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COMPREHENSIVE GAP ANALYSIS

PART 3 - INNOVATION FRAMEWORK

Greater Lima Region, Ohio, USA

December 2016

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This report has been produced as part of the overall development of a Collaborative Growth Plan for the region.

PREPARED BY:

future→iQ PARTNERS

ALLEN COUNTY DEFENSE INITIATIVE HOSTED BY:

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1.0 INTRODUCTION

Innovation has been the fuel that drives countries and economies forward for millennia. Industries have formed and prospered on the strength of new ideas going back to ancient times. Inventors have been applauded as heroes in the same way that we have celebrated presidents and generals. This is as true in the Greater Lima Region as is the case in every region.

The history of the Greater Lima Region is dotted with stories of bold dreamers and inventors. The creativity expressed by chemists, farmers, machinists, and mechanics has formed the basis of the region's industry leaders. Every firm has a story that harkens back to one of these bright ideas. This same spirit remains as part of the region's culture and is demonstrated in a number of firms.

As the Greater Lima Region considers the formation and structure of a Regional Collaborative Growth Plan, innovation has again risen to the fore. Innovation has been at the core of the region's economic resilience over the past several decades and regional leaders have identified it as a key to the region's economic future. Several steps have been taken to kindle the spark of innovation in the formation of the Ohio Energy and Advanced Manufacturing Center and the work of Link Lima and MakerFest, for example. These themes were also discussed in a 2014 regional application to be designated as a Manufacturing Community through the Investing in Manufacturing Community Partnerships grant program.

The innovation analysis that follows will build upon many of these recent successes by exploring the extent of innovation activity in the Greater Lima Region. It also seeks to advance the conversation by identifying areas where applied innovation is flourishing and proposing a series of bright ideas to propel the region forward. Before doing so, however, we must establish a few common terms.

1.1 A SIMPLE MODEL OF INNOVATION

Much of what we understand of innovation can be understood in how we speak about it rather than in what it actually is. The Oxford definition of innovation suggests that it is to "make changes in something established, especially by introducing new methods, ideas, or products." This suggests that innovation is, at turns, a process, a culture, and an outcome. It is also a narrative in that any innovative outcome traces its beginning to an existing product or practice. Innovation comes from somewhere and leads us to something.

This retrospective view of innovation was perhaps most famously summarized in a commencement address Apple co-founder Steve Jobs delivered at Stanford University in 2005. His definition of what innovation is can be summarized in the following:

> *"You can't connect the dots looking forward; you can only connect them looking backwards. So you have to trust that the dots will somehow connect in your future. You have to trust in something—your gut, destiny, life, karma, whatever. This approach has never let me down, and it has made all the difference in my life."*

Jobs identifies two fundamental aspects of innovation within the context of the analysis presented here. First, innovation viewed through this lens is depicted as a series of discrete events, with each building upon the one that preceded it. Second, innovation is intentional, but its intent can only be considered after the fact.

We know that the Greater Lima Region has had a remarkable history of innovation if considered this way. Each of the region's prominent manufacturing sectors, for example, has been built over the course of decades as changes in technology and the marketplace drove them always further. Similarly, the growth of a number of industries, such as the chemical and plastics industries have been largely dependent on innovations in the petroleum industry. In fact, many of the region's manufacturing sectors can be traced to three principal concerns – agriculture, oil, and transportation. Those same sectors have progressed along diverging paths for much of the region's history.

One final aspect of the model of innovation that has been added to our understanding over the past decade is one of additional intent. The definition of innovation that is generally accepted as a principal of business strategy is customer-driven, with the customer ultimately perceiving whether a product or process is innovative or not. As such, we see that innovation is something that is driven by external forces but occurs within the internal processes of a firm.

It is important to note that the model of innovation that is being presented and will be assessed within the course of this analysis does not distinguish between nor depend

on either new or existing firms for its success. Innovation is frequently mistaken for entrepreneurship in the belief that all new ideas lead to new enterprises. Rather, the majority of innovation that has occurred since the Industrial Revolution has occurred within and because of the infrastructure of established firms. While a new business venture might eventually emerge, this is not the intent of innovation in this respect.

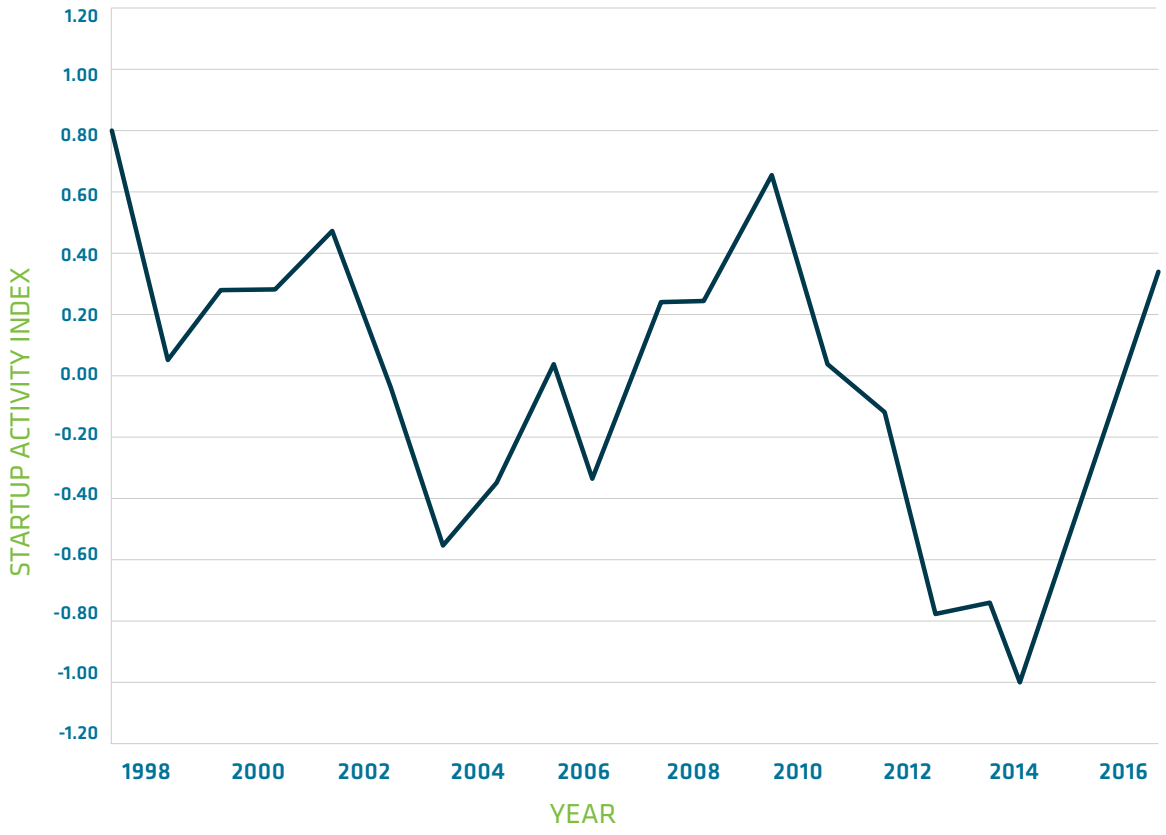
1.2 ENTREPRENEURSHIP IS NOT ALWAYS INNOVATIVE

The connection between innovation and entrepreneurship has particularly been tested over the course of the last several decades, as experts have noted that the rate of new business formation has slowed since 1970. The annual index of entrepreneurial activity produced by the Ewing Marion Kauffman Foundation indicates, for example that the rate of new business startups in the United States is 80.4 per 1,000 firms. Figure 1 details the rate of startup activity since 1997.

