published by Chetty and Hendren in 2015, Forsyth County was one of the lowest-performing counties in the United States, as measured by economic mobility for children born into a family in the bottom income quartile.[18] As seen in Section 2.3, much of the growth in jobs in the eastern part of the Corridor has been in low-wage industries, including restaurants, hospitality, and retail, while manufacturing has declined. Over the same period, high-wage tech industries that require advanced education have concentrated in the Raleigh–Durham–Chapel Hill area.

2.2 PLACE

People across the Corridor are highly mobile, but each place has unique economic history and economic development

[18] See footnote 9.

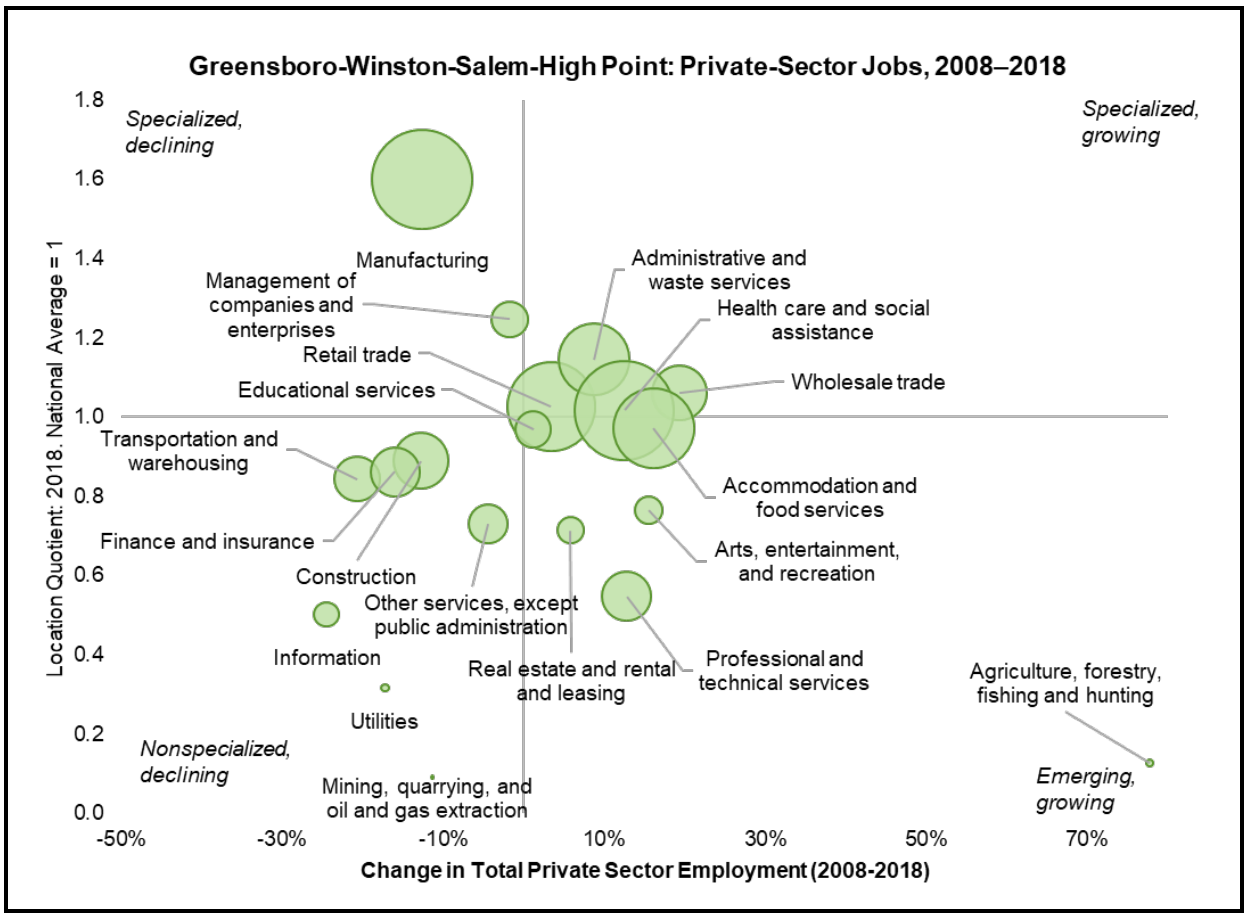
potential. Four of the metro areas in the Corridor (Greensboro–Winston-Salem–High Point, Raleigh–Durham–Chapel Hill, Rocky Mount–Wilson–Roanoke Rapids, and Greenville–Washington) illustrate those differences. In this section, we review each hub's industry structure and provide a brief economic history. In Section 3, we highlight additional characteristics of each place that further draws out each hub's sense of identity. By understanding the uniqueness of the economic structure of each hub in the Corridor and its social, cultural, and other local assets, we can better identify strategies for future growth.

Greensboro and Winston-Salem

The state's traditional economic hub, better known as the Piedmont Triad, was historically home to headquarters and major manufacturing facilities in tobacco, textiles, and furniture, along with headquarters of major banks and large corporations. Since the 1990s, the economic fortune of the Piedmont Triad has been marked by decline and departures of manufacturing facilities, tobacco companies, and headquarters. In Winston-Salem, at least 14 major companies have left the city over the past 2 decades, including Reynolds American, BB&T, and Targacept. Local stakeholders noted that HanesBrands is the last remaining of the region's historic corporate headquarters. Greensboro has recruited or retained some advanced manufacturers in aerospace (HondaJet) and transportation (Volvo Group) but no longer has the large base of textile producers it had in the 20th century.

After the Great Recession, the Piedmont Triad saw a decline in its historic strengths including manufacturing, logistics, and finance. As seen in ***Figure 2.3***, manufacturing remains a large and concentrated sector but has been in decline. Service sectors have been growing, but the majority have been in low-wage retail and hospitality jobs. High-wage professional service and health care jobs are growing, but the region's traditional finance sector has declined at the same time.

Figure 2.3. Sector Growth and Concentration in Greensboro–Winston-Salem–High Point Metro Areas: 2008–2018



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

The Piedmont Triad's economic decline did not begin with the recession but followed a long-term shift in tobacco, textiles, and furniture manufacturing that dated back to the 1990s. Local stakeholders pointed out that other efforts in economic development over the same time did little to stem the outflow of jobs, and recruitment efforts were mixed. However, stakeholders pointed to a recent shift in mindset with local and regional leaders focused on how to remake the region's economy based on its assets today instead of trying to revive the its historical base. There is a heightened focus, for example, on building out clusters in aviation, aerospace, and automotive industries, in addition to growing new resilient companies in areas such as life science, tech, and creative industries.

Winston-Salem and Greensboro boast major HBCUs, an active arts and maker community, and emerging efforts to grow and attract future growth businesses. Winston-Salem's Wake Forest Innovation Quarter and emerging start-up ecosystem are aligning toward new growth in life sciences.[19] Many in the area cite tech-oriented companies like Inmar and Qorvo as examples of the new kinds of industry important for the Piedmont Triad. LaunchUNCG in Greensboro serves entrepreneurs across the campus, and the University of Chapel Hill at Greensboro (UNC-G) and North Carolina Agricultural and Technical State University (NC A&T) are serving as the National Science Foundation's I-Corps sites seeding stronger commercialization pathways for innovators in the region. Several growing entrepreneurial support organizations across the Piedmont Triad are focused on cultivating the innovation pipeline potential from mid- to later-career professionals and graduates of higher-education institutions in Winston-Salem and Greensboro.

Winston-Salem is transforming downtown spaces, generating a walkable community, and better leveraging innovation assets of Wake Forest University and the Innovation Quarter. Greensboro's many colleges and universities and strong aviation and transportation manufacturing clusters provide a base to grow industry clusters and foster entrepreneurship. This hub also has created an environment for healthy collaboration among organizations in both places and a strong culture and appreciation for the arts. Geographically at the midpoint between Charlotte and the Research Triangle, the region is positioning itself as a new location to attract innovators and entrepreneurs from those places. Together these traits are fostering an emerging culture of growth and revitalization, and emergence of the next generation of economic growth through entrepreneurship and innovation.

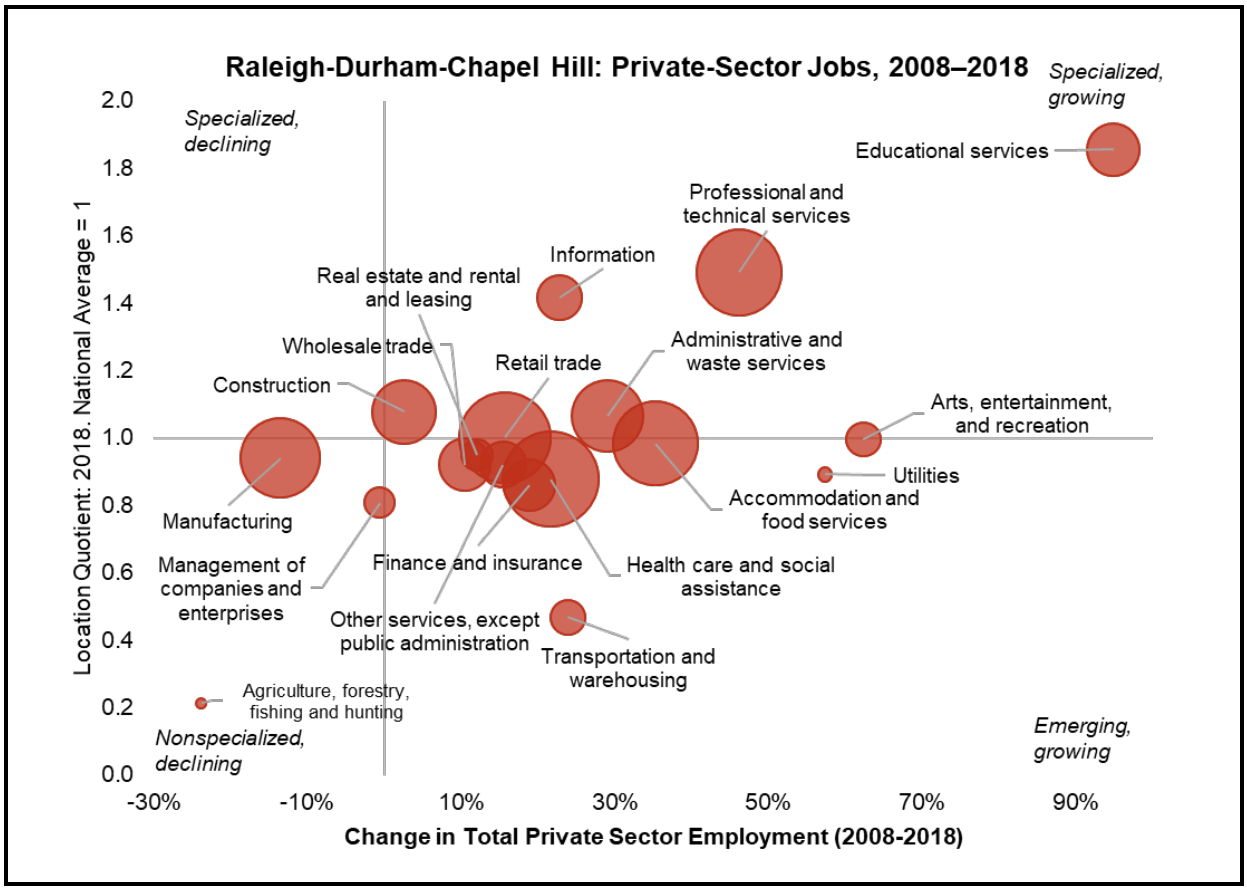
Raleigh and Durham

Raleigh, Durham, and the surrounding region (including Cary, Morrisville, Chapel Hill, and their expanding suburbs) have the state's highest concentration of knowledge workers, predominant research universities, and major technology and

[19] Porter, E. (2019, July 16). Why midsize cities struggle to catch up with superstar cities. *The New York Times*. https://www.nytimes.com/2019/07/16/business/economy/winston-salem-convergence.html

life science companies, contributing to a fast-growing knowledge economy. As seen in ***Figure 2.4***, professional and technical services and private educational services are the fastest-growing specialized sectors, with a large health care and fast-growing information sector.

Figure 2.4. Sector Growth and Concentration in Raleigh–Durham–Chapel Hill Metro Areas: 2008–2018



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

Since 2008, private-sector jobs have grown by 19%, led by growth of high-tech service jobs. The region's three major research universities, in addition to other colleges and universities, generate human capital, intellectual property (IP), and research resources that attract investment from out of state and support emerging start-ups in software, gene therapy, analytics, and other high-tech fields. The region attracts a high level of in-migration from other parts of the country and the world, with a high concentration of workers with advanced education. It has strong infrastructure whose

fundamentals include a major airport; high-speed internet; and high-performing schools, community colleges, and universities.

The innovation activity in the region is partially a product of RTP's 60 years of attracting and retaining large-scale, R&D-intensive companies with large facilities and vertically integrated operations. However, as the innovation landscape has shifted, the economic makeup of the region is shifting. Alongside the corporate innovation activity in the Research Triangle, entrepreneurial support organizations are also piloting ways to foster innovation in small businesses, increase the accessibility of entrepreneurship opportunities to women and people of color, and lower talent silos. Interviewees spoke about the importance of diverging from practices of "protective" R&D efforts internal to companies and research institutes and instead creating opportunities for more cross-pollination of ideas and transfer of people among entities as important to strengthening the local innovation ecosystem.

Renewed efforts in the past 10–20 years to foster dynamic downtowns have paid off, especially in Raleigh and Durham. Although much of the region once seemed "sleepy" and was characterized by suburban lifestyles that lacked a sense of place and local identity, local leaders talk about new excitement around downtowns, festivals, events, and a new sense of identity in the Raleigh–Durham–Chapel Hill region. Efforts to boost physical places such as the American Tobacco Historic District in Durham and Fayetteville Street Mall in Raleigh have paid off with more restaurants, festivals, and events that result in a stronger and more vibrant shared culture. With Hub RTP under way at the heart of RTP's campus and Innovate Carolina's efforts to physically build out innovative spaces, such as 1789 in downtown Chapel Hill, this region is significantly expanding the presence of local entrepreneurship, innovation, arts, and culture in each of the city's and town's downtowns.

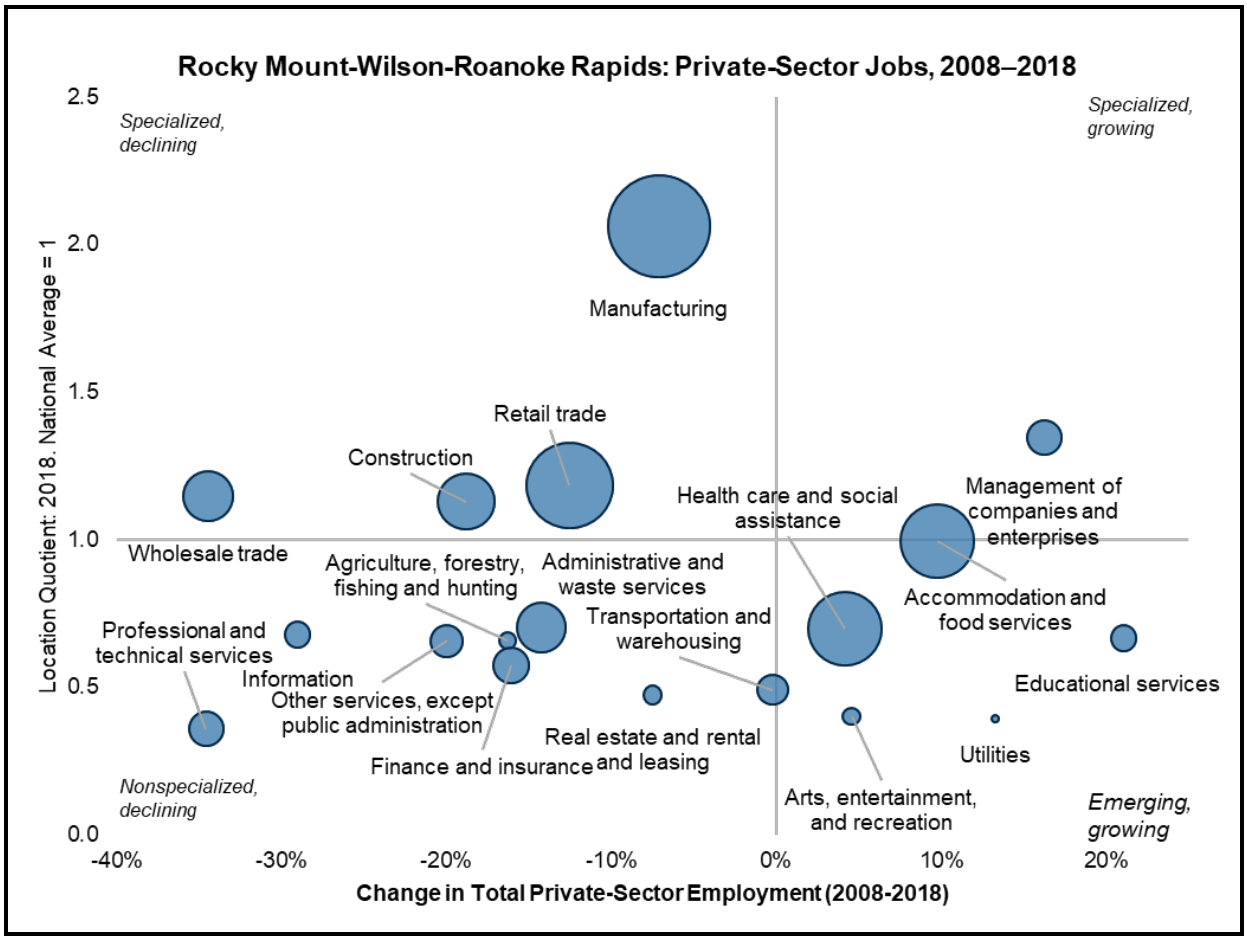
Rocky Mount

Rocky Mount is unlike the other three hubs along the Innovation Corridor in that it does not have a major research or medical university. However, Rocky Mount is home to pharmaceutical manufacturing companies and is in close proximity to Raleigh. Rocky Mount and the surrounding region are also representative of some of North Carolina's medium-sized towns that have been in decline and are seeking to

reinvent themselves as quality places to live and work. For these reasons, Rocky Mount is important to include in the Innovation Corridor.