We see that the rate of startup growth lags behind general economic trends, with the largest decline in startup activity occurring in the years following the economic recessions of 2001-2003 and 2007-2009. Startup activity has enjoyed a meteoric recovery over the last two years as a result of a number of factors including greater access to capital, expanded customer bases and an increased demand for local products.

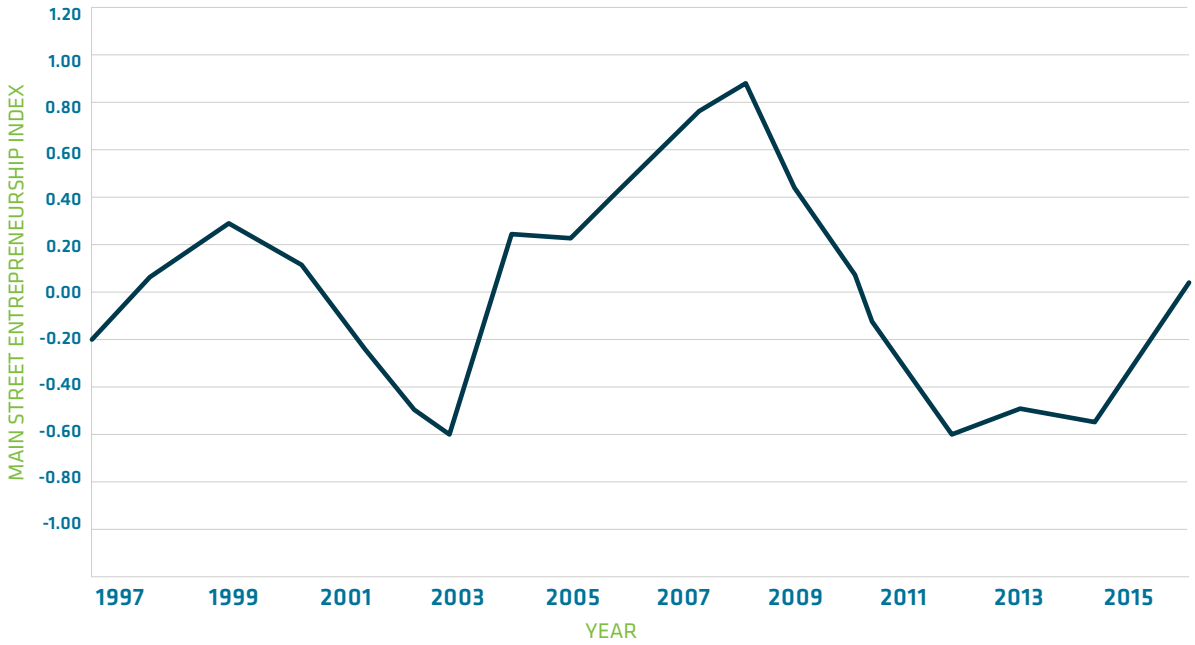
A single trend line does not tell the entire story, however. One of the strongest drivers of employment growth in the Greater Lima Region and throughout the United States is the vitality of its small business community. This is reflected in Figure 2, which measures the rate of formation of small businesses (under five employees) that have been in operation for at least five years.

Figure 1: Kauffman Index of Startup Activity (1997-2016)



Source: Author calculations using the CPS, BDS, and BEA.

Figure 2: Kauffman Index of Main Street Entrepreneurship (1997-2015)

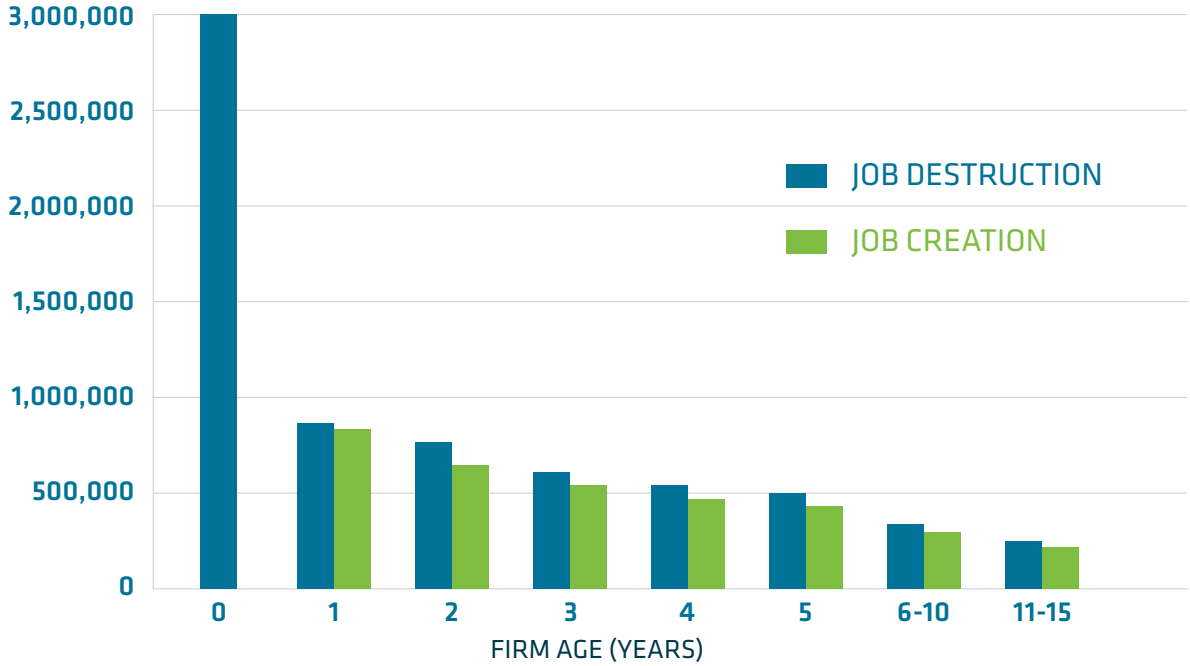


Source: Author calculations using the CPS, BDS, and BEA.

We again see that the rate of small business formation has plummeted over the past five years and has only rebounded within the past two years. The Lima/Allen County Chamber of Commerce has observed a similar trend with as membership engagement has improved since 2011.

The role of small and new firms is especially important as these firms generate at least half of all new employment growth nationally. This is especially true during the first three years of a firm's existence, as illustrated in Figure 3.

Figure 3: Job Creation and Loss by Firm Age – 1992-2006



Source: Marion Ewing Kauffmann Foundation

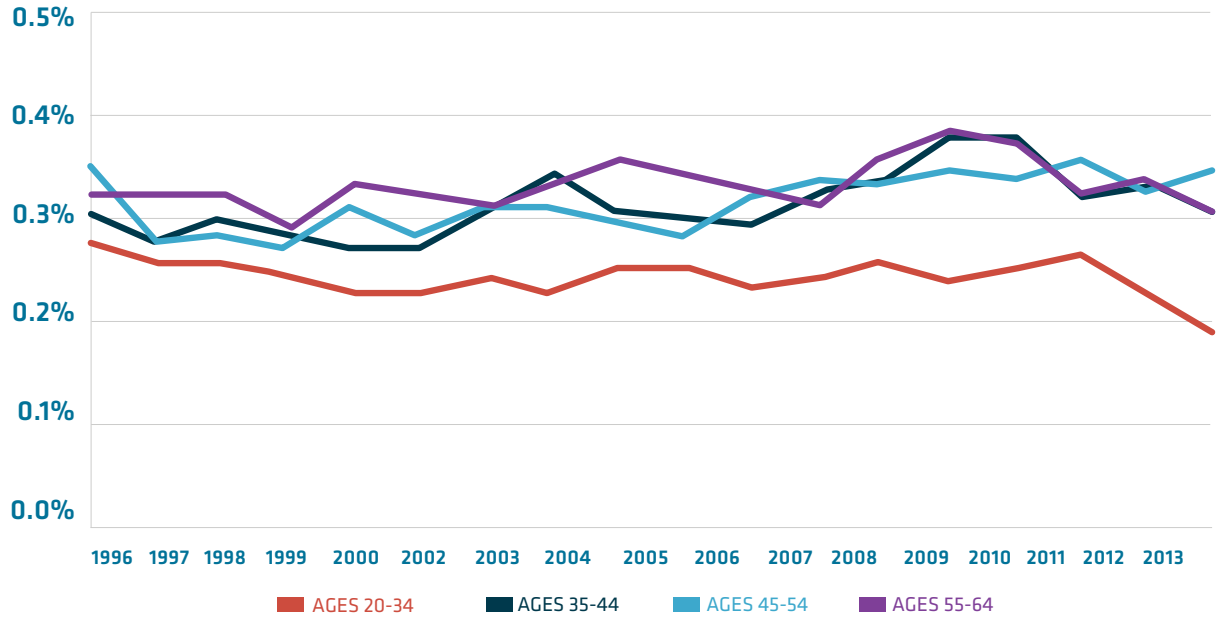
We can see that firms create the majority of their positions within the first five years of their lives, with most of the job destruction that occurs in subsequent years first as some firms fail and then as others mature and refine their business strategy. A firm has the greatest likelihood of succeeding if it makes it through its third year of business. This fact will be especially important as we consider the importance of new business formation in a comprehensive innovation strategy.

There is one other fact regarding the recent trends in startup activity and entrepreneurship that we must consider in drawing a link to innovation. The rate at which new businesses are formed is strongly correlated with the age of the founder. This is especially true in illustrating the divide between older and younger entrepreneurs, as illustrated in Figure 4.

A final point that bears note is the sharp rate by which business formations by the youngest age cohort – 20-34 has fallen. This can again be traced to changes in financial markets following the recession of 2007-2009, leaving those with a short banking history unable to secure needed funds. It may also represent a change in philosophy among the Millennial generation. This also points to a key opportunity discussed later in this analysis to create a so-called "Maker" culture to spur further innovation and entrepreneurship by young people.

The link between innovation and entrepreneurship, then, is more nuanced than previously assumed. As James Surowiecki points out, the very nature of entrepreneurship has changed over the past three decades, with the number of entrepreneurs who are considered "transformational" has declined.[1] These "high-growth" firms constitute only 15 percent of all new firms yet generate 50 percent of all job creation. Further, it is more likely that the entrepreneurship that occurs in many communities, including the Greater Lima Region, is dominated by "subsistence" businesses that benefit the interests of their owners. If the region is going to pursue a comprehensive innovation strategy, it must either foster its own transformational firms or look to another source for its innovative growth.

Figure 4: Rate of New Entrepreneurial Activity by Age



Source: Marion Ewing Kauffmann Foundation

We see that the rate of business formation has generally declined among all age groups except one – those between the ages of 45 and 54. This makes sense for a number of intuitive reasons. It is likely that individuals in this age cohort has reached a certain level of skill and experience to consider establishing a new firm. They may also have access to a higher level of capital than others. This age cohort also currently represents the last wave of Baby Boomers in the workforce, an important cohort in the Greater Lima Region. As such, there may be some potential to spur additional entrepreneurship via this age group cohort.

1.3 MOVING FROM INNOVATION TO APPLIED INNOVATION

One final aspect of our understanding of innovation needs to be clarified before we can continue with an analysis of innovation in the Greater Lima Region. Innovation is typically only understood within the context of the development of new ideas. We think of the greatest inventors largely in terms of their discoveries. Alexander Graham Bell is noted for the invention of the telephone and Thomas Edison the incandescent light bulb. These are not the only innovators that led to these discoveries, of course. Similarly, the value of these discoveries is intrinsic in one way for the value of the knowledge created. However, the true value to society of these and so many other discoveries comes in their application to solve a problem.

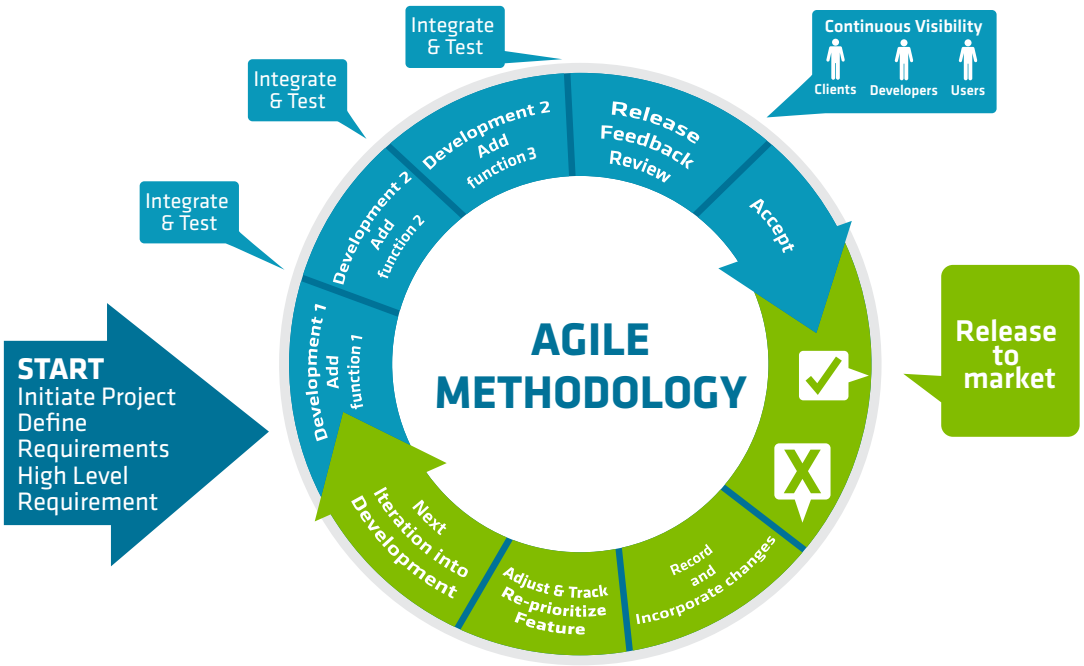
Innovation occurs in the space between a problem and the solution. This has been demonstrated time and again in the companies of the Greater Lima Region. The Lima Locomotive Works developed a world-class solution to serve the logging industry in 1880. The discovery of oil in Lima in 1885 sparked the growth of the modern chemical and petroleum industries. There are numerous other examples throughout the region, which has distinguished itself as a world-class leader in a number of manufacturing areas.

A similar pattern of development continues to occur at manufacturers throughout the region. Engineers at American Trim and General Dynamics Land Systems have experimented with the use of High Velocity Metal Forming technology. Husky Energy, Inc. has invested significant resources into research and development of new uses of petroleum distillates. The Technology Sciences Program at Ohio Northern University and a number of research centers at the Ohio State University have collaborated with regional firms to develop new processes and products. This has advanced the culture of innovation that serves as one of

the region's hallmarks, though we shall see that this has not yet yielded an abundance of local commercialization activity in the last decade.

This model of applied innovation that will be presented in this framework closely mirrors the traditional model of agile development that is presented in Figure 5.

Figure 5: Elements of the Innovation Process



Source: All Management PowerPoint Diagrams and Slides, 2016.