The city was a textile and tobacco hub that slowly declined over several decades. Manufacturing remains the largest and most concentrated sector, but it has declined since 2008, along with sectors in its supply chain including wholesale trade, logistics, construction, and professional and technical services (see ***Figure 2.5***). Rocky Mount retains much of the manufacturing infrastructure including intermodal rail, highway, and utilities. Management of companies, accommodation, and educational services are small sectors by comparison to manufacturing, yet they have been growing since 2008.

Figure 2.5. Sector Growth and Concentration in Rocky Mount–Wilson–Roanoke Rapids Metro Areas: 2008–2018



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

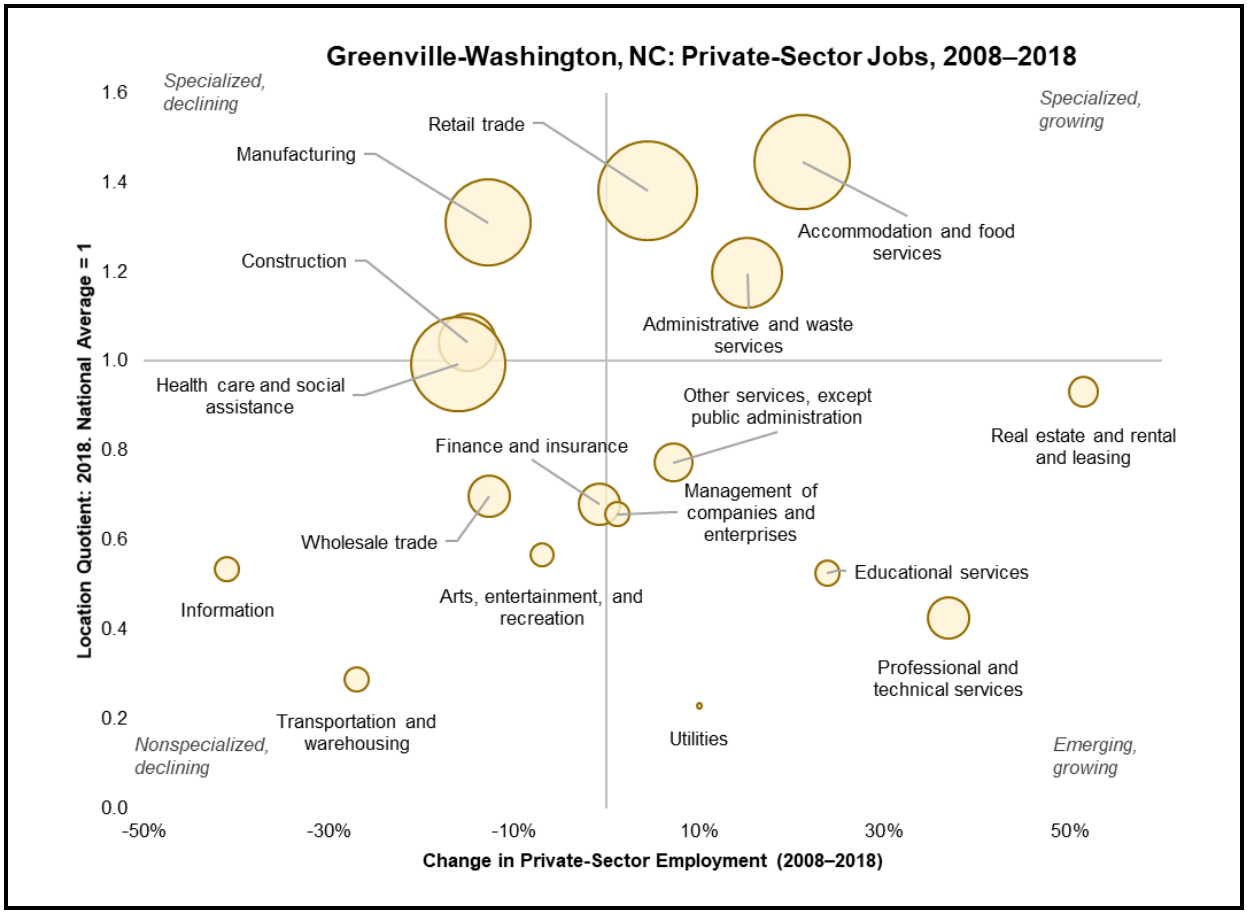
Long-term decline has sparked economic developers into action, promoting a fresh positioning of the region as a place to access many of the assets of neighboring Raleigh with a lower cost, more attractive quality of life, and ease of doing business. Rocky Mount and neighboring Wilson and Roanoke Rapids are showing signs of new investment, including Rocky Mount Mills, a growing biomanufacturing sector, and new activity in health care and agtech. Similar to other areas of the Corridor, Rocky Mount has experienced a growing demand for spaces to co-work and gather informally as well as an increase in the main street business community. Despite the economic declines experienced, stakeholders describe a local shift in the area's entrepreneurial culture and increased attempts to collectively support local entrepreneurship and business growth.

Rocky Mount is also proving itself to be a desired location for companies—small and large—that desire access to Raleigh and its workforce but do not want to locate in Raleigh's city limits. Major manufacturers include Pfizer and Cummins. Some interviewees noted that it is faster to commute between Raleigh and Rocky Mount than between Raleigh and Durham. With the new real estate development of Rocky Mount Mills, an emerging number of breweries and a brewery incubator, the Rocky Mount Event Center, and a reawakening of local main street businesses, Rocky Mount is positioned to offer the charm and quality of life of a southern town with job opportunities in areas such as advanced manufacturing and small businesses.

Greenville

Greenville is a prominent city in eastern North Carolina, home to East Carolina University (ECU) and an emerging health sciences and health care industry. It has the smallest economy of the four places with 65,000 private-sector jobs. The largest growth has been in low-wage service jobs including accommodation, food services, and retail. Manufacturing continues to be concentrated but is declining, with several pharmaceutical manufacturers in the region (see ***Figure 2.6***).

Figure 2.6. Sector Growth and Concentration in Greenville Metro Area: 2008–2018

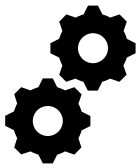


Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

Greenville is a unique city in eastern North Carolina because it is anchored by ECU and Vidant Medical Center, the teaching hospital for the Brody School of Medicine. ECU also established the Miller School of Entrepreneurship in 2015 and has grown multidisciplinary entrepreneurship opportunities on and off campus. These assets and activities are part of several broader efforts to increase university–industry collaborations, workforce development, and downtown revitalization. Downtown Greenville is under its own transformation with renovated buildings and a growing number of businesses and university offices in the city center. The city's business community is also a force for driving community and economic development. Greenville is unique in the shared enthusiasm and commitment for a resilient economy and strong sense of place that is marked by ECU's tremendous presence. It is striking, for example, that ECU's Miller School of Entrepreneurship is the

result of a one-time donation from a successful entrepreneur, and it is the only university in the state with a school for entrepreneurship in its business school. With time and the right cultivation, the efforts of this school alone could help seed growth in emerging innovation industries for the area. Greenville's growth and the high poverty rates in the rest of Pitt County continue to offer a sharp contrast between the potential of each of these hubs and their more rural surroundings. This dynamic exists across the Corridor and was noted in Winston-Salem, Greensboro, Raleigh, Durham, and Rocky Mount.

Even though each hub of the Innovation Corridor is notably distinct with its presence of innovation assets, economic structure, and potential for growth, each area also provides a template that business, economic development, and other leaders can follow to set a new vision to realize longer-term sustained growth.



2.3 BUSINESS AND INDUSTRY

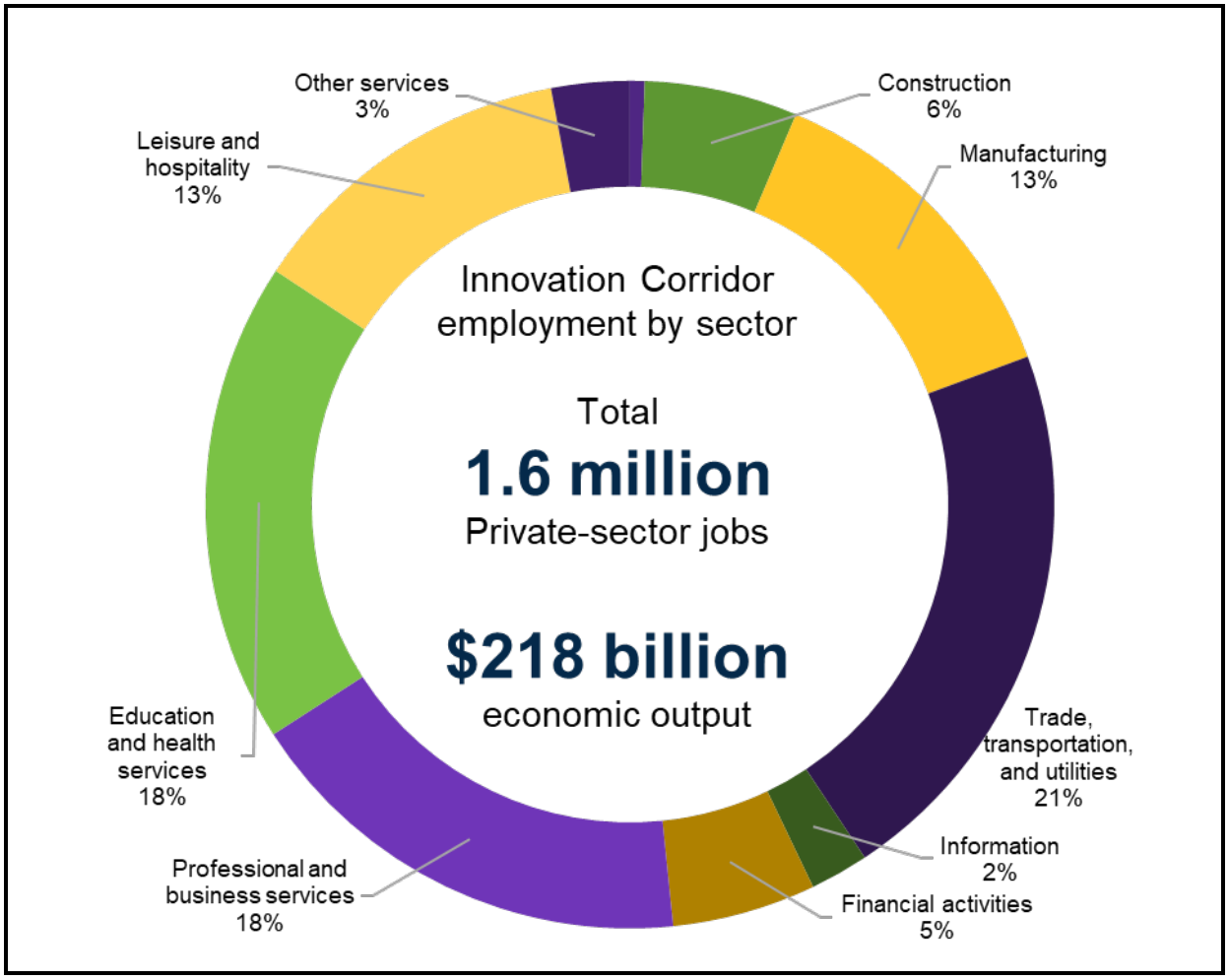
In 2018, the Innovation Corridor had 1.6 million private-sector jobs and $218 billion in economic output. The region recovered from the 2008 recession, surpassing its pre-recession peak of over 1.4 million jobs,[20] with a net job growth of 8% between 2008 and 2018. The fastest-growing sectors over the last decade were in services, ranging from low-wage leisure and hospitality services (27% growth) to high-wage professional and business services (20% growth). Manufacturing, the historic driver of industry in the region, saw a 12% job decline over the same period.

Measured by total jobs, the largest employment sectors[21] are trade, transportation, and utilities (21%); education and health services (18%); and professional and business services (18%). ***Figure 2.7*** outlines the sectors of private-sector employment in the Corridor.

[20] Jobs in this section refer to private-sector jobs and do not include public-sector positions, including those in state and local government, federal government, and public education.

[21] "Sector" refers to two-digit NAICS codes as defined by the North American Industry Classification System, a broad industry definition. "Subsector" refers to three-digit NAICS codes, a more detailed definition, and "industry" refers to four-digit NAICS codes. More information is available at https://www.bls.gov/bls/naics.htm.

Figure 2.7. Private-Sector Employment, by Industry Sector: 2018



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

High-Tech Employment in the Innovation Corridor

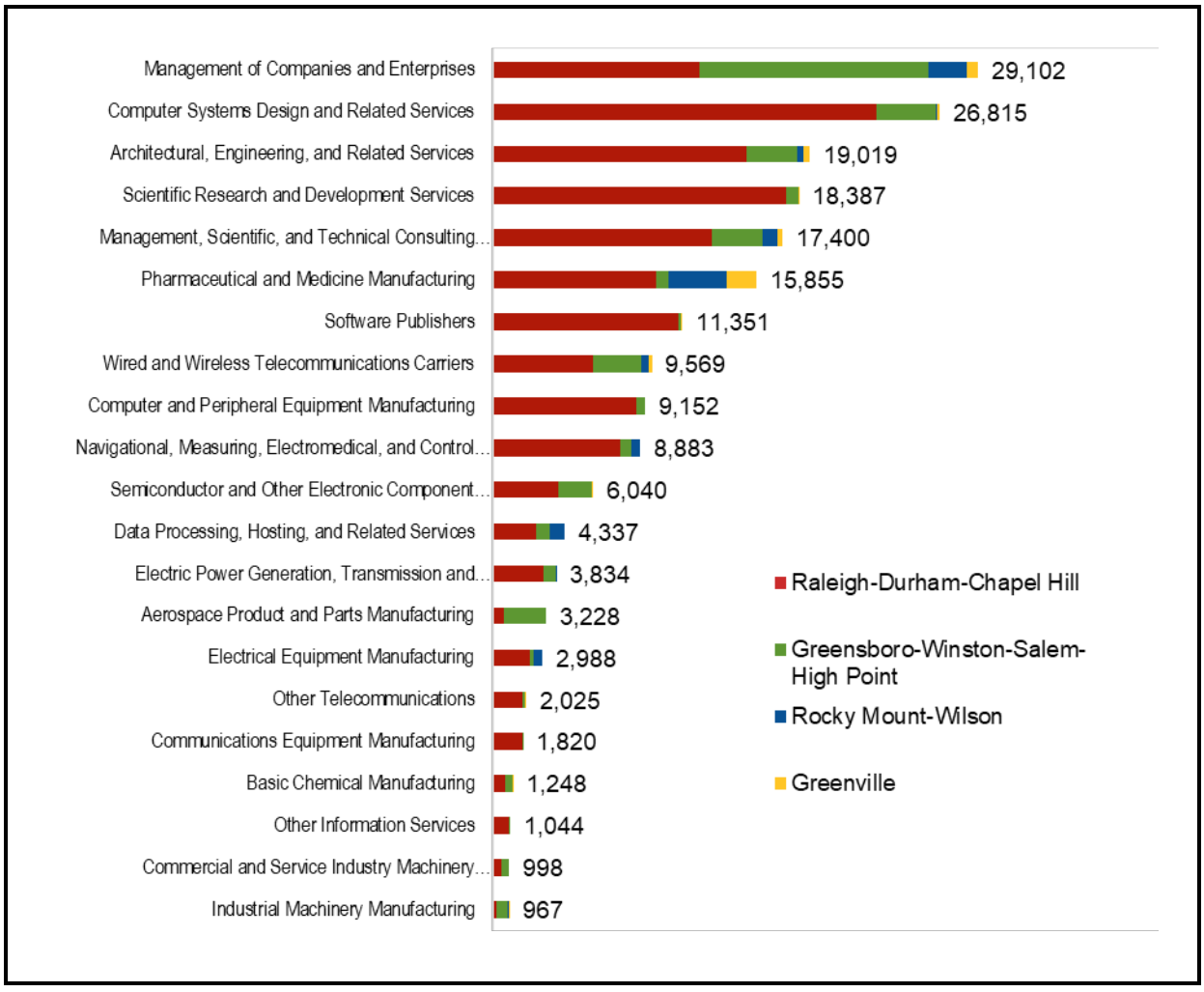
The high-tech sector, with a high level of STEM jobs and research activity, is central to the recent growth in the Innovation Corridor. High-tech employment in the Corridor is concentrated in Raleigh–Durham–Chapel Hill, and the largest high-tech industries include the following:

- Management of companies, including historic corporate headquarters in the Greensboro–Winston-Salem–High Point metro area
- Computer science fields including computer systems design, software publishers, computer equipment manufacturing, electromedical manufacturing, electronic component manufacturing, data processing, telecommunications, and other electronics manufacturing fields

- Professional services including architecture and engineering, scientific R&D, and management consulting
- Pharmaceutical and medical manufacturing, which makes up the largest high-tech sector in Greenville, Rocky Mount, and the eastern part of the state
- Aerospace manufacturing in Greensboro and the surrounding area

Figure 2.8 shows all high-tech employment by each region of the Innovation Corridor.