In this model, companies and customers are both factors in innovation diffusion. We will discuss the role that the Greater Lima Region's educational institutions, economic development organizations and funders at the state and federal level must play to successfully cultivate an innovation culture. The primary role that companies play in this framework is that as a driver of innovation. Again, a model of applied innovation requires companies to serve a role in both defining problems and validating solutions. As such, they stand at both the beginning and the end of the innovation process.

1.4 ORGANIZATION OF THE ANALYSIS

The innovation framework for the Greater Lima Region presented in this analysis will be defined in the next seven sections.

- Section 2 will present a discussion of the key innovation trends included in the *Future of Manufacturing* foresight analysis prepared in this project.
- Section 3 will present a case study-based comparative analysis of innovation best practices in a series of three communities – Newton, Iowa, Chattanooga, Tennessee, and Utica, New York.
- Section 4 will consider a number of salient regional innovation trends and assets.
- Section 5 will expand on the comparative analysis by presenting a best practice discussion of the key components of building a Maker culture in the region. The section will also include a discussion of the characteristics of a Center of Excellence approach.
- Section 6 will extend this discussion to present other key components of the proposed innovation framework. This will include recommendations for building an innovation culture, innovative companies, and communities.
- Section 7 will conclude with a series of targeted recommendations for implementation in the next 12-18 months.

The innovation framework presented here is meant to be considered in connection with the material presented in the *Comparative Gap Analysis*. The Greater Lima Region is confronted with a number of potential workforce and supply chain challenges. More innovative practices may serve as the solution to these issues.

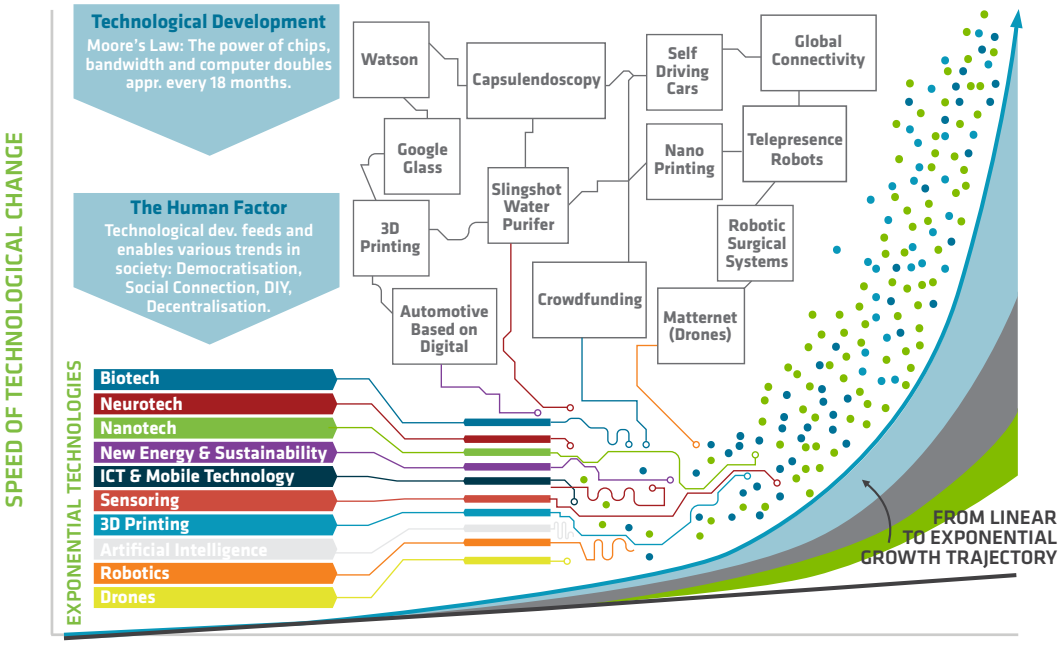
2.0 THE IMPORTANCE OF INNOVATION IN *THE FUTURE OF MANUFACTURING*

Future iQ Partners published The Future of Manufacturing: Building the Future Through Innovation and Agility in May 2016. This foresight piece has drawn on the collective knowledge of the Future iQ team and a number of industry experts and analysts, to discern and discuss some of the most pressing future trends affecting manufacturing vitality in the next twenty years. Many of these trends have been discussed at length in two previous analyses produced as part of a Comprehensive Gap Analysis; a *Regional Workforce Needs Assessment (August 2016)*, and a *Regional Supply Chain Analysis (August 2016).* The trends discussed indicate the importance of a highly skilled workforce and an integrated global value chain to ensure the vitality of the region's manufacturing base. These advancements will be fueled by new ways of thinking about work and business relationships.

Innovation plays a critical role in each of these aspects of manufacturing development. The advent of large-scale automation, for example, has changed the nature of work. The proliferation of additive manufacturing and 3-D printing technology has accelerated new product development and brought new prototyping and sourcing solutions to a number of firms. Each of these advances again represents innovation in the form of a problem seeking a solution.

The innovation analysis presented here is based on a number of core concepts underlying the foresight presented in the *Future of Manufacturing.* The first is that the rate of innovation adoption across a number of core industries has been accelerating, as has our understanding of the ways that multiple innovations interact with each other and therefore exponentially increase the impact of any single innovation. The rate of adoption is further influenced by the role of key disruptors such as visionary leaders and 'Makers'. These factors serve as the basis of the role of innovation in what is referred to as "Industry 4.0," as depicted in Figure 6.

Figure 6: Rate of Technological Change in Industry 4.0



Source: Deloitte. 2014. Industry 4.0 Challenges and solutions for the digital transformation and use of exponential technologies.

We see that there are a number of potential innovations that have been cited in Figure 5 in the areas of manufacturing technology, medical procedures, and information technology that have followed this exponential growth path. The recommendation that will emerge through this analysis will place the region along this exponential growth path as the hub through which these potentially disruptive innovations are validated and commercialized. This will require the coordination of a number of resources and the collaboration of key actors throughout the Greater Lima Region.

Two additional innovative trends that are especially salient to the applied innovation framework proposed for the Greater Lima Region are the adoption of scalable additive manufacturing technologies and new advances in materials science in the development of new polymers and nanomaterials. Each of these presents a significant opportunity for the region and share a number of co-dependencies.

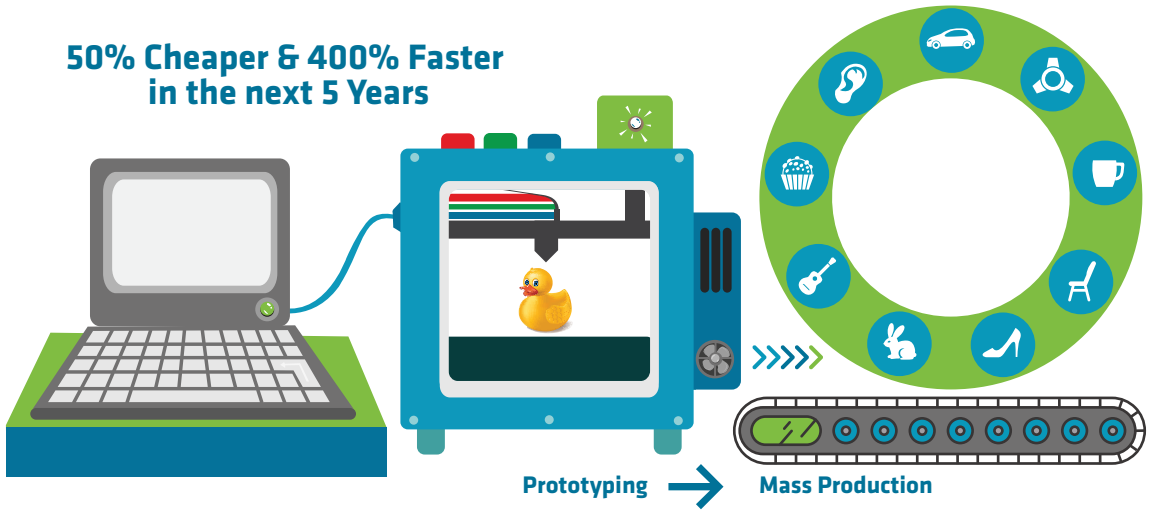
Growth in the additive manufacturing space, also known as 3-D printing has moved from what was generally considered the realm of hobbyists producing small parts from printable resins, to large scale production of sophisticated parts and finished goods using a variety of polymers and metal alloys. Printing technology has also recently moved into the use of organic materials in the food processing and biomedical spaces. Recent forecasts have estimated that global industry revenue will increase from $3 billion in 2010 to more than $21 billion in 2020.