Figure 2.8. Employment in High-Tech Industries: 2018



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

In the Innovation Corridor, 74% of jobs in high-tech industries are in the Raleigh–Durham–Chapel Hill area (which is home to approximately half the population). The growth in high-tech

industries is closely related to how the regional economy has fared.

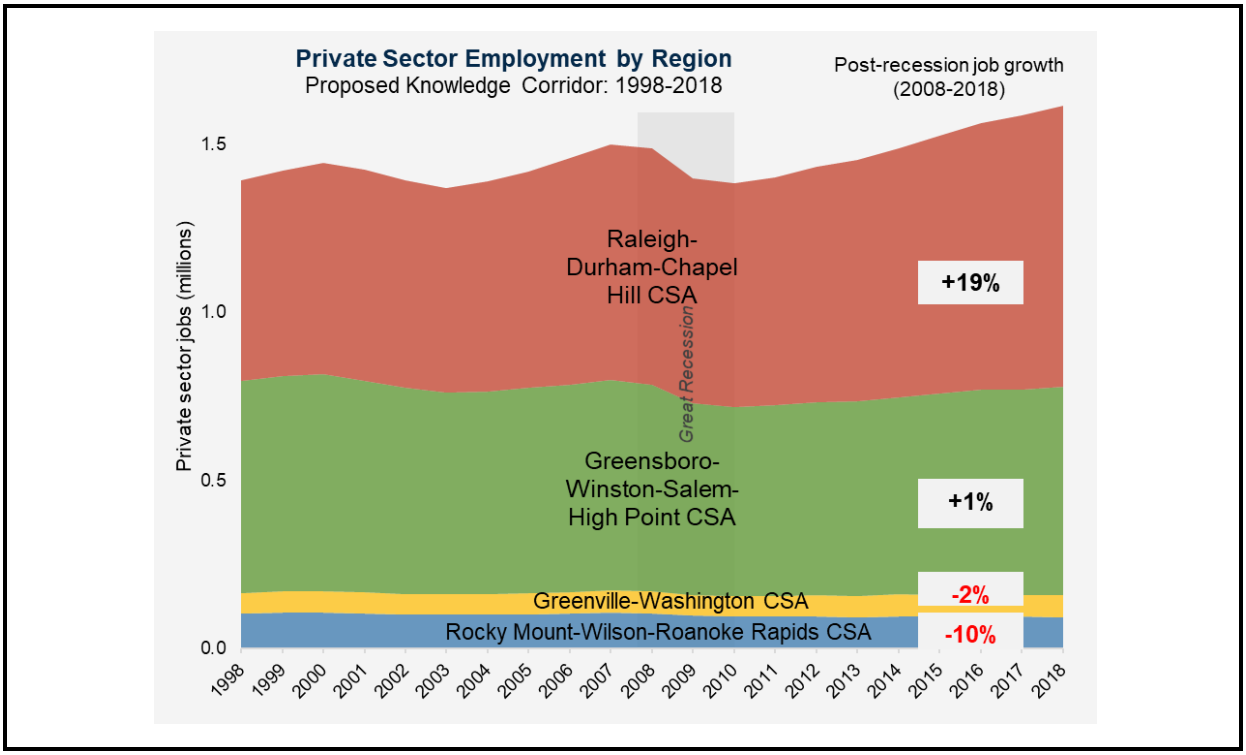
Long-Term Shifts in Industry in the Corridor

Since the turn of the 21st century, the Corridor's shifts in economic geography have been the result of several trends:

- Deindustrialization, automation of manufacturing, the decline of the tobacco industry, and international trade resulted in a long-term decline of manufacturing jobs in traditional hubs such as Greensboro, High Point, Winston-Salem, and Rocky Mount.
- Concentration of knowledge workers in high-performing metros such as Raleigh–Durham–Chapel Hill resulted in a sharp increase in jobs, most notably after the Great Recession.

The shift from manufacturing to services is reflected in the geographic shift of the economic center of the region: the Raleigh–Durham–Chapel Hill metro areas make up the majority of the jobs in the Corridor, with 19% growth from their pre-recession peak compared with flat or declining job numbers in the remaining regions (see ***Figure 2.9***).

Figure 2.9. Private-Sector Employment in the Innovation Corridor: 1998–2018



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

The composition and geography of jobs changed over the decade after the recession. Manufacturing jobs declined by 12%, while service jobs made up most new growth, split between high-wage professional services and low-wage hospitality and restaurant jobs. A significant shift occurred in the economic center of the region, moving from the manufacturing hubs and historic headquarters of the Piedmont Triad to the knowledge centers of Raleigh–Durham–Chapel Hill. In the Innovation Corridor between 2017 and 2018, the Raleigh–Durham–Chapel Hill region had

- 52% of all jobs,[22]
- 70% of science and engineering degrees conferred,[23]
- 74% of all jobs in high-tech industries,[24]
- 78% of STEM jobs, and[25]
- 99% of venture funding reported.[26]

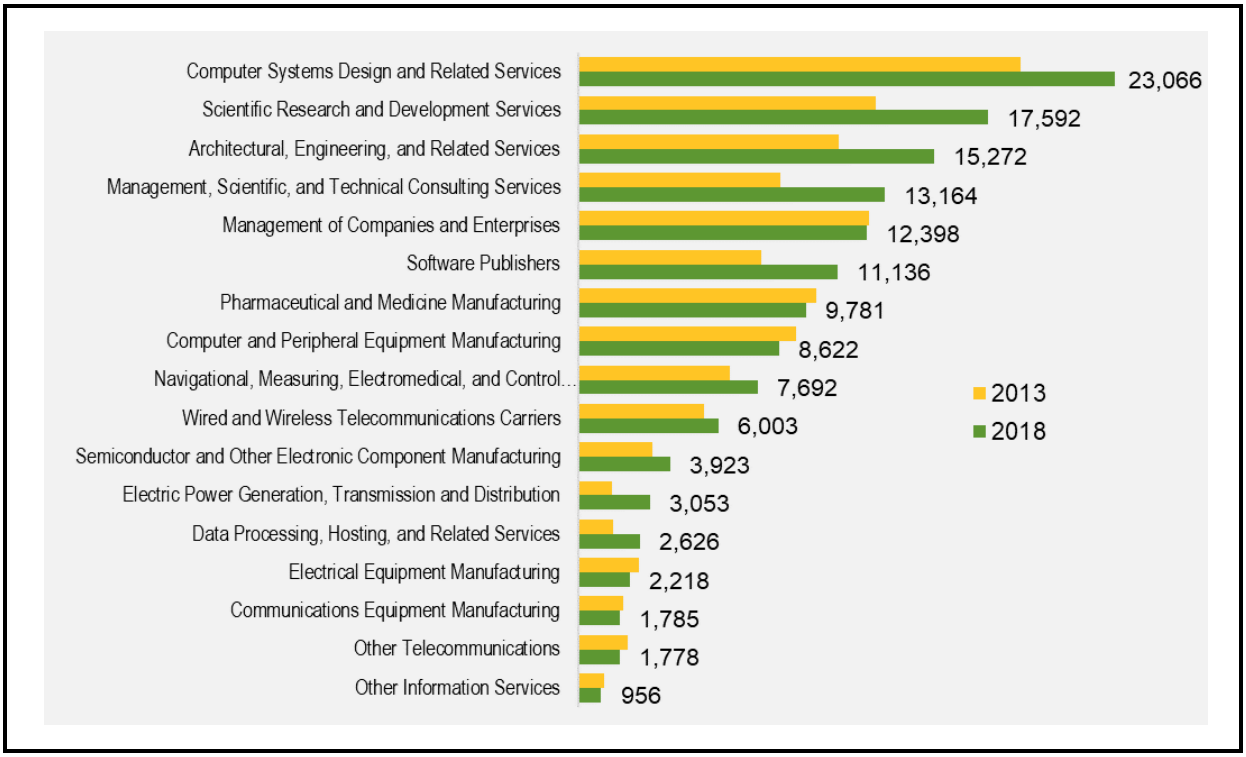
Emerging Industries and Technologies

Across the Corridor, several trends in emerging industries and technologies offer insight into where growth is occurring and is likely to continue to occur in the future.

High-tech industries, with the highest concentration of R&D activity and STEM jobs, are growing the fastest in the Raleigh–Durham–Chapel Hill area, including in computer systems design, scientific research services, engineering and technical consulting services, and software publishing (see ***Figure 2.10***). The region has the highest concentration and growth of knowledge-intensive industries that are projected to continue to grow in the future.

[22] Bureau of Labor Statistics, Quarterly Census of Employment and Wages. https://www.bls.gov/cew/data.htm
[23] U.S. Department of Education, IPEDS. https://nces.ed.gov/ipeds/
[24] Emsi. https://www.economicmodeling.com/
[25] U.S. Bureau of Labor Statistics, Occupational Employment Statistics (OES). https://www.bls.gov/oes/home.htm
[26] Pitchbook. https://pitchbook.com/

Figure 2.10. Growth in High-Tech Industry in the Raleigh–Durham–Chapel Hill Area: 2013–2018



Source: RTI International analysis of Emsi data (https://economicmodeling.com).

In the eastern part of the Corridor, pharmaceutical and medical manufacturing is the leading high-tech sector for growth, while aerospace manufacturing is growing in the Piedmont Triad around Greensboro.

Based on trends in growth of generation of IP, emerging technologies[27] illustrate trends toward the future. Data processing, analytics, and medical technology consistently continue to be the source of the largest amount of IP generated in the region. Life sciences receive the largest amount of university research funding, concentrated at Duke and UNC-CH. Recent growth in patent filings for emerging technology areas includes

- power electronics,
- health care informatics,
- wireless communication and signaling, and

[27] RTI examined patent filings from 2014 to 2018 based on cooperative patent classification technology codes to identify established and emerging sectors.

- gene therapy and microorganisms.

At the same time, established technologies in the region with recent declines include microelectronics, semiconductors, wired telecommunications technology, and optical systems.

Growth in venture activity reflects the trends in technologies and geography of industry growth: In 2017–2018, start-ups in the Innovation Corridor raised a total of $2.5 billion in venture funding, with the largest deals occurring in software and health care. Over 99% of that funding went to firms headquartered in Raleigh, Durham, Morrisville, Cary, Chapel Hill, and the surrounding area.[28]

2.4 CONCLUSIONS

Up until the recent COVID-19 pandemic, North Carolina had largely recovered from the 2008 recession, but its growth has lagged behind national trends and has been defined by divergence. Although cities and high-tech industries have thrived, many regions and industries in the state have struggled. During that time, the economic performance of the Innovation Corridor mirrored state and national trends: an ongoing, long-term shift from manufacturing to service jobs; concentration of high-wage service work in high-performing metro areas (Raleigh–Durham–Chapel Hill in this case); a loss of major employers in medium-sized cities and rural areas, and disparities in economic opportunity. The economic outcomes of residents vary widely across the Corridor: Although Raleigh–Durham–Chapel Hill outpaces state and national trends in jobs and high-tech growth, Greenville has one of the highest poverty rates in the state, and Winston-Salem scores among the worst nationally on measures of economic mobility.

Recently, economic development leadership in each of the hubs has noted a change in attitudes around innovation and entrepreneurship and how they fit into economic development. From Winston-Salem to Greenville, collective efforts have been made to support homegrown opportunities, make entrepreneurship more accessible, and make supportive efforts (networks, capital, services, spaces) more robust and better connected. Economic developers have recognized that innovation and entrepreneurship are critical components of the

[28] RTI analysis using Pitchbook data (www.pitchbook.com).

fabric of economic development and priorities that will support long-term growth in the region. More specifically:

- Economic development leaders in Winston-Salem and Greensboro are aligning efforts and resources to support innovation and entrepreneurship, after 2 decades of losses of headquarters and major manufacturing facilities.
- In addition to the large life sciences and technology companies in the Raleigh–Durham–Chapel Hill area, a mix of initiatives are providing an abundance of resources and are supporting growth in start-ups in life sciences, tech, and business-to-business services. Although not yet a mature start-up hub, the region's ecosystem is on a trajectory to reach levels of growth and capital investment that rival those of national and global hubs.
- After long-term decline in traditional industries, Rocky Mount and the surrounding area are seeing new investment in place-based projects, such as Rocky Mount Mills, and potential for more growth in pharmaceutical manufacturing and agtech.
- Greenville and eastern North Carolina face tough challenges of poverty and economic restructuring, but a new mindset and rollout of initiatives in entrepreneurship, workforce training, and health care provide hope for new waves of sustained economic development.

In each of these hubs, economic development leaders expressed a desire to coordinate better and identify ways to attract innovators and entrepreneurs, retain human capital, and broaden the benefits of innovation-driven economic growth. Although each of the hubs that make up the Corridor is unique, their leadership has shown initial signs of a shared vision of strengthening their development through innovation and entrepreneurship.

3 Building Blocks for the Blueprint

The goal of this Blueprint is to set a foundation that begins to build a shared vision and identify long-term opportunities that make people, place, and business and industry thrive in a dynamic regional innovation ecosystem.

The Innovation Corridor is envisioned as a public–private effort to build and strengthen innovation-focused economic growth centers in medium-sized cities across central North Carolina.

The Innovation Corridor seeks to accomplish the following:

- Drive and expand growth in globally competitive industries.
- Create more job opportunities across a wider geography.
- Strategically coordinate research university and private-sector innovation assets.
- Launch North Carolina into the national and global innovation ranks.

This Blueprint establishes building blocks to help create a shared vision and identify long-term opportunities that make people, place, and business and industry thrive in a dynamic regional innovation ecosystem.

In this section, we describe some of the key assets that the region can leverage including an abundance of universities and colleges, a well-educated and trained talent pool, many start-up and innovation support entities, and communities with a strong sense of place. However, leaders will have to incorporate ways to tackle issues such as lack of economic mobility, affordable housing, and accessible effective public transportation.

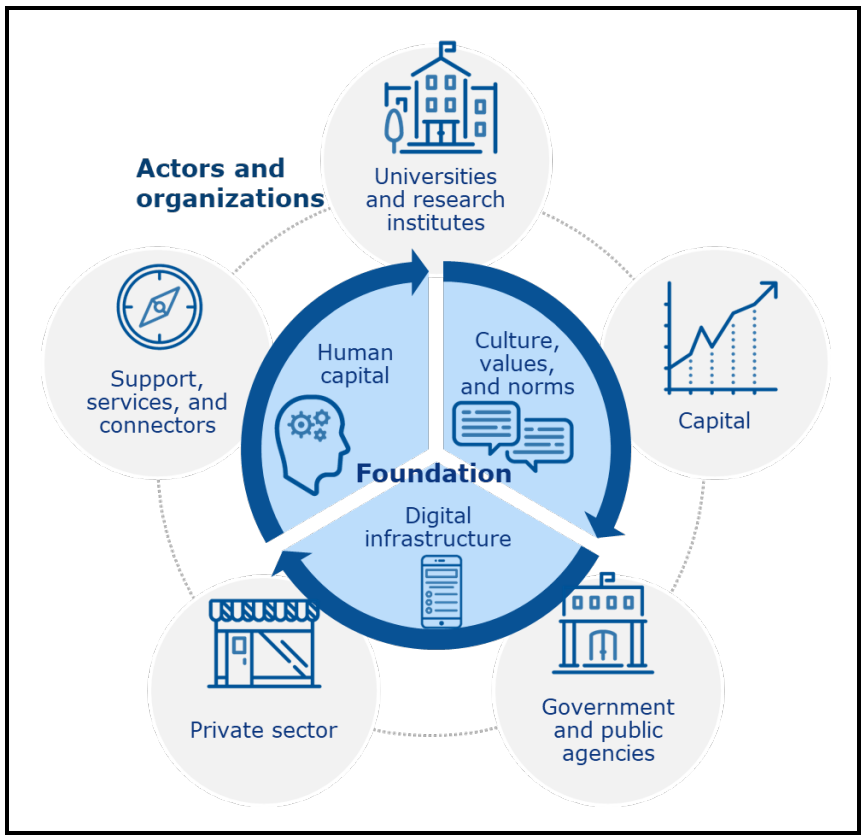
3.1 INNOVATION ECOSYSTEM BUILDING BLOCKS

An innovation ecosystem provides a solid framework from which to review the critical assets for building an innovation Corridor. Innovation ecosystems are defined as networks of organizations and people that interact to cultivate ideas into successful enterprises. Like natural, biological ecosystems, they consist of many moving parts that operate in an ever-changing economic and social landscape (see ***Figure 3.1***).[29] *Innovation* is referred to as introducing new products and processes into new places and markets. The concept is broad and much more than scientific or technological invention. Thus, the implications for a thriving innovation ecosystem extend to affecting entire supply chains and their respective workers, not only research laboratories and researchers.

The ecosystem is based on a foundation of people, culture, and digital infrastructure. Surrounding this foundation, public agencies, small and large businesses, capital, universities and research institutes, and other support services and connectors build out a critical network. No two ecosystems are exactly alike, and there is no one innovation ecosystem model to copy—an Innovation Corridor must reflect its local culture and norms.

[29] Lawrence, S., Hogan, M. Q., & Brown, E. (2019). *Planning for an innovation district: Questions for practitioners to consider* (RTI Press Publication No. OP-0059-1902). RTI Press. https://doi.org/10.3768/rtipress.2018.op.0059.1902

Figure 3.1. Innovation Ecosystem Components



Source: RTI International.

We review each of these building blocks and note high-level strengths and barriers in the study region as they relate to the components of the ecosystem. Each of these elements is worthy of its own in-depth research study, but we review them at a high level to

- share insights gleaned from interviews as a starting point for expanding future research, and
- provide a perspective on these elements from an innovation-driven economic development lens.

Foundational Elements

The core of an innovation ecosystem is its people, the ability of people to connect with idea platforms and markets through a digital infrastructure, and the culture that nurtures values and norms for people to experiment and engage in new ways of working and places that attract people and businesses to locate there (see ***Figure 3.1***).

Human Capital: People, not technology or research laboratories, are at the center of an innovation ecosystem. The

Innovation Corridor's continued success will depend on educated and talented people. Challenges of having this robust talent pipeline, according to stakeholder interviews, are a lack of tech talent, especially outside of Raleigh–Durham–Chapel Hill, and inconsistent quality of K–12th grade education, which chokes the talent pipeline at the outset.

Opportunities abound, however, with the Innovation Corridor having over 49 colleges and universities, including 7 research universities. These institutions provide an asset base to train and recruit talent in STEM and in liberal arts, which provide foundations in complex problem solving and degrees that strengthen individuals' backgrounds in the soft skills—such as empathy, teamwork, and communication—that many employers say they need.[30]

Digital Infrastructure: Broadband internet connectivity is a necessity in a digital economy. Interviewees across the Innovation Corridor named affordable, accessible, quality internet access as a lacking necessity, especially outside the major hubs of the Corridor. Affordable, high-quality, and accessible internet is patchy at best and nonexistent at worst. One interviewee said if "you could do one single thing to transform the region, it would be ensuring broadband internet access. That would be a game changer for North Carolina." The innovation ecosystem approach assumes that physical infrastructure such as highways, rail, and ports exist to transport products and people from business to market.

There is a growth and a scarcity mindset. Some areas of the Corridor are operating in a growth mindset focused on building and fostering industries that will generate long-term and perhaps new kinds of job growth. Others are operating from a scarcity mindset presuming limited resources for development, especially shared development, and a focus on near-term job gains.

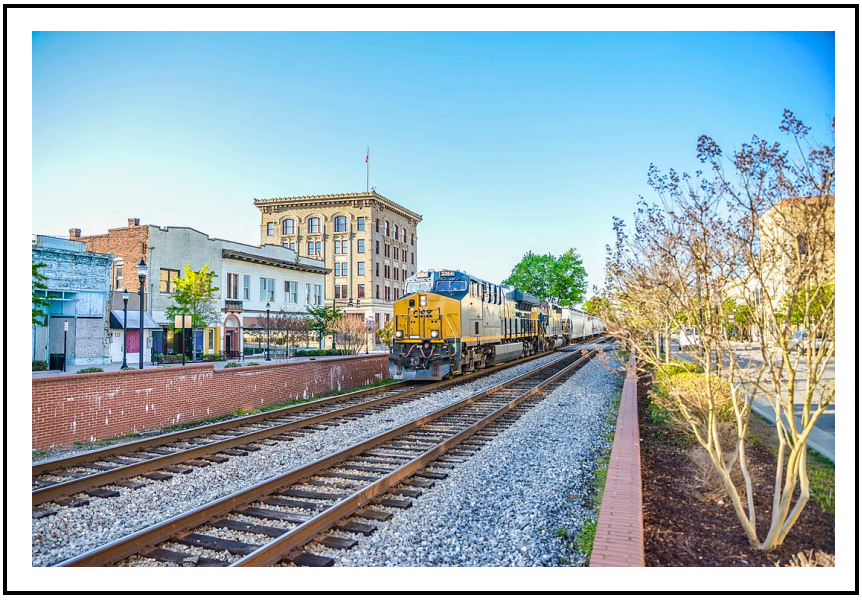
Culture, Values, and Norms: The Corridor has a diverse culture, values for economic development, and ways of working together. Following are some notable observations on the Corridor's culture, value, and norms:

- There is a growth and a scarcity mindset. Some areas of the Corridor are operating in a growth mindset focused on building and fostering industries that will generate long-term and perhaps new kinds of job growth. Others are operating from a scarcity mindset presuming limited resources for development, especially shared development, and a focus on near-term job gains.

[30] Wake County Economic Development. (2017). *Triangle talent: A regional skills assessment*. http://files.raleigh-wake.org/talent-workforce/regional-workforce-skills-analysis/WCED_TriangleTalent_Booklet_2018_v1.pdf

- A heightened emphasis on quality of place that incorporates local history, the arts, and natural assets. For example, Greensboro interviewees noted how LeBauer Park has changed the ability of people across the community to come together for events. It was also noted that Durham created a water source to flow through its American Tobacco Campus, whereas Rocky Mount has the Tar River, which could be used as an asset to attract more talent and businesses to the area and seed recreational businesses near its riverfront.
- Private–public leadership for real estate development, downtown revitalizations, and support for entrepreneurship. For example, in places like Rocky Mount Mills, Winston-Salem's Innovation Quarter, and Durham's American Tobacco Historic District and American Underground point to the vast potential of private–public partnerships to revitalize innovation hubs.
- An emergence of new narratives about possibilities for hubs in the Innovation Corridor as a result of visible changes to downtowns, local successes for homegrown entrepreneurs, and the attraction of new kinds of innovation businesses. Interviewees said there was an even greater need for more widespread storytelling about local success in economic development.

Figure 3.2. City of Rocky Mount, North Carolina



Source: Wikipedia (photo taken by Carl Lewis).

Actors and Organizations

The healthy dynamism of an Innovation Corridor depends not only on having key innovation assets in place, but also relies on

the *quality* and *frequency* of interactions between actors and organizations including higher education, business, capital providers, the public sector, and connecting services. Frequent and quality interactions lead to more creative collisions that result in new ideas, products, processes, and businesses.

These actors and institutions include the following:

Universities and Research Institutes

The Corridor has a plethora of universities and research institutes, with the research engines and highly specialized technology fields concentrated at Duke, UNC-CH, and NCSU. The Corridor is home to more than 40 universities and research institutes that, taken together, present an even greater opportunity to better collaborate on research and training for graduates in tech-related fields. The key is identifying incentives for collaboration such as resources for technical training or technology commercialization in particular sectors and for retaining talent trained in the Corridor. For example, NC A&T is the largest HBCU in the nation, generating the most African American engineering graduates in the country. Identifying ways to connect these engineering students and graduates with industry needs in the Corridor is a mutual benefit for the region.

Figure 3.3. UNC Old Well in the City of Chapel Hill, North Carolina

Source: iStock by Getty Images.

Capital

Across the Corridor, interviewees noted a dearth of capital to support start-up and scale-up companies. Many interviewees talked about lack of financing that can be scaled or accessed by people outside a narrow range of business sectors and

demographic profiles. Most regions in the country face similar issues, especially for more capital-intensive, R&D-based industry sectors such as biotech, energy, and advanced manufacturing. Investing in these sectors requires longer time horizons, more technical expertise about technologies driving the industry, more sophisticated business models, and a heightened regulatory risk. This is a tall order for venture capital and angel investors, yet interviewees across the Corridor strongly believe that without significant infusions of capital for start-ups and scale-ups, the Corridor and its potential will significantly lag behind other regions.

"The corridor has money, but it's scared money." Interviewees said that despite the Corridor having high-wealth individuals interested in investing in hometown businesses, there is a lack of experienced investors who know how to deploy a range of financing options to support entrepreneurs

Interviewees note that there is ample capital for business-to-business service start-ups, but access to riskier funds is much more difficult. One interviewee noted, "The corridor has money, but it's scared money." Interviewees said that despite the Corridor having high-wealth individuals interested in investing in hometown businesses, there is a lack of experienced investors who know how to deploy a range of financing options to support entrepreneurs. Furthermore, some interviewees noted an unevenness in access to investment networks, especially those based on race.

Encouragingly, we did note that many small grant programs have sprouted across the region, including Winston Starts, the ECU Pirate Entrepreneurship Challenge, and RISE-29. These grant programs are meaningful for entrepreneurs across the Corridor and are fostering a culture for start-up communities across the region, with some companies taking off into growth stages. However, these mechanisms cannot yet scale to the levels needed to meet needs for new and growing enterprises.

Figure 3.4. City of Greenville, North Carolina

Source: City of Greenville (photo taken by Aaron Hines).

Government and Public Agencies

Many interviewees spoke of the fragmented nature of economic development and lack of a shared vision across many kinds of economic development–related entities. Breakdowns tended be along lines of

- political boundaries (e.g., city–county lines or between counties),
- "new" economic development (e.g., a focus on entrepreneurship, quality of place, or business-led initiatives) versus "old" economic development (e.g., attracting or retaining large businesses that may be in decline or efforts led by government only),
- visions for the economic future (e.g., reclaiming growth in industries of the past) versus industries that show potential for emerging growth that are new to the area,
- the role of incentives for attracting or retaining large businesses versus incentives for start-up and scale-up businesses, and
- perceptions of investment and focus in only the Raleigh–Durham–Chapel Hill area at the exclusion of medium-sized towns and rural areas.

On the whole, the Corridor is viewed as having a friendly business climate with low costs of living and quality places to live.

Private Sector

The Corridor is home to a healthy industry mix from which to build emerging and sustained businesses that drive GDP and create local employment opportunities including large anchor companies, start-ups, medium-sized businesses, and main street businesses. The Corridor needs a more supportive pipeline of capital and industry/market expertise to foster start-up and growth companies (see the earlier "Capital" section). Regions outside the Raleigh–Durham–Chapel Hill region would benefit from a healthier industry mix in more tech-driven businesses that can better weather economic downturns. Section 4 describes in more detail potential target industry clusters in which the Corridor could consider developing growth strategies. We also noted in our interviews that as downtowns across the Corridor have sprung back to life over the past decade, many main street businesses have also emerged, including new coffee shops, breweries, and restaurants.

Ensuring access to loans and business support for these entrepreneurs is equally important for economic development across the Corridor.

Support Services and Connectors

The vision for the Innovation Corridor ecosystem is a strongly connected network of innovators, investors, workers, employers, and service providers who can readily tap into the resources and opportunities the ecosystem provides.

The Corridor has experienced a steep rise in the number of services and connectors supporting entrepreneurship and innovation including incubators, accelerators, and networking events. Combined with chambers of commerce, economic development organizations, community organizations, and others, there is a new level of energy for and commitment to broad-based economic development.

Support services and connectors face challenges of a lack of ability to scale and a lack of opportunity to align resources across the region. This varies, however, across the region. For example, the Piedmont Triad has formed a more unified vision and related programming, whereas the Raleigh–Durham–Chapel Hill region is saturated with service providers that are sometimes described as duplicative and less coordinated. There is, however, plenty of goodwill among service providers and connectors that can readily be channeled under a collective vision for an Innovation Corridor.

Figure 3.5. City of Winston-Salem, North Carolina

Source: iStock by Getty Images.

Overarching Elements

An ecosystem is much more than the sum of its parts. Cross-cutting themes that emerged from our interviews related to the

linkages, *capacity*, and *inclusiveness* of the ecosystem. We review the insights gained in each of these three areas.

Linkages

The vision for the Innovation Corridor ecosystem is a strongly connected network of innovators, investors, workers, employers, and service providers who can readily tap into the resources and opportunities the ecosystem provides. A key challenge to realizing the potential of this connected network is the lack of a shared vision across the region. Interviewees from across the Innovation Corridor also noted weak links or fragmented approaches across political boundaries for innovation, entrepreneurship, and economic development.

Interviewees highlighted multiple opportunities to better connect the Innovation Corridor. Organizations such as NC IDEA and HQ Raleigh (https://hq.community/hq-raleigh-locations/) are leading the way. NC IDEA provides ways for many to connect through its grants, programs, services, and events. HQ Raleigh stretches its networks among Raleigh, Greensboro, Charlotte, and Wilmington. The Piedmont Triad exemplifies a region proactively building synergies with its entrepreneurship support services between Winston-Salem and Greensboro. For example, stakeholders formed the Triad Entrepreneurial Consortium with over 30 leaders and experts, providing coordinated support to local entrepreneurs and start-ups.

Figure 3.6. City of Raleigh, North Carolina

Source: VisitRaleigh.com.

Capacity

Next, interviewees noted a lack of capacity in longstanding institutions and within communities to dedicate time, resources, and talent to nurture economic development emphasizing innovation and entrepreneurship. Because these functions are still relatively new to the economic development practice, some organizations, institutions, and communities do not have the bandwidth to stretch into new areas for economic development while still doing their existing jobs.

Yet universities are building out entirely new schools or offices for innovation and entrepreneurship including ECU's Miller School of Entrepreneurship and LaunchUNCG at UNC-G. The Institute for Emerging Issues and Forward Cities also provide templates for community capacity building for economic development oriented toward innovation and entrepreneurship.

Figure 3.7. City of Greensboro, North Carolina

Source: iStock by Getty Images.

Inclusiveness

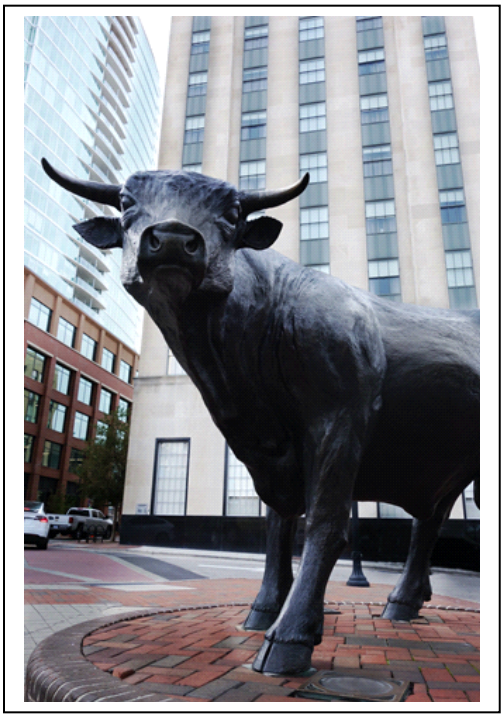
Interviews revealed that issues of affordability and access pervade the Innovation Corridor. Specifically, as downtowns in these hubs redevelop, gentrification and lack of affordable housing ensue, often displacing many from homes and neighborhoods where they have lived for generations. Further compounding these issues is a lack of affordable and accessible transportation in each hub, in addition to transportation between hubs across the Innovation Corridor.

Yet one of the features many interviewees noted across the ecosystem was how easy it can be to access people or services.

Many, especially in Greensboro, Winston Salem, Rocky Mount, and Greenville, said that one of the best attributes of these communities is that it is "easy to get a seat at the table" and stated that "anyone you want to talk to is just two phone calls away." Several interviewees who recently moved to the Raleigh area noted how much more active and open the ecosystem was in the Research Triangle region, citing similar ease of connecting with people and organizations.

This type of interconnectedness provides a great base to ramp up this culture of connectedness. The Innovation Corridor can build on this to be more inclusive by more intentionally extending this culture of openness to women and communities of color. Specific opportunities could include a more prominent women-in-technology organizing entity across the region and ways to elevate entities like Black Founders Exchange.

Figure 3.8. City of Durham, North Carolina



Source: 123rf.

3.2 CORRIDOR ASSETS: LEVERAGE AND POTENTIAL

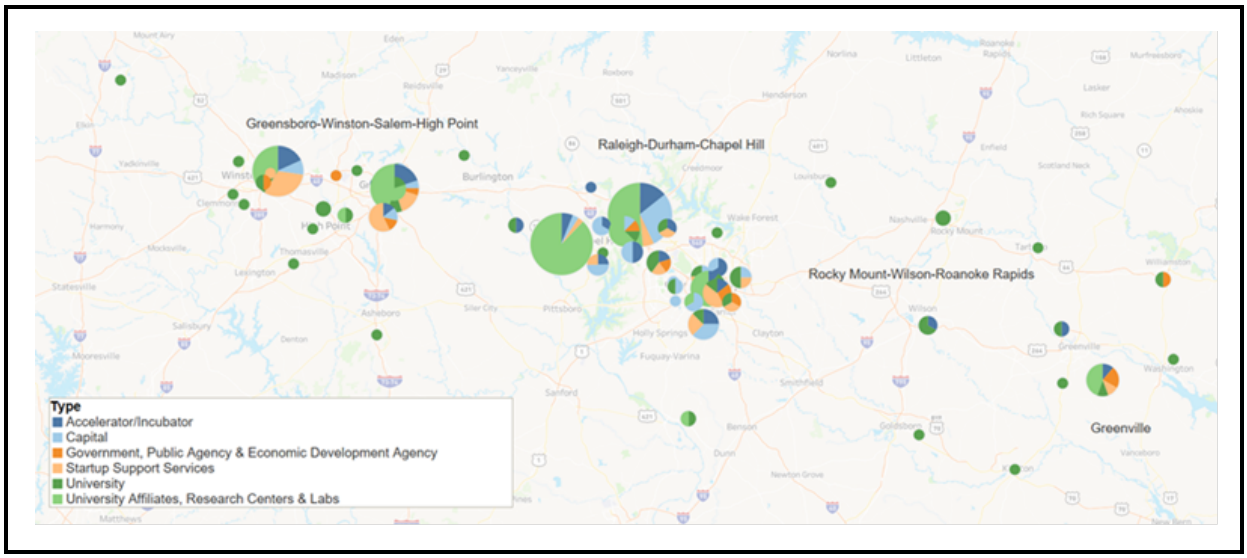
As illustrated in Section 2, there are disparities in the economic outcomes of the regions that make up the Corridor, driven by a concentration of high-tech activity and assets in the Raleigh–Durham–Chapel Hill region. However, innovation assets exist

across the Corridor and offer a view of the potential for future collaboration among academia, the private sector, independent connectors, capital investors, and the public sector. In an initial scan in fall 2019, RTI identified 282 organizations that support a growing, innovation-driven economy, including[31]

- 38 incubators and accelerators,
- 13 government and public agencies,
- 49 higher-education institutions,
- 91 university-affiliated organizations,
- 38 funders,
- 36 start-up support organizations, and
- 13 annual or recurring events.