also pushed additive processes closer to viability for small-to-mid-sized manufacturers. A number of regional manufacturers are currently using additive technologies at some scale and national best practice consortia have formed in Cincinnati and Youngstown through the National Network for Manufacturing Innovation (NNMI).

The Greater Lima Region has the opportunity to organize around the potential application of additive manufacturing in sectors such as automotive, transportation equipment, machinery manufacturing, and food processing. This will be discussed in greater detail as part of the innovation roadmap later in this analysis. A number of locations in the United States, such as the State of Pennsylvania, have already laid the groundwork for similar collaborations.[2]

Similar advances in materials science present a significant opportunity for the Greater Lima Region. The growth of additive and customized manufacturing technologies

Figure 7: Use of Additive Manufacturing

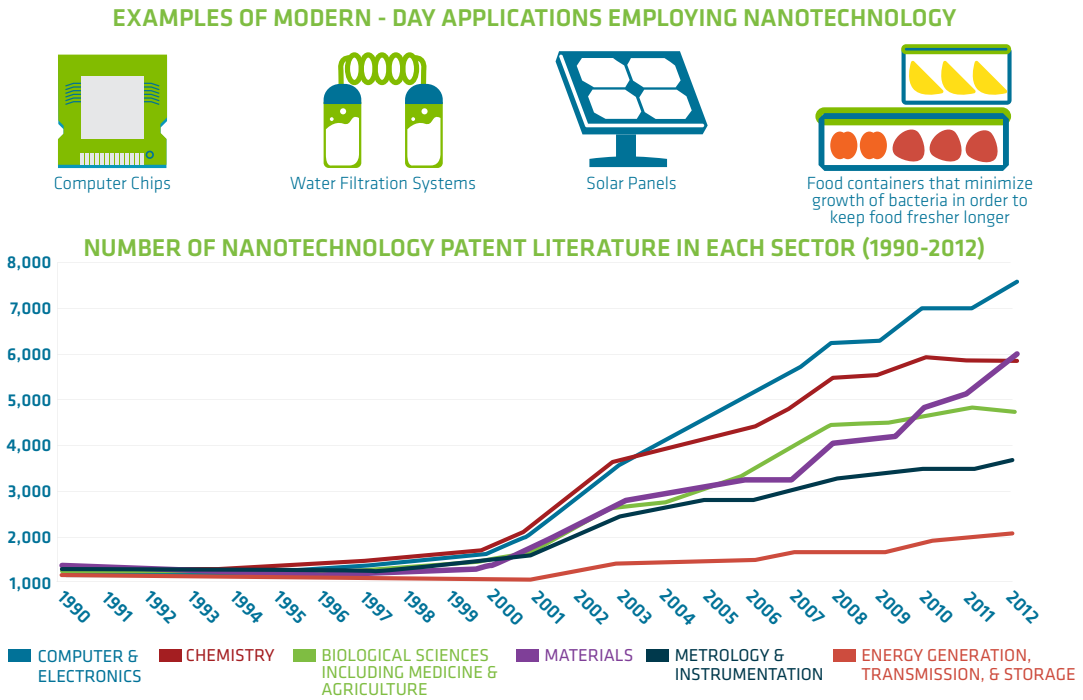


Source: Siemens. 2016. 3-D Printing: Facts and Forecast.

At the same time that the application of additive technologies has expanded into a variety of industry sectors, advances in printing technologies have both shrunk the scale and cost of many platforms. This has again driven the technology first into the consumer space, but has more importantly made it accessible for manufacturers of all sizes. This has expanded the scope of additive manufacturing and greatly decreased time to both prototype and full production in a number of product markets. A significant increase in the speed of printing on a number of platforms has

and processes have spurred advances in the utilization of a variety of materials in new ways. This includes both additive and extracted processes. At the same time, there has been considerable innovation in the addition of a number of new properties to plastic resins, such as antibacterial resistance, longer wear, and anti-UV fading enhancements. These same resins are also more flexible and can be produced in smaller diameters for use in a number of consumer goods.

Figure 8: Growth of Nanotechnology Patents by Sector



Source: Column Five, Nanotechnology Patents in the United States and Beyond.

Another area of significant innovation has occurred in the field of nanomaterials. This can be seen in the growth trend presented in Figure 8. This area of material science is focused on the development of new applications at the atomic level. Products such as carbon nanotubes, graphene, and other composites are currently being researched for commercialization possibilities in construction, manufacturing, and medicine. The Greater Lima Region is strategically positioned to play a key role in this growing field as it contains both the raw petrochemical materials used in a number of processes and the technical knowledge to consider potential applications.

A number of other innovative trends, ranging from the growth of the Internet of Things to the expansion of multimodal transportation models may also have a profound impact on the future of the Greater Lima Region's manufacturing base. These are further explored in the Future Manufacturing. The trends presented here represent what we consider to be the most salient to our current discussion of an opportunity-driven applied innovation framework. We will next discuss how other communities have developed innovative solutions to capture opportunities and how these present best practices for consideration to the Greater Lima Region.

3.0 INNOVATION COMMUNITY CASE STUDIES

The Greater Lima Region has had an extensive history of innovation. From the discovery of oil in the 1880's, the growth of the Lima Engine Plant as a global industry leader, the transition to the supplier of battle tanks to the military, and through to more recent innovations at Ford Motor Company, National Trim, Potash Corporation and other regional leaders. The region possesses considerable innovation potential and an extensive infrastructure guided by the Ohio Energy and Advanced Manufacturing Center.

There are a number of potential lessons that the Greater Lima Region can benefit from in studying the experience of other communities that are considered to represent best practices in innovation and industry readjustment. The case studies presented here depict the challenges and accomplishments that Newton, Iowa, Chattanooga, Tennessee, and Utica, New York have achieved in gaining national and international recognition as leaders in the Brain Belt movement.

3.1 NEWTON, IOWA

Newton is a case study in the successful revitalization of a small Midwestern city after a long-standing primary employer terminated its operations. Instead of folding up shop, Newton challenged conventional thinking and became a magnet for innovations in renewable energy and printing and opened its doors to small business development.

BACKGROUND

Established in 1846 and incorporated in 1857, Newton is the county seat and most populous city in Jasper County, Iowa. Located 30 miles east of Des Moines, this vibrant small town of 15,254 (2010 U.S. Census) has faced potential economic disaster and come out the other side all the more resilient for it. Historically a town of coal mines, cigar factories, manufacturing of patent medicines, ant poison and farm equipment, Newton become Washing Machine Capital of the World when the Maytag Corporation moved into town in 1893.[3] Maytag built its first washer in 1907 and by 1924, was producing one out of every five American washers.[4]

The City of Newton benefited greatly from the 100 plus years of presence of the Maytag Corporation. As the largest employer in town, Maytag had a far-reaching legacy that endowed the city with a strong educational system, recreational and cultural facilities, corporate facilities, and a highly trained workforce.[5] During WWII, Maytag undeniably supported the war effort by halting washer production to produce special components for airplanes, tanks and other military equipment. Maytag resumed making washers in 1945,[6] and continued to be Newton's primary employer until 2006.