Although the largest number are in the Raleigh–Durham–Chapel Hill area, including major research universities and institutes, assets can also be leveraged east and west of the Research Triangle. The ecosystem map, shown in ***Figure 3.9***, illustrates the assets spread across the Corridor, indicating the potential for opportunities to strengthen and link these innovation assets.

Figure 3.9. Innovation Ecosystem Assets in the Innovation Corridor



Source: RTI International.

[31] This information was collected in fall 2019. The ecosystem is rapidly evolving, and the map is intended to show the wealth of organizations on which leaders and stakeholders can draw.

Table 3.1 further describes the strengths of and barriers for each hub in the Innovation Corridor with a broad description of each hub's potential in a wider ecosystem of innovation-driven growth. This table is intended to depict a potential for each location within a regional approach to development based on its assets and barriers to date.

Table 3.1. Summary of Strengths, Barriers, and Potential, by Hub

Innovation Hub	Notable Innovation Strengths	Perceived Barriers	Innovation Ecosystem Potential
Raleigh–Durham–Chapel Hill	▪ Globally recognized research and innovation hub with Research Triangle Park legacy and brand ▪ Three R1 research universities, Duke, UNC-CH, and NCSU, plus HBCUs and community colleges ▪ High levels of R&D and innovative output at universities ▪ Large, growing pool of tech talent in software development and computer systems design ▪ Tech industry growth that outpaces national trends ▪ Research facilities for major pharmaceuticals; emerging growth in gene therapy ▪ Emerging leadership in wireless communication, internet of things, and power electronics	▪ Growing lack of accessibility and affordability in transportation and housing ▪ Siloed visions for innovation growth ▪ Lack of risk capital compared with other national innovation hot beds	▪ Top-tier global innovation growth engine characterized by relative accessibility and affordability when compared with other major metro areas
Greensboro–Winston-Salem–High Point	▪ Thirty colleges and universities – NC A&T: largest HBCU with most African American engineering graduates in the country – Wake Forest Baptist Health ▪ Strong aviation–aerospace–automotive sector; strong textile–performance material sector ▪ Business and real estate investors transforming downtowns ▪ Established norms of regional collaboration ▪ Active, invested business community	▪ Mixed mindsets for growth: "old industry" versus "new industry" ▪ Lack of risk capital ▪ Lack of research and innovation output (e.g., patents, licenses)	▪ Robust industry clusters with established businesses, start-ups, and scale-ups in respective supply chains in sectors such as aviation–aerospace–automotive, medical tech, and defense innovation ▪ Vast tech talent pool trained and retained across the region in growing engineering-related businesses and industry

(continued)

Table 3.1. Summary of Strengths, Barriers, and Potential, by Hub (continued)

Innovation Hub	Notable Innovation Strengths	Perceived Barriers	Innovation Ecosystem Potential
Rocky Mount–Wilson–Roanoke Rapids	▪ Pharmaceutical manufacturing base (e.g., Pfizer) ▪ Rocky Mount Mills; real estate and community development ▪ Proximity and easy commute to Raleigh	▪ Lack of higher-education institutions and research institutes	▪ A quality place for entrepreneurs and innovators to locate and scale their businesses with ready access to Raleigh–Durham–Chapel Hill. ▪ Growth in medical tech, manufacturing, and agtech industries
Greenville–Washington	▪ East Carolina University – Brody School of Medicine – Miller School of Entrepreneurship ▪ Active and invested business community	▪ Weak R&D and innovation outputs	▪ Research and entrepreneurial engine of the east with industry growth in medical tech, defense innovation, and agtech

HBCU = historically black college or university; NC A&T = North Carolina Agricultural and Technical State University; NCSU = North Carolina State University; R&D = research and development; RTP = Research Triangle Park; UNC-CH = University of North Carolina at Chapel Hill.

Source: RTI International research and interviews. 2019–2020.

3.3 EXPERIENCES FROM OTHER PLACES

Transformative efforts to reshape economic development are rare. Changes in economic development practice are more often an evolution—a result of incremental changes and unique local circumstances—but there are examples of efforts that have set the stage for transformation. RTI examined past and ongoing transformative efforts in places across the United States outside the traditional tech hubs, including a mix of large, medium, and small cities and regions. ***Table 3.2*** lists each location and the initiative reviewed. We selected these regions based on input from interviewees, national press and thought leaders, and examples of new courses for economic development.

Table 3.2. Cities, Places, and Initiatives Reviewed

City or Place	Initiative
Research Triangle Park, NC	Foundation of Research Triangle Park in the 1950s and subsequent tech growth
Washington, DC, metro area	Alignment of regional economic development priorities after an unsuccessful Olympic bid
Chicago, IL	Chicago's P33 initiative: to transform the Chicago metro into a tech hub
Portland, ME	Investment by billionaire David Roux in a new research institute
San Diego, CA	Expansion of tech development out of Silicon Valley companies
Pittsburgh, PA	Economic transformation through Carnegie Mellon University, robotics, and artificial intelligence
Boulder, CO	Evolution of the start-up ecosystem and creation of a "start-up community"

Source: RTI International.

These efforts have several common features across these efforts that may offer insights for jump-starting the Innovation Corridor:

- **Sparked by a crisis or event.** Economic development organizations spring to action as a result of a major crisis or opportunity. Although they may not always give the desired results in the short term, they generate the types of collaborations and vision for long-term growth. For example, Silicon Valley emerged from military research during World War II, RTP was a project to offset the long-term economic decline of North Carolina's industries,[32] the District of Columbia built a regional coalition around a failed bid for the Olympics,[33] and Chicago's new P33 initiative (https://www.p33chicago.com/) was a product of the city's failed bid to attract Amazon HQ2. As the Blueprint is completed in April 2020, our country and state are at the beginning of a growing economic crisis due to the

[32] Link, A., & Scott, J. (2000). *The growth of Research Triangle Park*. https://www.dartmouth.edu/~jtscott/Papers/00-22.pdf

[33] O'Connell, J. (2015, June 12). Why the Olympics Washington didn't win could still transform the city. *The Washington Post*. https://www.washingtonpost.com/news/digger/wp/2015/06/12/why-the-olympics-washington-didnt-win-could-still-transform-the-city/

global COVID-19 pandemic. There will be a great need to address unemployment and fast-moving economic shifts as a result of the rapid slowdown of the restaurant, retail, hospitality, service, and tourism industries.

- **Attract investment from individuals with high net worth who strive to leave a legacy.** Cities such as Portland, Maine,[34] are learning from the experience of others that have seen large investments from private benefactors for transformative real estate investments that go beyond what government or academia can provide. Individuals, families, or foundations are important actors in economic transformation.
- **Do not rely solely on low costs to attract industry; places that successfully develop around innovation invest in human capital and placemaking.** Although there is some effect on tech workers and companies leaving high-cost places like the San Francisco Bay Area, they are more likely to relocate to places with geographic proximity or a workforce that can compete with what they would find in a high-cost metro. Places like San Diego have benefited from an educated workforce, an attractive quality of life, and proximity to high-tech industry further north in California.[35] If cost is the only factor, tech or life science companies may be more likely to look at a low-cost location overseas than at a low-cost part of the United States that lacks the human capital needed.

If cost is the only factor, tech or life science companies may be more likely to look at a low-cost location overseas than at a low-cost part of the United States that lacks the human capital needed.

- **Involve research universities.** The leading centers of tech innovation in the United States (Silicon Valley, Boston) and around the world (Tel Aviv, London, Singapore) have research universities at their core. Cities emerging as a new generation of centers of innovation have research universities that connect to the private sector. Pittsburgh's emergence as a new tech hub is closely tied to Carnegie Mellon University's research in robotics and artificial intelligence.[36]
- **Invest for long-term return.** Investments in innovation- and knowledge-based economic growth take time to show return: New research, human capital, and start-up activity can take decades to translate into

[34] See footnote 3.
[35] See footnote 3.
[36] Kurtz, S. (2017, July 22). Pittsburgh gets a tech makeover. *The New York Times*. https://www.nytimes.com/2017/07/22/style/pittsburgh-tech-makeover.html

significant economic transformation. RTP struggled to attract tenants in its first 20 years,[37] and Carnegie Mellon University's investment in robotics in the 1980s did not result in significant economic growth in Pittsburgh until the 2010s. Initial growth is likely to be slow because new innovations can take a decade or more to get to market, and it can take longer for them to translate into new jobs and new industry. Similarly, Brad Feld, citing the example of Boulder, Colorado, hypothesizes that a start-up ecosystem takes 20 years to mature, as deal flow accelerates and successful exits result in reinvestment in the start-up ecosystem.[38]

[37] See footnote 34.

[38] Feld, B. (2012). *Startup communities: Building an entrepreneurial ecosystem in your city.* Wiley.

4 The Blueprint

Alongside swift actions to support individuals destabilized [by the crisis], there will also be a need for a long-term plan for more sustainable, equitable economic growth with a focus on the future of industry and for business growth that can better position our state as a whole to weather economic shocks.

While North Carolina and the Innovation Corridor grew in the post-recession decade, economic challenges persisted. The current COVID-19 crisis will exacerbate those challenges and vulnerabilities. Immediate health and economic priorities will be needed to address the impacts of this pandemic. Alongside swift actions to support individuals most destabilized, there will also be a need for a long-term plan for more sustainable, equitable economic growth with a focus on the future of industry and for business growth that can better position our state as a whole to weather economic shocks.

To redefine economic development more broadly for the Corridor, local and state-level leaders will need to embrace flexible approaches, communication across the Corridor, and ways to continually reassess the potential for growth. These "glue factors" will help bind the building blocks and activate the Blueprint.

- **Flexible approaches:** The future can change, and without flexible approaches, opportunities can be missed due to unexpected changes in the landscape. Plans or investments that allow for global or local social, economic, and other kinds of market shifts are much more likely to adapt to dynamic market opportunities. Thus, they will be much better positioned to take advantage of opportunities that reap greater economic opportunity for their region and its people.
- **Cross-Corridor communication:** Frequent, meaningful, and quality communication across key stakeholders in the Corridor will draw together the people and organizations, or agents, that are critical to advancing aspects of the Innovation Corridor. Interviewees suggest annual or biannual events that

serve as easy ways to convene stakeholders as a starting point.

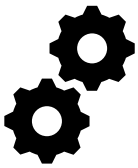
- **Continual reassessment:** Flexibility and frequent communication will likely result in the need for continual reassessment of efforts for the Innovation Corridor. Design approaches also teach us that more frequent (e.g., quarterly) yet rapid assessments (e.g., 4–8 weeks) can prove more productive than large, year-long efforts to inventory and strategize for the future.

We provide two types of starting points from which Corridor stakeholders can develop the Blueprint and translate it into action. First, RTI's practice in economic development has observed that a strong motivator to bring diverse innovation and economic development stakeholders together is targeted industry growth efforts. Industry clusters provide a logical way to encourage collaboration up and down the value chain and to leverage assets across the Corridor to broad-based growth and development. For example, clusters of private, public, and academic innovators led to the Research Triangle region's leadership in pharmaceuticals and biotechnology innovation.[39] In Section 4.1, we offer four industries for potential focus as a starting point to build out action plans for development.[40]

Next, efforts to ensure that people can access economic opportunities and that quality places are cultivated are important for regional growth. Investments in people and places generate virtuous cycles of talent generation and quality of life that support long-term, diversified growth and reduced socioeconomic disparities. Section 4.2 discusses ideas to consider based on RTI's research and interviews.

[39] Porter, M. E. (2001). *Clusters of innovation: Regional foundations of U.S. competitiveness*. Council on Competitiveness. https://www.hbs.edu/faculty/Publication%20Files/COI_National_05202014_ad0fe06c-674c-494b-96f6-6882db4e6aaf.pdf

[40] These are not intended to be definitive sectors of growth for the Innovation Corridor. They are proposed as a means to demonstrate potential for growth and development with positive impacts across a wider geography into the future.



4.1 BUSINESS AND INDUSTRY CLUSTERS FOR THE FUTURE

Innovation-driven economic development strategies with an industry cluster focus allow stakeholders to channel limited resources in a targeted way around bringing new products to market, capturing greater market share, and raising North Carolina's visibility on the national and global stage. RTI details three industries ripe for global market disruption and one industry undergoing disruption that the Corridor can leverage to better capture more market share.

Methods for Industry Cluster Focus

Starting from a key question, "How might the Corridor expand the potential, opportunity, and impacts of an innovation economy across a region from Greensboro to Greenville?," RTI first conducted economic, talent, and innovation asset analysis on the region to understand the sectors and industry shifts, job growth and type, STEM fields, talent pipeline, incubators and accelerators, research output, IP generation and type, commuting patterns, population, and income. We then talked with community representatives along the Corridor to understand local culture, opportunities, and barriers. Finally, innovation analysts conducted a short foresight exercise to consider how high-level political, economic, social, and technical trends might affect different industries 10 to 20 years into the future. Using the analysis, RTI identified industries in the Corridor, focusing on the areas east and west of the Research Triangle and considering the following guideposts:

- Innovation and economic performance
- Emerging industry, technology, and human capital trends
- Established and emerging assets to leverage
- Potential for creating broader-based growth across regions

RTI then reviewed the industries, considering the strengths of the following elements: industry growth, ability to enable regionalism, broader geographic development potential, and human capital development. At this point, RTI identified four potential industry clusters that could enable the growth of their broader industries within the Innovation Corridor. These clusters were chosen as test cases for further exploration

because they met a vision of transformational change and growth; there are other industry clusters that could do the same. The clusters selected for study are **agriculture technology (agtech)**, **biohealth technology (biohealth)**, **power electronics for transportation**, and **defense innovation**.

These industry areas were initially selected for the following reasons:

- **Agtech:** Agtech has a strong presence in the Research Triangle area with potential application of agricultural technologies in the eastern region with animal and crop farms. Food will always be in demand and will be in higher demand as population increases globally. Eastern North Carolina is already viewed as an agtech testing location.

- **Biohealth:** The entire health sector is represented in the region: from research to start-ups, accelerators, clinical trials/testing, regulatory knowledge, and biomanufacturing. The Corridor is home to four research universities and is the sixth largest recipient of National Institutes of Health (NIH) funding in fiscal year 2019. Market demand for biohealth tech will increase with population increases and exporting potential; there is a strong innovation support organization.

- **Power electronics for transportation:** This nascent industry cluster has high growth potential and strong innovation assets with PowerAmerica. A cluster of power electronics and semiconductor companies lies in the Research Triangle area and west to Greensboro. Further, the transportation industry is set for disruption as electric vehicles (EVs) replace gas powered. Truck, automotive, and aerospace companies, and their supply chains, can position themselves for power electronics application needs for growth trends in this area in the future.

- **Defense innovation:** The cross-cutting defense industry is under disruption, with the Department of Defense (DOD) incorporating innovation methods that will drive industry from staid, large prime contractors to smaller, nontraditional solution providers. The state is well positioned with the fourth-largest footprint of military personnel and veterans who understand military application domains. The Research Triangle's strengths in computer programming, data science, and artificial intelligence, coupled with an opportunity for secondary industry benefits through dual-use technology

commercialization, leaves the Corridor in a strong position to build out a National Security Innovation Network and DOD-funded research and test sites.

Our vision for each of the industry cluster focus areas is to support a mix of actors across the region, working with small, medium, and large businesses to work with their strengths and build clusters. ***Table 4.1*** summarizes the definition of each industry, the proposed vision for growth, and areas of action to set a common strategy that better unifies the assets and potential of the Innovation Corridor.

Table 4.1. Industry Focus Areas for the Innovation Corridor

Industry Title	Definition	Vision	Areas for Action
Agtech	Life science, digital tech, and other tech to improve or disrupt the agricultural sector	Become a global leader in developing, adopting, and integrating high-impact agtech applications, propelling a modern golden age of agriculture in NC	▪ Build on the momentum of the private sector to grow the livestock waste-to-energy subsector ▪ Invest in Ag-biotech start-ups and scale-ups ▪ Incentivize farmers to adopt technology for improved farm productivity
Biohealth	Pharmaceuticals, medical devices, diagnostics, and other applications of biotechnology, engineering, and health technology	Establish a leading biohealth epicenter in the United States, utilizing all the assets in the ecosystem including universities, hospitals, health centers, private companies, and pharmaceutical manufacturers	▪ Build out a full ecosystem of small-, medium-, and large-scale companies ▪ Expand small-scale manufacturers
Power Electronics for Transportation	Application of high-capacity, wide-bandgap technology for the electric vehicle industry	Position NC as "electric motown" for the next generation of transportation technology	▪ Retain and attract key innovative companies ▪ Invest in skill development ▪ Establish an open silicon carbide foundry

(continued)

Table 4.1. Industry Focus Areas for the Innovation Corridor (continued)

Industry Title	Definition	Vision	Areas for Action
Defense Innovation	Application of new technologies and processes to meet national security needs and enable technical superiority for the U.S. Department of Defense (DOD), with a focus on human performance, data science/artificial intelligence, cybersecurity, and others	As the defense industry is disrupted through innovation initiatives and structural changes, position NC as a place for nontraditional innovation to capture an increased share of DOD spending in emerging areas of R&D, products, and services	▪ Coordinate among defense-related actors in the state ▪ Establish a defense innovation hub with connection to NC bases ▪ Certify companies for cybersecurity

Source: RTI International.