SITUATION

2006 marked the year that Whirlpool Corporation bought Maytag and relocated operations. During the final years between 1996 and 2006, Maytag hit enormous financial difficulties opening the door to the buyout by Whirlpool and the subsequent announcement of the closure of Newton operations.[7] Faced with the tremendous impact of job losses on their economy, community leaders realized the need for an overarching economic and workforce development strategy to deal with the situation. Leaders also understood that the strategy would need to be regional in nature as Maytag employed people from outside of the City of Newton as well.

ACTION/RESOLUTION

Faced with an impending economic shock due to the loss of up to 3,000 jobs and corresponding income in the region, the City of Newton created the Newton Transformation Council (NTC) to provide cohesive leadership and organization for the city's transition from corporate city to city of innovation. The NTC did two things that provided clarity and direction for the city: it commissioned a regional analysis including asset mapping to determine the boundaries of the local labor market and Newton's functional economic area (using commuting patterns, intra-regional trade, and infrastructure considerations)[8] , and it brought in Future iQ Partners to conduct a community visioning session for the city.

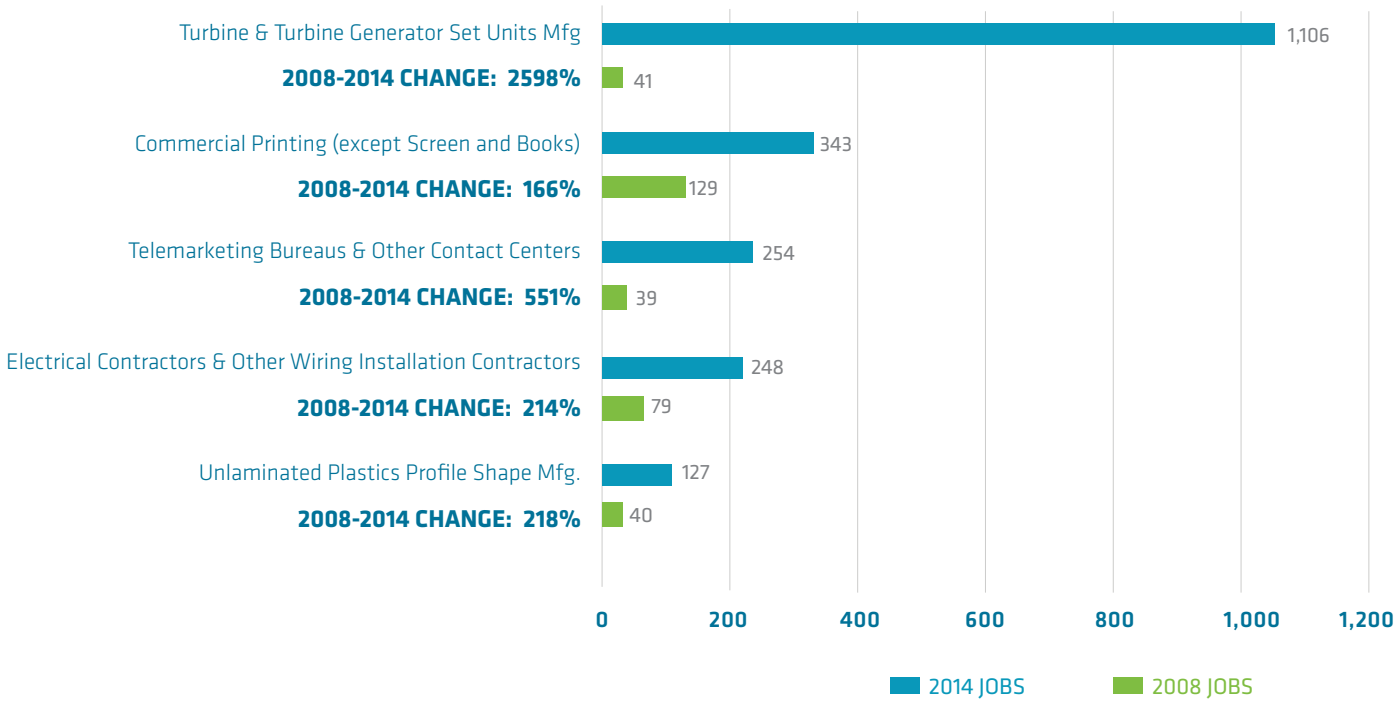
The importance of both the data-driven economic reports and public engagement in the city's plans for the future and recovery cannot be under emphasized. A regional Leadership Group (LG) was formed to assess the data-driven economic reports and to explore opportunities and challenges for the ten-county region. In addition, according to Kim Didier, then Director of the NTC, the visioning session became a turning point for the city as over 300 participating community members were able to see hope in the potential to turn its economy into something broader than a one-corporation town, particularly in the area of renewable energy.

Two primary goals in the transition strategy were to keep as many Maytag workers employed as possible in the region, and to provide transitional training to those who wanted it. This emphasis on retaining its skilled workforce in the long run greatly benefited Newton and the business environment it subsequently created to support new industry and innovation. Acting on this strategy, and with the use of a federal Regional Innovation Grant (RIG), by the fall of 2008, Newton had attracted more than 1,200 new jobs through advanced manufacturing and high-tech companies, mostly in the renewable energy wind sector.[9] Examples of these efforts include:

- The city quickly located a buyer for the old Maytag facility, Iowa Telecom. This new company was able to easily assimilate the highly skilled former Maytag employees into its operations and created 40 skilled jobs.
- The arrival of Iowa Telecom drew an information technology company, Caleris, to the building with the arrival of 100 more jobs.
- Whirlpool transitioned two additional Maytag buildings in the downtown area to the Des Moines Area Community College (DMACC). The College has programs for students and community members that serve as a "feeder system" to area jobs. This was especially important for "fast track" training of former Maytag executives looking to enter new fields.
- Newton became a designated region for MyEntreNet, a community-based entrepreneurship development system designed to connect startup and operating companies with technical assistance and training.

The success of Newton's efforts grew out of strong community leadership and an understanding of the need to change from a one-corporate town model to one with a more diverse structure that grows more organically. Newton used two methods to grow its economy: the first involving attracting companies to move to Newton, such as Iowa Telecom, the second in growing the economy from within. With regards to the second model, Kim Didier, now Executive Director of DMACC, points to the economic gardening model akin to the experience in Littleton, Colorado and led by Chris Gibbons. The focus in Littleton, has been on assisting second stage companies, while creating a friendly environment for local entrepreneurs.[10] For Newton, this change involved a complete realignment of perspective and business culture. And according to Didier, "The community (has learned) to work with a different structure that's organic, grass roots, and focused on smaller business diversification."[11]

Figure 9: Industry Growth in the Newton Region



Source: Column Five, Nanotechnology Patents in the United States and Beyond.

ROLE OF INNOVATION

Newton's three largest innovation successes have been in the areas of wind manufacturing, printing (becoming an industry cluster), and in identifying itself as a supplier network for its burgeoning new industries. It has been recognized by the Department of Defense, Office of Economic of Adjustment as a model for innovation as a case study that shows how a city faced an economic crisis and emerged with a regional collaboration plan in the form of the "Iowa Innovation Gateway."[12] Support for Newton's long-term economic strategy has remained high, especially buoyed by the unemployment rate in Jasper County falling from 9.6% in 2008 to 3.7% in 2014. New industry growth in the city has mushroomed in some sectors such as the turbine and turbine generator set units manufacturing industry growth by 2,598% in seven years.[13]

President Obama recognized Newton's recovery and revitalization from the loss of the Maytag Corporation in visits he made to the city in 2009 and 2012. The city has succeeded in its revitalization to such a degree that the current challenge is to find employees to fill open positions. Employers have turned to innovative solutions such as the use of nontraditional sources of employees as in the recruitment from out of state and looking to the refugee community for qualified workers. This employment strategy has been working and continues to provide new growth opportunities for the city.

"I love this t-shirt because it symbolizes to me the work we did that fateful night (September 21, 2006) with 300 + plus residents to put our vision together with David Beurle, CEO of Future iQ Partners help. To me, that was the night that we created hope for our community and a sense of empowerment to move beyond the loss of Maytag and forge a new identity. This is lasting transformation!!!"

– Kim Didier, Executive Director, DMACC Business Resources

KEY LESSONS LEARNED FOR THE GREATER LIMA REGION:

1. The importance of being able to pivot to a new type of economy. Newton needed to shift from a one-corporation town to one of a more diverse economic structure, and its leaders supported this transition.
2. The importance of a collaborative leadership network and stakeholder engagement. An aligned vision for the future was critical for community engagement and support.
3. Workforce retention and reeducation were important elements of long-term economic success.
4. The importance of nontraditional employment strategies to promote workforce development.

3.2 CHATTANOOGA, TENNESSEE

Chattanooga is a case study in the purposeful creation of an innovation district by a Mayor with a vision that encouraged entrepreneurialism. Chattanooga demonstrates entrepreneurial growth as an economic development strategy.[14]

BACKGROUND

Chartered in 1852, Chattanooga is the fourth largest city in Southeastern Tennessee (2015 census population est. 176,588) and is located at the junction of four interstate highways near the border of Georgia. Historically, the arrival of the train to Chattanooga in 1850 made the city an important location for both corn and cotton industries. In 1899, three Chattanoogans bought exclusive rights to bottle Coca-Cola and the company grew to be one of the primary economic drivers of the city. Other industries to flourish in Chattanooga were iron, steam boilers and hosiery products.[15]

Unfortunately for the city, in 1969, the E.P.A. dubbed Chattanooga the "America's Dirtiest City, " caused by years of pollution from its major industries, including multiple foundries and an ammunition plant.[16] Both private and public stakeholders came together to address this negative label for the city and through the 1970s, Chattanooga addressed its environmental issues. One of the primary areas needing attention was the waterfront. In 1982, the Lyndhurst Foundation funded a task force to study the waterfront and in 1986, The River City Company was formed to help lead redevelopment. In 2002, then Mayor Bob Corker announced a follow up revitalization plan, the Twenty-first Century Waterfront Plan.[17] Chattanooga has since received national recognition for the renaissance of its beautiful downtown and redevelopment of its riverfront.[18]

SITUATION

Between the years of 2008-2010, Chattanooga's publicly owned utility company, the Electric Power Board (EPB), began the process of modernizing the city's electrical system. The company's vision for the city was to install smart grid technology using fiber optics and thus enabling a suite of gigabit-level advanced communication services available to every home and business throughout its entire 600-square-mile service area. These improvements have become known as the Gig, and are among the fastest communication services in the world.[19]

The original intent of these power upgrades was not only to improve utility connections for local residents; it was also to attract large companies to invest in or relocate to Chattanooga. Where the first goal was achieved – and residents enjoy first-rate power accessibility – the second goal was not. This prompted current Mayor Andy Berke to articulate a vision that he had for the city – one that involved bringing together existing start-ups and businesses and growing what is now commonly known as Chattanooga's Innovation District.[20]

ACTION/RESOLUTION

Creating the Gig was the catalyst that set in motion the exponential growth process of entrepreneurial spirit in the city of Chattanooga. Several factors were essential in the success of this process including financial support by local foundations and angel investment capital; strong entrepreneurial support organizations that provide space, resources, and expertise to startups; strong mayoral support; and also the emergence of an "innovation district" providing for concentrated space in the Chattanooga landscape for entrepreneurial development.[21] This multiple-support system of entrepreneurialism has created a graduated support system for new businesses and startups throughout their development.

Below is a brief outline of the entrepreneurial support layers in Chattanooga, as described in Bruce Katz's, An Innovation District Grows in Chattanooga (2015).

1. Foundations and Funding: Chattanooga is fortunate to have two philanthropic foundations, the Lyndhurst Foundation and the Benwood Foundation, that have played significant roles in the redevelopment of the city. In addition, the angel fund founded by key members of the entrepreneurial community, the Chattanooga Renaissance Fund (CRF), invests in seed and early-stage companies.

2. Entrepreneurial Support Organizations: Katz highlights five primary entrepreneurial support organizations in the Chattanooga area: Company Lab (CO.LAB), Chambliss Startup Group, Lamp Post Group, LAUNCH, and Launch Tennessee. CO.LAB is a business accelerator that helps starting entrepreneurs take their ideas from initial concept to startup.[22] Chambliss is a law firm that provides low-cost legal services to startups. The Lamp Group is a type of venture incubator that provides a conduit to the professional investment community.

LAUNCH engages different populations, including immigrants and the recently incarcerated, into the entrepreneurial movement. Launch Tennessee is a statewide organization that acts as a sponsor for all regional accelerators and helps startups by connecting entrepreneurs to external capital and by providing mentorship.

3. Public Role/Support: The roles of the EPB and the Mayor's office can not be understated in the launching of entrepreneurial spirit and support in Chattanooga. The Gig created the conditions ripe for entrepreneurial growth and the Mayor provided the bully pulpit, coordination and cheerleading support to encourage it.

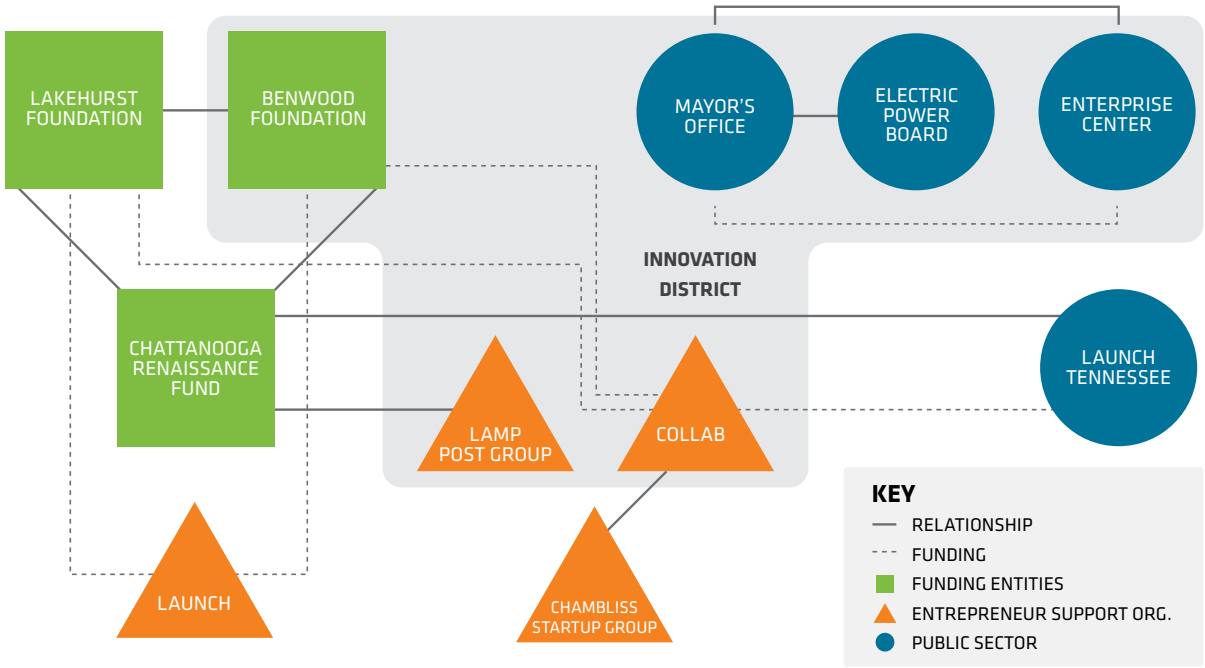
4. The Innovation District: The Innovation District in Chattanooga spans a 140-acre area in downtown Chattanooga. It is meant to provide a dense, mixed-use array of buildings, office space and living that appeals to Millennials, and start-ups alike. This intentional effort to centralize life and work locations is a hallmark of innovation districts.