The subsequent sections outline each of the four industry sectors. For each sector is an overview of the industry's potential, the global market potential, and concrete ideas for action for stakeholders to convene around in the Innovation Corridor. We believe these industry-focused actions can guide region-wide growth, positioning existing assets to be more competitive and strengthening regional value chains.

Agricultural Technology (Agtech)

Definition, Market Potential, Requirements, and Assets to Leverage

Agtech applies the tools of life science, digital, machine learning, and other forms of technology to improve or disrupt the global agricultural sector. These technologies typically focus on enhancing the productivity, efficiency, sustainability, and/or profitability of the global agriculture industry.

North Carolina can become a global leader in developing, adopting, and integrating high-impact agtech applications, propelling a modern golden age of agriculture in North Carolina and beyond. This booming agtech industry would require

- active collaboration among large firms;
- innovative start-ups;
- state-funded research institutions; and
- forward-leaning farmers to fuel unprecedented gains in on-farm productivity, efficiency, sustainability, and profitability across the state.

Each of these areas (livestock waste-to-energy, agricultural biotech growth, and integrated tech in farming operations) has the potential to have wide-reaching impacts across the Corridor, including research laboratories in RTP, large- and small-scale farming in all 100 counties, and the entire farming and food supply chain.

A modern golden age for North Carolina agriculture would be enabled by a dynamic, integrated ecosystem of agtech developers and users that see their success as inextricably linked.

The convergence of North Carolina's biotech capabilities and agricultural economy points to opportunities for growth in three key areas. Each of these areas (livestock waste-to-energy, agricultural biotech growth, and integrated tech in farming operations) has the potential to have wide-reaching impacts across the Corridor, including research laboratories in RTP, large- and small-scale farming in all 100 counties, and the entire farming and food supply chain.

Livestock waste-to-energy. North Carolina's ample biomass resources (e.g., manure from hog farming operations) from small to large farms can be transformed from an underutilized asset to a valued renewable natural gas (RNG) fuel source, bringing added income to farms across the Corridor.

In 2025, the total global addressable biogas market value (combined for all bioenergy sources) is expected to be $37.7 billon, with 45% of this expected to be derived from agricultural waste.

As the third richest state in bioresources in the nation,[41] North Carolina has the assets to build a thriving livestock waste-to-energy sector. Animal biomass makes up approximately 60% of the state's total bioresources, with over 2,200 hog, 160 dairy, and 5,700 poultry farms. Anaerobically digesting all manure produced on the state's swine farms (8.7 million tons annually) would exceed the total energy consumed by 70,000 households.[42]

One example brings together a large global leading food processor with an energy utility and local farmers. Smithfield Foods, the largest manufacturing employer in the state,[43] is a

[41] National Renewable Energy Laboratory. (2013, October). *Energy analysis: Biogas potential in the United States* (NREL/FS-6A20-60178). U.S. Department of Energy. https://www.nrel.gov/docs/fy14osti/60178.pdf

[42] Goldstein, N. (2018, September). *Moving the biogas needle in North Carolina.* BioCycle. https://www.biocycle.net/2018/09/11/moving-biogas-needle-north-carolina/

[43] North Carolina Department of Commerce. (2019). *North Carolina's largest employers*.

key driver of growth in the sector. It has set an ambitious goal to reduce its carbon emissions by 25% by 2025, with the intent to create waste-to-energy projects across 90% of its hog finishing spaces in North Carolina and beyond. The company created a joint venture with Dominion Energy called Align RNG and is supporting many of the biogas investments being undertaken across the state. This goal and partnership provide an excellent step from which to encourage more sector-wide growth and transformation.

Agricultural biotech growth. Agricultural biotech (Ag Biotech) is the application of biotechnology tools such as traditional breeding, genome editing, synthetic biology, and genetic engineers to alter living organisms, or parts of organisms, as a means to enhance the productivity, efficiency, and resilience of agriculture.[44,45] The Corridor exhibits nationally recognized strengths in plant gene editing utilizing clustered regularly interspaced short palindromic repeats and in biologics and plant stimulants. Biotech-enabled animal health and nutrition, such as for animal gut health, represents another subsector gaining traction across the Corridor.

In 2030, 10 years from now, the total global addressable ag biotech market value is expected to be $107.7 billion, of which crop biotech is expected to account for $58.8 billion and animal biotech is expected to account for $48.9 billion.

North Carolina is home to a world-class ag biotech industry cluster that it can leverage for more broad-based and future growth for the Innovation Corridor and beyond. Over 100 ag biotech companies span multinational corporations and innovative start-ups in the state. More than 50% of those companies are in the Research Triangle, giving the region a natural cluster from which to expand support and services to these companies. This cluster is gaining momentum, signaling future growth. Since 2010, 18 Ag-Biotech companies have

https://files.nc.gov/nccommerce/documents/LEAD/Top-Employers/Manufacturing_Employers_Only_2019_Corrected.pdf

[44] Bergin, J. (2020, April). *Agricultural biotechnology: Emerging technologies and global markets*. BCC Research. https://www.bccresearch.com/market-research/biotechnology/agricultural-biotechnology-markets-report.html

[45] U.S. Department of Agriculture. (n.d.). *Agricultural biotechnology glossary*. https://www.usda.gov/topics/biotechnology/biotechnology-glossary

announced prospective investments summing more than $1 billion. Signals of the state's attractiveness for business in this sector include more than 50% of companies being founded in or relocating to the state since 2010.[46] Innovation Corridor universities such as Duke, NC A&T, NCSU, and UNC-CH are cited by industry leaders as tremendous partners in the ag biotech field. NCSU's $150 million Plant Sciences Initiative is poised to become a world-class resource accelerating the state's ag biotech contributions even further.

Focusing on integrating technology to farmers is important to the Innovation Corridor because North Carolina boasts tremendous agricultural diversity and significant economic impacts to the NC economy including $91 billion in yearly economic activity.

Integrated tech into agriculture to empower farmers. Farmers across North Carolina are longstanding producers and employers across the state. With better technology applications, data specialization techniques, and farmer-facing adoption incentives, farmers can be more consistently profitable, operating more sustainable businesses.

The Innovation Corridor is well positioned to fill a significant market gap in proving models for small and medium-sized farmers to use agtech. The Corridor then becomes not only a leader in developing agtech, but also a proof of concept for small and medium-sized farmers, especially in the precision agtech space. If inventors, businesses, and farmers can bring the combination of crop biotech, precision agtech, and sustainable business models to bear for small and medium-sized farmers, the Corridor stands to not only unlock untapped market opportunity for agtech developers, but also to enhance productivity, efficiency, sustainability, and/or profitability of North Carolina farmers, a recipe for the Corridor to drive substantial industry transformation.

In 2025, the total global addressable crop agtech market value is expected to be $62.1 billion. This total comprises primarily crop biotech, and $9.3 billion is attributed to the precision agtech market.

Focusing on integrating technology to farmers is important to the Innovation Corridor because North Carolina boasts tremendous agricultural diversity and significant economic impacts to the NC economy including $91 billion in yearly

[46] Shank, K., & Johnson, S. (2019, January). *North Carolina ag tech: Economic growth report*. North Carolina Biotechnology Center. https://www.ncbiotech.org/sites/default/files/inline-files/AgEconomicGrowthReport_Jan%202019%20-%20rev.1%20FINAL.pdf

economic activity.[47] Marrying this with the boom in precision ag and "smart farming" creates vast opportunities for North Carolina farmers. Further, North Carolina has a unique innovation opportunity with its generally smaller and more diverse operations as compared with its Midwest counterparts. Large farms are more likely to adopt precision agricultural technologies, which often are used in tandem with one another.[48] Making integrated suites of precision ag (and ag biotech) work for small farms like those representative of North Carolina agriculture stands as a big challenge—and exciting innovation opportunity—poised to tap into a currently underrepresented market segment.

Impacts and Next Steps to Realization

Together, these three facets of the agtech sector would have economic, employment, and growth impacts across the Corridor, likely encouraging growth in large and small to medium-sized companies particularly in livestock production, crop production, animal biotech, crop biotech, and precision agriculture. With integrated and stronger approaches to help farmers adopt new technologies, the implications for more efficient and productive small and large farms would compound the impacts of a robust agtech sector to individual farmers across the region. With 17% of the state's workforce in agriculture producing over 80 commercially grown crops across approximately 48,000 farms, coupled with the potential of the accelerating rate of innovation in agtech from the state's companies and universities, focused growth of the agtech industry of North Carolina offers a transformative effect on this important longstanding cluster in the state.

For North Carolina to realize its potential as a global leader in developing, adopting, and integrating high-impact agtech applications, it will need to boldly pursue the following:

- **Invest in agtech start-up and scale-up businesses.** Animal biogas shows significant potential as a growth sector across a broader region of the Innovation

[47] North Carolina State University. (n.d.). *N.C. agtech and agricultural assets: Agtech industry*. https://cals.ncsu.edu/psi/n-c/

[48] Schimmelpfennig, D. (2016, October). *Farm profits and adoption of precision agriculture* (Economic Research Report Number 17). U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/webdocs/publications/80326/err-217.pdf?v=0

Corridor and beyond. Creating and accessing investment mechanisms that can reduce risk and/or that are familiar with this emerging market could alleviate the barriers in place for more widespread sector growth. More broadly, the start-up ecosystem is underfunded, with many perceived investments going to larger, more established companies. Efforts to expand the potential for start-up and scale-up companies could ignite more sector-wide growth.

- **Incentivize farmer participation.** Farmers are more likely to adopt these technologies if they can see that the technologies work *and* result in profits and efficiency gains that make the investment worthwhile. Unlike large farms in the Midwest, the relatively smaller farms in North Carolina operate under smaller margins. Weather events and low commodity prices further narrow these margins. The time, money, and short-term risks associated with changing how one farms can be high. It will be important for agtech stakeholders to make efforts to understand each farmers' needs, not presenting a one-size-fits-all approach. North Carolina's Agricultural Extension program, through NCSU and NC A&T, is an important tool to bring technology to the farmer. Agtech application bundles that are tailored to meet individual farmers' business needs and opportunities will drive greater profitability. Experts express optimism about the change that may be ahead as second- and third-generation farmers who grew up as "digital natives" take on expanded farm leadership roles. Incentives to encourage current and future farmers to embrace digital technology will be especially important to accelerate technology adoption. Cost-sharing schemes and project management support will help farmers take advantage of the market opportunities in animal biogas.
- **Foster growth in an animal biotech subcluster.** Animal biotech represents a large market opportunity that North Carolina is uniquely poised to seize. The state, not just the Corridor, has many companies innovating in animal health and nutrition including areas such as gut health, feed additives, vaccines, and other applications. The state's sizable livestock industry and NCSU's veterinary school—one of only 30 in the country—provide further assets from which to build a cluster of businesses and research organizations that can better capture the market potential.
- **Improve rural infrastructure including broadband and natural gas pipeline access.** Industry

representatives shared that farmers and businesses in agriculture cannot take advantage of growing agtech markets with poor broadband internet access. Many agtech applications require internet access for full functionality, especially tools for connected systems that share data between equipment and locations.

Connecting RNG to the natural gas pipeline is difficult, and as a result, it is a significant barrier limiting agtech industry growth in the waste-to-energy subsector. Improving access to the natural gas pipeline will help livestock farmers better capture the market for this emerging sector.

- **Deepen collaboration as industry grows.** Efforts to build more collaborative networks for agtech can get lost amid the much larger health biotech sector. The state has much to showcase with its biotech cluster, and agtech has much to leverage with the biotech-related assets. Industry experts state that low-cost ways to bring people together specifically in agtech could prove helpful (e.g., speaker series, joint events). This can help foster collaboration among industry representatives, researchers, and others.

Biohealth Technology

Definition, Market Potential, Requirements, and Assets to Leverage

Biohealth technology (biohealth) encompasses the discovery, development, and production of pharmaceuticals, medical devices, diagnostics, and other applications of biotechnology, engineering, and health technology to solve biological or medical problems related to human health.

The Innovation Corridor has the potential to become a leading biohealth epicenter in the United States. North Carolina has all the key ingredients of a comprehensive, healthy biohealth ecosystem, from technology innovators to end users. To realize this vision, the sector will require the following:

- Concerted efforts to help new and emerging companies cross the technology "Valley of Death." As companies are better positioned to advance their technologies past the proof-of-concept stage, more investors and commercialization partners will be attracted to the state, which would in turn create more of a critical mass of companies, investment, and R&D.
- A competitive business climate to attract established biohealth companies to relocate to North Carolina, as

well as to encourage new and emerging companies to stay and grow in the Corridor.

- Additional workforce development programs to meet the needs of the growing biomanufacturing sector. As this subsector continues to flourish, there could be exponential economic and job growth for North Carolina across a wider geography in the state.

RTI proposes two specific areas to strengthen the biohealth sector in the Innovation Corridor:

Build a robust presence of start-up, scale-up, and established biohealth companies

The Innovation Corridor has a strong start-up culture, and by further supporting biohealth companies to advance the stage of their technologies, it will in turn further attract investors and commercialization development partners to build out the biohealth cluster. Active collaborations between companies and health care providers could further enhance North Carolina's position in the biohealth industry. With a robust talent pool of skilled manufacturing workers in biohealth, large- and small-scale bio and pharma manufacturers will be better positioned for further growth.

These kinds of efforts will position North Carolina to better capture the global medical device market, which was valued at $425.5 billion in 2018. The market is expected to grow to $612.7 billion by 2025.[49] As of 2018, North Carolina's medical device subsector (defined as medical devices and equipment) supported 11,639 jobs with $800 million in labor income, generating $92 million in state and local government revenues.[50] North Carolina is well positioned to grow this

[49] Fortune Business Insights. (2019, April). *Medical devices market size, share and industry analysis by type (orthopedic devices, cardiovascular devices, diagnostic imaging, IVD, MIS, wound management, diabetes care, ophthalmic devices, dental & nephrology), end user (hospitals & ambulatory surgical centers and clinics) and regional forecast, 2019–2025)* (Report ID: FBI100085). https://www.fortunebusinessinsights.com/industry-reports/medical-devices-market-100085

[50] TEConomy Partners, LLC. (2018). *2018 Evidence and opportunity: Impact of life sciences in North Carolina*. Prepared for North Carolina Biotechnology Center. https://www.ncbiotech.org/sites/default/files/inline-files/TEConomy%20-%20NCBiotech%20Report%202018%20%28Final%202%20-%20Print%29.pdf

subsector, which will multiply jobs, income-earning opportunities, and revenue for the state.

The Innovation Corridor has many innovation assets to leverage to grow this industry cluster, including the following:

- Universities—including four R1 research universities and four university-affiliated medical centers—rich with commercializable IP. As more basic research is advanced into relevant industry applications, the number of start-ups and spin-outs into industry will multiply.
- Strong and growing presence of start-ups and global companies, which include LabCorp, TransEnterix, and Cook Medical.
- Sixth state in fiscal year 2019 research awards, totaling $1.6 billion, from NIH.[51]
- A vibrant life science sector that has attracted $1.7 billion in investments and created 3,000 new jobs in 2019,[52] a large majority of which are in biohealth.
- Current regional research agendas in regenerative medicine, nanotechnology, drug discovery, and rural health, which are relevant for growth in the biohealth sector.
- Five major medical centers—including top-tier medical facilities in Greenville, Durham, Raleigh, and Chapel Hill—and 126 hospitals in 84 counties across the state.

[51] National Institutes of Health (NIH). (n.d.). *NIH awards by location & organization*. U.S. Department of Health and Human Services. https://report.nih.gov/award/index.cfm#tab1

[52] North Carolina Biotechnology Center. (n.d.). *2019 was another year of growth*. LinkedIn. https://www.linkedin.com/posts/north-carolina-biotechnology-center_lifesciences-transformnc-activity-6620429939214737408-SUki/

As the industry moves toward precision medicine, there is a need to move from mass production to adaptable, on-demand manufacturing. North Carolina has a good presence in large-scale biomanufacturing, but we are missing an opportunity to build out smaller-scale production.

Expand small-scale biomanufacturers

As the industry moves toward precision medicine, there is a need to move from mass production to adaptable, on-demand manufacturing. North Carolina has a good presence in large-scale biomanufacturing, but we are missing an opportunity to build out smaller-scale production. Building out a better infrastructure and business environment to adapt to these market shifts will position the state to better capitalize on this market opportunity, in addition to creating jobs and expanding business opportunities across the Corridor.

The pharma contract development and manufacturing global market size is expected to grow by over $36 billion: from $90 billion in 2018 to $126.6 billion in 2024.[53] The Innovation Corridor is well positioned to better capture this global market growth. North Carolina stands apart from other locations with its existing large-scale manufacturers and the strong presence of contract research organizations. In fact, North Carolina leads the country in biopharma manufacturing by total employment[54] and is second in concentration of pharma manufacturers next to California. In 2020, 80 North Carolina biopharma sites supported 26,800 manufacturing employees, and, by 2024, employment is expected to grow by 5,000 jobs.[55] Further signals of potential growth in employment and businesses could occur if the state were better positioned to support small to medium-sized manufacturing. Currently, North Carolina has limited support for small-scale manufacturers. As the industry moves toward precision medicine, there is a need to diversify the large-scale manufacturing strength and incorporate adaptable, on-demand manufacturing abilities. Expanding the infrastructures to react to this shift will strengthen North Carolina in the long term.

[53] MarketsandMarkets. (2019, July). *Pharmaceutical contract development and manufacturing market by service, end user global forecast to 2024*. https://www.reportlinker.com/p05803740/Pharmaceutical-Contract-Development-and-Manufacturing-Market-by-Service-End-User-Global-Forecast-to.html?utm_source=PRN

[54] Economic Development Partnership of North Carolina (EDPNC). (n.d.). *Biotechnology & pharmaceuticals*. https://edpnc.com/industries/biotech-pharmaceuticals/

[55] North Carolina Biotechnology Center. (2020). *NC's biopharma workforce key to success of life science sector*. https://www.ncbiotech.org/news/ncs-biopharma-workforce-key-success-life-science-sector

Impacts and Next Steps to Realization

North Carolina has the potential to capture a more significant section of the biohealth market over the next 5 years, resulting in more R&D, spin-outs, and start-ups; investment in the state; and a rejuvenated small-scale manufacturing base across the Innovation Corridor in a globally competitive industry sector. More investment, small to medium-sized companies, and trained labor in this sector naturally attract a greater number of large and small companies to the area, building out a robust biohealth industry cluster.

To help realize this vision, a multifaceted approach will be needed. Areas of focus will likely include the following:

- **Increasing Access to Investment for R&D, Start-Ups, and Scale-Up Companies.** Biohealth companies are struggling to overcome the "valley of death" in commercialization of new technologies that have the potential to spawn a new generation of companies in the Innovation Corridor. Improved ways to attract R&D and investments in companies—especially at the proof-of-concept and scale-up stages—will greatly increase the odds of the Innovation Corridor becoming a global epicenter for biohealth. Expertise of business and industry professionals to guide companies through these critical stages will also be required.
- **Cultivating collaborations between industry and medical facilities.** The Corridor's competitive advantage in biohealth will be enhanced by supporting strategic emerging areas like digital health and precision medicine through stronger partnerships between technology developers and health care end users. These partnerships will provide early feedback on technology value propositions and can contribute to early stage testing to better inform technical and operational feasibility and influence product design. These types of collaborations will help advance the technologies' stage of development and further contribute to overcoming the "valley of death."
- **Fostering a business-friendly environment to drive vertically integrated companies to North Carolina.** Experienced commercialization partners are critical to a company's success in scaling up. Attracting and growing vertically integrated development and commercialization biohealth companies in North Carolina will help ensure direct impact on North Carolina's economy.

Workforce development programs, such as the Golden LEAF Foundation and Wake Tech BioWork program, have been successful, but the demand still outweighs the labor force supply.

- **Providing additional office, laboratory, and manufacturing space.** Companies report growing pains in the Innovation Corridor. As companies hire more employees and have greater infrastructure needs, they require more space to expand. Additional real estate investment in incubators, shared biotech laboratories, mixed laboratory–office spaces, and manufacturing sites conducive to small-scale manufacturing will foster more growth in the biohealth sector.
- **Expanding workforce development programs.** To meet the needs of such manufacturing shifts, stakeholders in the Corridor will also have to consider workforce demands. Existing manufacturing workforce development programs, such as the Golden LEAF Foundation and Wake Tech BioWork program, have been successful, but the demand still outweighs the labor force supply.

Power Electronics for Transportation

Definition, Market Potential, Requirements, and Assets to Leverage

The value chain for transportation manufacturing is set for disruption. New developments in Power Electronics utilizing wide-bandgap (WBG) materials are enabling next-generation EVs that will replace internal combustion engine–powered vehicles, transforming the automotive industry and the transportation sector in general.

North Carolina can leverage its existing power electronics cluster to create a global hub for research, development, and manufacture of next-generation electric vehicles, components, and supporting infrastructure.

North Carolina can leverage its existing power electronics cluster to create a global hub for research, development, and manufacture of next-generation EVs, components, and supporting infrastructure. Not only will this help the Corridor build a thriving industry sector, but it will also help ease negative impacts in the current supply chain from these expected disruptions. Driven by the need to reduce carbon emissions from fossil fuel use and innovations in electrical energy storage and power conversion, the automotive industry is expected to convert largely to EV production over the next 10 years.

A key enabler of this transformation is the commercialization of WBG materials in power electronics, which enables the design of EVs that are competitive with, or even superior to, internal combustion engine–powered vehicles in key buying criteria like

purchase price, total cost of ownership, range, and acceleration.

To realize the potential of the Corridor's power electronics industry cluster, the following is required:

- Talent trained in the specialized skills inherent in Power Electronics for Transportation (as the industry shifts from the current powertrain-related jobs to electric motor manufacturing, EV-specific transmission manufacturing, WBG power electronics device and module manufacturing, and electronic control design and manufacturing for electric motors and charging systems).
- National centers of excellence (PowerAmerica, FREEDM Systems Center) must continue to invent and develop key WBG power electronics technologies for applications.
- Access to the projected $300 billion investments expected in EV production by 2030.
- A strategy for silicon carbide with initial focus on EV that will lead to growth across sectors including smart grid, 5G, aerospace, and other power applications.

Volvo Group's North America R&D technology center in Greensboro is investigating electrification of heavy trucks, and Piedmont Community College collaborated with Tesla in developing one of its first EV service training programs. These assets, combined with the greater transportation supply chain across the state, further establish a foundation from which an innovative industry can thrive.

The Corridor is home to companies and research organizations with enabling skills, resources, and technologies, poised for leadership in the WBG power electronics supply chain. Many key players in this market are located in RTP, including manufacturers (Cree/Wolfspeed, Delta Electronics, ABB, Eaton, and others), and Qorvo (located in Greensboro), that are actively pursuing EV applications and participating in research from R&D centers (PowerAmerica and FREEDM Systems Center). In vehicle manufacturing, Volvo Group's North America R&D technology center in Greensboro is investigating electrification of heavy trucks, and Piedmont Community College collaborated with Tesla in developing one of its first EV service training programs. These assets, combined with the greater transportation supply chain across the state, further establish a foundation from which an innovative industry can thrive.

Today, there are over 230 unique automotive companies in North Carolina,[56] including engine and transmission

[56] Economic Development Partnership of North Carolina (EDPNC). (n.d.). *Automotive, truck & heavy machinery*. https://edpnc.com/industries/automotive/

manufacturing, that may be negatively affected by global industry transitions to EVs. Engine and transmission manufacturers and component suppliers are particularly vulnerable. These same businesses are also well poised to get ahead of industry trends to capture a growing new market.

Electric motown. Our vision is that North Carolina is recognized as a global hub for vehicle electrification, nurturing a thriving ecosystem of R&D and manufacturing. Ultimately, these components will attract EV original equipment manufacturers that will employ thousands of skilled workers, bring tax revenue to the state, and attract additional suppliers to the state.

This year, the Power Electronics market is estimated to be about $1 billion, of which about 10% is WBG. In only 7 years, the share of the power electronics market represented by WBG products is expected to reach 40%. By 2027, the total value of the global WBG power electronics market is expected to be $13 billion. To claim more of this growing market, steps to better coordinate and leverage the significant aviation cluster in the Piedmont Triad and the emerging WBG hub in the Research Triangle area will need to be taken. Ideas for stakeholders in the Corridor to consider are as follows:

- **Create an industry strategy to retain and attract key innovation companies.** Although the effectiveness of incentives in general is debated in economic development circles, New York and other states may continue to lure companies away from or outcompete North Carolina for new projects. Developing a proactive promotion strategy targeting innovative power electronics firms and EV suppliers that highlights the many advantages of North Carolina as a location for vehicle electrification will augment the Corridor's ability to attract and retain companies in this sector. New York, for example, is eager to create an "EV City." The city used $500 million in incentives to attract Cree/Wolfspeed's $1 billion wafer manufacturing plant from North Carolina. This signals the attractiveness of some of the Corridor's leading assets. With an industry strategy, the Corridor can be prepared to protect its asset base whether or not the use of incentives is a desired tool to use. It may be important to include economic impact studies or cost/benefit analyses to best determine the long-term potential of investments in the sector.

- **Increase job training and skill development.** The region is home to many excellent training programs for manufacturing workers. As the power electronics sector grows, the demand for more skilled workers in this sector will, too. Relevant training will need to expand across the Corridor to provide a talent pool for companies.
- **Establish an open silicon carbide foundry.** Cree is vertically integrated and owns its own silicon carbide device fabrication facilities (fabs). Although Cree will grow rapidly, its fab is closed to other "fabless" device design development firms, which use open fabs in Texas and elsewhere. Establishing an open silicon carbide foundry would attract "fabless" device design companies to the area, especially with the existing silicon carbide power electronic assets that exist in the Corridor. This in turn would attract downstream module, subsystem, and system manufacturers that would benefit from working closely with device developers. Ultimately, the ecosystem would be more robust and more complete across the value chain. Cree is a critical partner to the development of the power electronics sector and it will be important to work with the company on the creation of an open foundry in the Corridor.
- **Establish or attract funding for power electronic hardware start-ups.** Unleashing more funding for start-ups in power electronics will create a much more dynamic ecosystem. Signals show unrealized potential. For example, the FREEDM Systems Center has an extensive portfolio of valuable IP. One interviewee reported that the IP languishes due to lack of start-up capital focused on hardware technology.

Defense Innovation

Definition, Market Potential, Requirements, and Assets to Leverage

Today's defense industry is changing—from major prime contractors providing products and services to meet DOD's needs through slow, traditional acquisition pipelines, to nontraditional and entrepreneurial small companies connecting directly with DOD's end users. Over the past few years, DOD has been enacting changes to create a new focus on innovation, to quickly problem-solve and apply modern technologies for the warfighter. Cybersecurity, however, is a threat to this new paradigm. DOD needs agile and innovative companies with

cyber-secure business processes to support DOD's needs with tomorrow's technology.

We envision North Carolina to be the future hub of innovation for the defense industry, with innovative, secure, high-quality companies and organizations providing research, products, and services to DOD. DOD is increasing focus on soldier-centered design and cutting down the years-long process of needs-to-requirements-to-acquisitions to be more agile and responsive to demands of the soldier. Defense programs such as the Defense Innovation Unit, SOFWERX, AFWERX, and so on are using user-centered design techniques to assist nontraditional problem solvers in meeting military users' needs.

As the state with the fourth-largest footprint in DOD personnel[57] and seventh in veteran population,[58] North Carolina has the military user knowledge and experience to understand operating environment constraints and security needs. On the technology and innovation side, North Carolina ranks high in R&D capabilities with strong research universities and research centers focused on emerging technology areas. The Corridor's proximity to and overlap with major military facilities in the eastern part of the state position it well to lead in new defense technology.

[57] Office of Economic Adjustment. (2018). *Defense spending by state: Fiscal year 2018*. U.S. Department of Defense. http://oea.gov/dsbs-fy2018

[58] National Center for Veterans Analysis and Statistics. (n.d.). *North Carolina state summary*. U.S. Department of Veterans Affairs. https://www.va.gov/vetdata/docs/SpecialReports/State_Summaries_North_Carolina.pdf

The state has the potential to gain more defense contracts by helping nontraditional companies identify opportunities in the defense market, navigate complex government contracting requirements, gain access to funders and users with needs, and develop cyber-secure business processes.

Given North Carolina's strong military footprint, it is surprising that it ranks 23rd in defense contract spending. One of the many reasons for this is that no major prime contractors are headquartered in the state. However, given the changing nature of the industry, the state has the potential to gain more defense contracts by helping nontraditional companies identify opportunities in the defense market, navigate complex government contracting requirements, gain access to funders and users with needs, and develop cyber-secure business processes. Additionally, North Carolina can increase its leadership in emerging technology areas of defense innovation such as data analytics, human performance, advanced manufacturing.

Accessing more defense contracts for North Carolina companies will not only enable company growth in the defense market, but also help these companies develop new commercial products. Defense R&D funds provide nondilutive capital for small companies, allowing them to retain their IP. Research shows that a 10% increase in government-financed R&D generates 4.3% additional privately funded R&D.[59]

Further, DOD needs more than research and technology development; it needs places to bring users and technology developers together to co-design and test solutions that can be used in practice in the field. North Carolina can create or augment test beds and test sites near the bases to facilitate these exchanges and move technology further into the hands of the military users.

To reach this vision, the following is required:

- Innovative, high-quality companies providing research, development, products, and services in DOD secure business settings. Businesses in the DOD supply chain in the Corridor need to have cybersecurity certification.
- Ability to readily understand and engage with DOD as research contractors.
- Real estate investment in innovation hubs, a model similar to the Capital Factory in Austin, Texas, that

[59] Moretti, E., Steinwender, C., & Van Reenen, J. (2019, November). *The intellectual spoils of war? Defense R&D, productivity and international spillovers* (Working Paper 26483). National Bureau of Economic Research. https://eml.berkeley.edu/~moretti/military.pdf

provides an innovation working space bringing together inventors, investors, and users.

- Test facilities near military bases with access to end users or military personnel to test and verify that research and products meet the demands.

North Carolina is well positioned to grow as a robust defense innovation sector building out an innovation-focused industry cluster of secure innovation-focused businesses that can create, pilot, and test defense industry innovations. It is a rapidly emerging market, ranking first or second in job growth for defense sector growth areas of data and knowledge management, human performance, advanced manufacturing, and power technologies.

The Innovation Corridor can capture a greater share of DOD spending, making this sector appealing for long-term transformative growth. At present, North Carolina gets 2.2% of the DOD budget, or $4 billion, in DOD contracts for products and services, but only 3% of the state's DOD contracts are in R&D. Yet the Innovation Corridor is home to some of the country's strongest research-based assets. Budget projections reveal that the U.S. defense budget is expected to be $937 billion by 2030, with a defense innovation budget of approximately $515 billion.[60] We estimate that the state has an opportunity to capture $30 billion of this defense innovation contracting if it focuses efforts to grow North Carolina's organizations in key technology areas of future DOD needs; bring companies, funders, and users together to generate and test innovative solutions in these technology areas; and enable cybersecurity through a rigorous program of company certification. Attracting R&D funding is important because it often results in additional private-sector investments, more people trained in tech-related jobs, new company formation, and other employment spillovers, thus creating a compound effect for economic development.

Currently, North Carolina has a defense support infrastructure with economic development and industry organizations to foster growth in defense innovation. The Corridor has a foundation in

[60] Congressional Budget Office. (2020, January). *The budget and economic outlook: 2020 to 2030*. Congress of the United States. https://www.cbo.gov/system/files/2020-01/56020-CBO-Outlook.pdf

innovation from which to build out the sector's potential. Assets include

- the DOD National Security Innovation Network's Southeast Region headquarters (established in Durham in 2018);
- world-class research laboratories, programs, and facilities including NCSU's National Security Agency–funded Laboratory for Analytic Sciences;
- the Army Research Office, the major funding arm for army basic research, headquartered in RTP; and
- over 84,000 veteran-owned businesses, some of which can readily transition to secure innovation-based businesses to support growth in defense innovation.

North Carolina also has an advantage of hosting the fourth largest contingent of military personnel from most of the agencies, including Army, Marines, Navy, and Air Force. These bases are located in generally rural spaces with the potential to acquire large tracts of land on which to build test sites. One such test site already exists for U.S. Special Operations to test drones.

Further signals of the state's positive position in this sector is the fact that North Carolina was a finalist for the Army Futures Command. The state ultimately lost to Texas because of the proximity to STEM workers, private-sector innovators, academia, quality of life, and civic support that Austin offered.[61] More opportunities like this will be lost if stakeholders are not focused and aligned.

Impacts and Next Steps to Realization

Building a secure industrial base in North Carolina, with test beds and connection to military users, will help companies attract more DOD research contracts to build out a more widespread industry cluster for defense innovation in the Innovation Corridor. This could have implications for businesses in data analytics, human performance, textiles and performance materials, and many other related industry areas. North Carolina's universities will build research budgets by winning contracts to solve DOD needs. DOD-focused technology

[61] Gronberg, R, & Murphy, B. (2018, July 13). Raleigh loses out on Army Futures Command center. *The News & Observer*. https://www.newsobserver.com/news/business/article214569155.html

accelerators and test/transition centers will become the supporting infrastructure to grow new companies aimed at meeting defense needs.

To help realize this vision, stakeholders of the Innovation Corridor can consider:

- **Convene defense-focused support organizations to clarify roles and responsibilities.** To best grow the sector and take advantage of the state's assets in defense innovation, relevant entities can clarify their roles, partnerships, and ways to best network to focus on growing North Carolina's defense business. It will also help to clarify ways to seamlessly communicate roles to industry.
- **Move forward on implementation plans from the recent NC Defense Asset Inventory and Target Industry Cluster Analysis Study.** The study listed many recommendations focusing on developing the six technology areas identified as important to the future of DOD via targeting DOD programs with funds and bringing program managers to meet with companies and organizations in these focused areas. The study's major next step is to establish implementation teams made up of North Carolina stakeholders focused on attaining defense contracts in each technology area.
- **Establish a defense innovation and testing hub in a central location near the bases.** Engage DOD innovation leaders, real estate developers, and the appropriate defense support organization to discuss establishing a central location, near the bases, for a defense innovation hub. The Army Futures Command has a $32.4 billion budget, some of which will be spent in Austin. It is attracting defense contractors, start-ups, consulting firms, and other support industries.
- **Certify North Carolina companies in cybersecurity business practices.** Organizations such as the North Carolina Manufacturing Extension Partnership and third-party providers are available to advise and certify companies in cybersecurity. DOD will require this certification of its supply base companies in the near future. A focused awareness campaign and a central information hub with a listing of qualified third-party certification providers can quickly guide companies to the right resources.

4.2 PEOPLE AND PLACE

Industry growth alone does not guarantee broad-based growth or access to participate in the innovation economy. Investments in people and place are also required to build talent pipelines and a workforce that drive new innovation and GDP and to attract businesses to locate across diverse geographies. The Innovation Corridor presents an interesting scenario for people- and place-based growth: Each of the cities that make up the Corridor offers a different mix of history, culture, quality of place, and innovation assets. We offer 10 considerations based on interviews and placemaking research for local planners and developers to consider when designing a strategic plan for the Innovation Corridor.

What Is Placemaking?

Placemaking combines physical space with social fabric integrating measures of cultural identity, equity, and accessibility alongside economic results. CityLab summarizes placemaking as strategies to "strengthen community identity and sense of place, and help revitalize local economies."[62]

People Focus

#1 Develop and Retain Tech Talent

Tech talent ready to participate in the local innovation economy begins with quality K–12 education. Currently, North Carolina ranks 49th in the United States for the level of elementary and secondary public school expenditures as a percentage of state GDP. As the Office of Science, Technology & Innovation noted, investments in K–12 education are a critical step in preparing a future innovation-capable workforce.[63] The quality of K–12 education varies across the Innovation Corridor. Interviewees in each hub echoed the need to prioritize student success, especially in areas outside the Raleigh–Durham–Chapel Hill region, so these K–12 graduates easily feed into the Corridor's strong higher-education institutions. Interviewees also noted that K–12 is central to recruiting families to the Corridor and providing a pipeline for future talent.

Given the enormity of needs for K–12 education, some communities are advancing what they can within their control. For example, the Greenville Chamber of Commerce partners with the school district and private-sector companies like Mayne Pharma to provide thousands of students with a firsthand look at the skills and occupations associated with a range of industries. Through this Grow Local program, students spend a

[62] Benfield, K. (2013, January 7). *4 Examples of powerful placemaking*. CityLab. https://www.citylab.com/design/2013/01/3-examples-powerful-placemaking/4329/

[63] See footnote 12.

week learning about the day-to-day activities of a chemist, a marketing professional, or an attorney.

The Corridor is saturated with higher-education options that graduate a broad range of talent—from engineers at NC A&T to the next generation of medical talent educated at ECU. Continuing to link students with opportunities in industry, innovation, and entrepreneurship—like the student teams at the Center for Entrepreneurship at Wake Forest University with Winston Starts—will be important.

#2 Invest in Women and People of Color

One interviewee captured this sentiment well, noting that in order to reach our region's innovation potential, "we have to go deep," investing equitably across the population of innovators, entrepreneurs, and business leaders who are often overlooked. For example, black women are the fastest-growing group of entrepreneurs in the United States, yet they received less than 1% of venture funding.[64] The population of the Corridor, like that of much of the country, is diversifying, and the opportunity to "go deep" is now—by intentionally backing diverse entrepreneurs and building supportive and accessible networks within the innovation ecosystem.

Other interviewees focused specifically on the needs for equity investments for people of color across the Corridor. One interviewee lamented that "white people get capital, while people of color get programs." Promising efforts to scale are Black Wall Street 2.0 and the Black Founders Exchange, aimed at enhancing access to resources, spaces, networks, and expert guidance for the diverse business leaders in our communities. Few interviewees mentioned the needs of Latinx communities despite the growing population. More exploration into the specific needs of other minority populations will be important to encourage full participation of all North Carolinians in the innovation economy.

[64] Williams, B. A. (2017, May 25). The tech industry's missed opportunity: Funding black women founders. *Fast Company*. https://www.fastcompany.com/40422830/why-the-tech-industry-is-hurting-itself-by-not-funding-black-women-founders

Place Focus

#3 Protect and Highlight Natural Assets

Current literature on placemaking highlights the importance of our surroundings while building places that inspire communitywide commitment, accessibility, and identity. The natural assets of the Corridor include places ranging from Pilot Mountain and Hanging Rock State Parks, urban parks such as Raleigh's Dorothea Dix Park, agricultural land, and coastal waterways. New developments should highlight those natural assets, taking advantage of features like river access, protected forests, and parks for local recreation. One interviewee noted the untapped potential of the Tar River in Rocky Mount, comparing it to the success of the manmade water flow through the redeveloped American Tobacco Campus in Durham.

#4 Build Walkable, People-Oriented Streets

Walkable, people-oriented streets are among the most valuable assets a place can have. Narrower roads with safe crossings, slower speed limits, safe sidewalks, a varied and continuous streetscape, and other elements of walkability are tied to improved health outcomes, improved business outcomes, and an improved sense of community. Increased walkability also generates greater return on investment for local governments. Dense, mixed urban development generates more property tax per acre than sprawling, big-box or strip mall development.[65] Local government zoning decisions should prioritize adaptive reuse of existing buildings, historic tax credits, reduced parking minimums, and design of streets and greenways that allow for people to spend more time out of their cars and connecting with each other through a variety of "live, work, play" options.

#5 Incorporate Arts

Quality placemaking draws from the unique assets of each location. The hubs across the Corridor have rich arts communities on which to expand for greater placemaking. These communities contribute public art, including murals and other art-related experiences, that deepens the sense of place

[65] Adapted from Quednau, R. (2018, December 4). Best of 2018: Why walkable streets are more economically productive. *Strong Towns*. https://www.strongtowns.org/journal/2018/1/16/why-walkable-streets-are-more-economically-productive-3bzg5 and from Transit Oriented Development Institute. (n.d.). *Elements of placemaking*. http://www.tod.org/placemaking.html

for each part of the Corridor. For example, Wilson designed its Whirligig Park to highlight its arts assets in a centralized open space. Durham has commissioned new murals throughout the city, and businesses in Raleigh have added murals to their external facades.

Opportunities to elevate the arts, culture, and history can help foster more vibrant networks across an innovation ecosystem. A prominent planning researcher, Ann Markusen, notes that "not only is the arts a diverse, innovative, and export-generating economic sector, but a thriving arts scene … fosters a unique identity and workforce retention."[66] While researching quality of place, we found that arts and culture foster a sense of belonging for residents and reinforce desires to invest personally and professionally in that location. An interviewee noted how art transforms spaces, along with those who pass by, because "the eye feeds the mind which starts to change behavior." A 2013 study out of Michigan State University quantified this sentiment, drawing correlations among arts exposure, patentable inventions, and new company starts.[67] Moreover, community art and activities are widely accessible to residents, often celebrate important historical moments and people, and foster a shared pride or local "brand."

#6 Connect to Transit

Transit is a persistent challenge in a low-density, dispersed region without an existing high-capacity transit system. Current bus systems require additional investment in dedicated lanes for rapid-transit bus service, and an introduction of electric and autonomous vehicles.

The existing Wake Transit Plan calls for an enhanced commuter rail line between Durham and Garner, using the existing rail line.[68] An expansion of that plan, connecting high-frequency rail service to Wilson in the east and through Alamance County and the Piedmont Triad in the west, could generate opportunities to

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[66] Markusen, A., & Gadwa, A. (2010). *Creative placemaking*. National Endowment for the Arts.

[67] LaMore, R., Root-Bernstein, R., Root-Bernstein, M., Schweitzer, J. H., Lawton, J. L., Roraback, E., Peruski, A., VanDyke, M., & Fernandez, L. (2013). Arts and crafts: Critical to economic innovation. *Economic Development Quarterly*, *27*(3), 221–229. https://doi.org/10.1177/0891242413486186

[68] Go Forward. (n.d.). *Wake County: The plan*. http://goforwardnc.org/county/wake-county/the-plan/

build a truly connected Corridor with high-capacity, reliable transit.

#7 Expand Access to Broadband

For knowledge-based economic growth, broadband internet access is required. There is a sharp divide between broadband access and adoption rates between urban and rural areas, and in urban areas, income and access challenges persist across income levels. The connectivity of the Corridor will rely on ongoing expansion of broadband and public incentive structures that allow for low-cost, high-speed internet to currently disconnected residents throughout the region.

#8 Ensure Affordable Housing Options

The concentration of high-wage tech jobs in emerging urban centers alongside downtown revitalization efforts have generated an urgent demand for a new approach to housing affordability. For example, rapid growth in Raleigh and Durham is provoking fierce debates over gentrification and access to downtowns, which saw a surge in investment over the past decade. Local housing policies should promote affordable housing and medium-density development and ensure that new developments are accessible to people who have traditionally been excluded from planning processes and are most vulnerable to rapid change.

#9 Balance Tourism and Livability

Tourism is an attractive economic development strategy: Quality places can attract people to visit and spend money locally at hotels, restaurants, venues, sporting events, and local businesses. Local festivals, restaurants, breweries, arts events, concerts, sports, and so on generate a sense of place and a sense of identity. Stakeholders in Raleigh noted how the city has transformed from a sleepy state capitol to a destination for events, arts, and food. However, fast expansion of tourism assets is a risky endeavor: Tourism alone does not always provide a consistent return on investment; tourist events are often seasonal or time limited, and they may drive up the cost of living without providing increased access to high-wage, quality jobs.

Balancing tourism and livability should, for instance, include zoning for mixed-income housing in addition to hotels and event venues. Decision-making processes around tourism-

focused investments and amenities should transparently incorporate community input and include legally binding stipulations that support community-based jobs and investment returns, particularly in historically disinvested areas. Revitalization projects are important in creating quality places, and they should go forward and include affordable housing, grocery stores, parks, and amenities that improve the quality of life for the people who live there. In doing so, these projects will create an authentic sense of place and organically attract tourists while prioritizing the needs of residents.

#10 Connect Urban, Medium-Sized, and Rural Places

In the Corridor, one of the sharpest divides in economic outcomes is between urban and rural places. Access to jobs, education, health care, transportation, and broadband varies across the Corridor's urban and rural areas. Interviewees across the Corridor described the stark changes that exist just outside our urban cores, as well as the opportunities to engage a greater diversity of talent, pilot new innovations—particularly in agtech—and leverage existing assets to improve urban–rural connections and realize greater socioeconomic outcomes in North Carolina's rural communities. Partnerships, programs, and investments that account for rural places can identify areas of mutual benefit in broadband, infrastructure, and other place-based development. These actions will also connect industry value chains across the Corridor and deepen the bench of entrepreneurial opportunities far beyond the geographic limits of urban centers.

Investing in people and places is a long-term, multistakeholder endeavor that evolves as the needs of the population change. The areas of action outlined here are beginning ideas for how to pinpoint where partnerships, policies, and resources will best serve the residents of the Innovation Corridor.

4.3 CONCLUSION

As North Carolina navigates the economic fallout from the COVID-19 pandemic, this region and the state will remain confronted with the persistent challenges of how to generate high rates of economic growth that are accessible to a larger swath of the population. In the Blueprint, we have laid out ideas, using an innovation ecosystem approach, to generate more broad-based growth across a wider geography (~100-

mile radius) around North Carolina's research and innovation engine—RTP. This region is hypothetical and was selected as a means to test a variety of relevant economic development approaches in places with very different economic, cultural, research, and population traits.

Among our many findings described in Sections 2–3 was the need for a unified vision for innovation-driven economic growth. Many activities are under way across the Corridor, but they lack a shared focus and investment. Ways to collaborate these efforts will be difficult to scale at a level to have an impact. In terms of next steps, it is unclear which actors or organizations are best positioned to translate this research into action. Moving forward, we offer three criteria for stakeholders to consider as they review these ideas, and others, to determine next steps:

1. Desirability: Is there is a champion and consensus to advance the idea?
2. Viability: Is there organizational capacity and critical mass to execute?
3. Sustainability: Is there is revenue or funding to continue or scale the effort?

Many of the ideas we present are focused on building stronger industry clusters that can positively affect associated supply chains, entrepreneurs, researchers, and inventors across the region. Also, interviewees resoundingly shared that mechanisms to provide more early stage, risk-averse capital to area start-ups will likely help unleash a new wave of innovation-driven business and industry.

Business and industry alone, however, cannot carry a region through new stages of transformative growth. K–12 education is the bedrock of building a human capital base to provide a pipeline for future talent and is a critical element of attracting and retaining companies in the area. Placemaking and investments that incorporate the arts, protect natural assets, and accentuate shared local histories create environments that intrinsically attract talent and businesses to an area. It will be important to identify entities to coordinate selected initiatives to help build more robust networks across the region and to ensure that efforts are integrated for maximum impact. Additionally, outlets must work to better share the success

stories across the region to accelerate new narratives about the possibilities for hubs in the Innovation Corridor.

In summary, with a commitment to a long-term transformation that focuses on industry cluster growth, people, and places, economic development benefits from innovation are likely to be more widely experienced across a variety of geographies. The current trends of uneven growth across this region are likely to be exacerbated in the coming years if left unchecked. It is an opportune time to rethink and reimagine ways to generate more broad-based growth.

Appendix A: Interviewees

RTI interviewed 55 individuals across the Innovation Corridor, representing a cross-section of businesses, higher-education institutions, nonprofits, and a variety of entrepreneurial support organizations. Following is a list of the interviewees (alphabetized by organization name).

Interviewee Name	Organization Name
Liz Tracy	4DLaB; independent consultant
Anne English	Bamboo Strategic Advisors Ltd.
Jason Caplain	Bull City Venture Partners
Adam Klein	Capitol Broadcasting Company
Brad Hufford	Carolinas Gateway Partnership
Dan Cohen	Center for Entrepreneurship, Wake Forest University
David Gardner	Cofounders Capital
Mike Van Scott	East Carolina University
Michael Harris	East Carolina University
Colin Kiser	Economic Development Partnership of North Carolina
Emil Runge	First Flight Venture Center
Peter Marsh	Flywheel Coworking
Chris Gergen	Forward Cities
Ted Lord	Golden LEAF Foundation
Kathy Howard	Greenville Utilities Commission
Kate Teel	Greenville-Pitt County Chamber of Commerce
Jess Porta	HQ Raleigh
Michelle Bolas	Innovate Carolina, University of North Carolina at Chapel Hill
Bridget Harrington	Innovate Raleigh
Sarah Langer Hall	Institute for Emerging Issues
Maggie Woods	Institute for Emerging Issues
David Joyner	Joyner Media & Strategies Inc.
Lou Anne Flanders-Stec	Launch Greensboro, Greensboro Chamber of Commerce
Tommy Sowers	National Security Innovation Network
Thom Ruhe	NC IDEA
Thaddeus McEwen	North Carolina Agricultural and Technical State University
Laura Collins	North Carolina Agricultural and Technical State University
John Hardin	North Carolina Department of Commerce
David Kaiser	North Carolina Department of Commerce
John Chaffee	North Carolina East Alliance
Tom White	North Carolina State University
Lisa Hazlett	Nussbaum Center for Entrepreneurship

Interviewee Name	Organization Name
Veronica Creech	Office of Economic Development and Innovation, City of Raleigh
Wilson Lester	Piedmont Business Capital
Stan Kelly	Piedmont Triad Partnership
Penny Whiteheart	Piedmont Triad Partnership
Toni Thompson	Piedmont Triad Partnership
Adrienne Cole	Raleigh Chamber of Commerce
Susan Sanford	Research Triangle Cleantech Cluster
Emmit Owens	Research Triangle Cleantech Cluster
Sarah Glova	RIoT Labs
David Farris	Rocky Mount Chamber of Commerce
Evan Covington Chavez	Rocky Mount Mills, Capitol Broadcasting Company
Doug Speight	Serial Startups
Adrian Smith	Startup Grind
Tarryn Henry	T.H.E. Founder Project
Nichola Lowe	University of North Carolina at Chapel Hill
Justin Streuli	University of North Carolina at Greensboro
Sam Seyedin	University of North Carolina at Greensboro
Karen Barnes	Venture Café
Michael Haley	Wake County Economic Development
Ashley Cagle	Wake County Economic Development
Betsy Brown	Winston Starts
Mo Green	Z. Smith Reynolds Foundation
James Gore	Z. Smith Reynolds Foundation

In addition to the interviewees listed earlier, RTI also interviewed 31 leaders from several corporations and organizations related to the four industry sectors focused on in this Blueprint and ***Appendix C***. Following is a list of these entities (alphabetized by organization name).

Industry Sector	Corporation/Organization
Agtech	AgBiome
Medtech	Bioventus
Agtech	Carolina Precision Consulting, Inc.
Medtech	Continuous Precision Medicine
Agtech	Coastal AgroBusiness
Power Electronics	Cree/Wolfspeed
Power Electronics	Delta Power Electronics Laboratory, Inc.
Defense Innovation	Fayetteville Cumberland Economic Development Corporation
Agtech	FoodLogiQ
Power Electronics	FREEDM Systems Center at North Carolina State University
Defense Innovation	Fusion3
Medtech	Gilero
Medtech	GlaxoSmithKline
Defense Innovation	Gusto Global
Agtech	McLawhorn Crop Services, Inc.
Medtech	MEDTOX Diagnostics
Agtech	North Carolina Biotechnology Center
Medtech	North Carolina Biosciences Organization
Agtech	OptimaBio, LLC
Agtech	Pairwise
Medtech	Panaceutics
Agtech	Power Resource Group
Power Electronics	PowerAmerica Institute
Medtech	Precision BioSciences
Medtech	Rho
Agtech	SAS Institute Inc.
Agtech	Smithfield Renewables
Agtech	Stephen Lilley Farms, LLC
Defense Innovation	Tanjo
Defense Innovation	Triad Semiconductor
Defense Innovation	Vector Solutions

Appendix B: Innovation and Economic Data Analysis

The appendix is available from RTI as a standalone report and is not included in this Blueprint.

Appendix C: Industry Cluster and Market Analysis

The appendix is available from RTI as a standalone report and is not included in this Blueprint.