Since 2010, over ninety-one companies have been founded in Chattanooga, many of those attracted by the inexpensive access to bandwidth. The Gig has quite simply provided an attractive place for entrepreneurs to start operations. Where the Gig was not originally intended to be part of an economic growth strategy for the city, its success has made it foundational to city planning going forward.

ROLE OF INNOVATION

The role of innovation is woven throughout Chattanooga's history. Since its beginning as a railway hub for manufacturing, the community of Chattanooga has repeatedly rebuilt itself when needed. This resilience and openness to change has been called "The Chattanooga Way", a city trait that describes its "value on cooperation, initiative, and problem solving to improve the community at large."[23] The Mayor's vision and strong support for inclusive innovation and entrepreneurial expansion continues to lead the city of Chattanooga and provides the basis for a preferred vision of the future.

Figure 10: A Model of the Chattanooga Innovation District Ecosystem



Source: Bruce Katz. 2015. An innovation district grows in Chattanooga. The Avenue/Rethinking Metropolitan America..

KEY LESSONS FOR THE GREATER LIMA REGION:

1. Foresight in public planning – for example, the decision of EPB to upgrade the city's power system to the Gig was critical to later opportunities for innovation.
2. The importance of the ability to pivot planning goals (for example, when the Gig did not bring in large companies, but rather spurred entrepreneurial startups).
3. The importance of strong financial backing of innovation and entrepreneurial efforts.
4. The importance of strong entrepreneurial support organizations with an emphasis on inclusiveness to gain maximum community engagement.
5. Key leadership by a visionary leader, in this case Mayor Andy Berke.

3.3 UTICA, NEW YORK

Utica is a case study in the successful revitalization of a Rust Belt community that faced severe economic hardship after the decline of the textile industry. Mayoral leadership and community acceptance of a workforce development strategy that involved thinking outside of the box has led this city back to self-confidence and renewed efforts in innovation.

BACKGROUND

The city of Utica was first settled in 1773. Located on the Mohawk River in Mohawk Valley, the city of Utica is the county seat of Oneida County, New York. With a population of 62,235 (2010 US Census), and an area of 17.02 square miles, Utica is the tenth most populous city in the state of New York. It's location 90 miles northwest of Albany and 45 miles east of Syracuse, as well as its access to the railroad and eastern canal system helped to make it a manufacturing hub for the textile, lumber, heavy machinery and furniture industries in its early days.

At the turn of the century, Italian, German, Polish and Irish immigrants were drawn to Utica's mills and many started their own businesses. Syrian and Lebanese immigrants arrived around the same time and eventually opened dry goods stores and groceries.[24] The city continued to grow until the middle of the century when the textile industry began to falter.

SITUATION

Like many other Rust Belt cities, the city of Utica fell into decline during the second half of the twentieth century as the textile industry tapered off and jobs relocated. After the textile mills closed during the 1950s, large companies like General Electric and Univac, and the Griffiss Air Force Base stepped in to provide thousands of jobs to displaced workers. But those too either eventually downsized or as in the case of the Air Force base, closed, and the city struggled to maintain its downtown and neighborhoods. The population fell from its high of 100,000 to 50,000, and a common symbol of the dire conditions in Utica at the time was a popular bumper sticker stating: "Last one out of Utica, please turn out the lights."[25]

ACTION/RESOLUTION

Continuing into the 1970s, several urban renewal programs were attempted, but were unsuccessful until a new wave of immigrants began to settle in the city. At this point, the arrival of refugees from Vietnam, Bosnia, Burma, Bhutan and Somalia was the catalyst for the city of Utica to change direction from a state of decline to one of small business development and innovation.

Refugees that arrived over the past few decades have stabilized the population of Utica. The 2010 census showed the city had a bump in population for the first time in decades. In response, a Center for Refugees was established to provide guidance and assistance to the new arrivals. Within a few years of arrival, most have integrated well and many have established their own businesses. According to Joe Marino, a Utica city councilor, "This city that we have now, these new refugees really, really rebuilt the city."[26]

There have been numerous efforts by concerned citizens and organizations to build renewed vitality in the broader Utica region. For example, in 2006, Utica hosted a series of community visioning sessions facilitated by David Beurle, Future iQ Partners, entitled "Community Conventions for the Future" which were organized and hosted by Breakthrough Central New York, a local citizen action group. Events such as these worked to build renewed hope and vision in the community, and to mobilize people to begin to think beyond the past, and identify actions for the future.

In 2010, the City of Utica published its first Comprehensive Master Plan in many years. Its ten goals focus on the rebuilding of infrastructure and waterfront development using smart growth principles with an eye to promoting business development, sustainability and innovation throughout. The Plan established a Partnership Advisory Board consisting of public and private leaders with diverse backgrounds and expertise. The role of the Partnership Advisory Board is to:

1. Evaluate and monitor Master Plan implementation
2. Coordinate partnerships for plan implementation
3. Staff the Executive and Standing Committees
4. Resource funding related to Master Plan implementation
5. Provide annual reports on activities related to Master Plan implementation

An update on progress related to this Plan was published in the city's 2014-2015 Consolidated Annual Performance Evaluation. The report highlights the city's turnaround in many of its targeted areas and emphasizes the importance of community involvement in the process. Citing the city's turnaround in 2014, the US Department of Housing and Urban Development (HUD) chose Utica as one of three municipalities to conduct a Community Needs Assessment (CNA) resulting in a two-year Action Plan. This Action Plan was incorporated into the City's 2015-2019 Consolidated Plan and 2015-2016 Annual Action Plan.[27]

Regionally, innovation efforts are being pursued through new programming made to align New York's SUNY higher education system with K-12 education. Workforce development associated with the region's nano-related economic development extends to the high school level. Learning opportunities include innovative nano-related science and technology coursework offered at various high schools. According to information supplied by schools, these programs enroll a diverse mix of students from both urban and rural backgrounds and from a range of socioeconomic backgrounds.[28]

Workforce development has been a focal point for the revitalization of Utica. A recent report on significant industries in the Mohawk Valley points to three industries in particular that managed to increase their regional employment levels between 2009 and 2014 despite the worst national economic downturn in 75 years. These industries were manufacturing (in particular food manufacturing), health care and social assistance.[29] Overall, labor statistics for the Mohawk Valley Region support the progress of economic development in Utica, using the indicator of unemployment levels in the region.

Figure 11: Recent Workforce Trends in the Mohawk Valley

LABOR STATISTICS FOR THE MOHAWK VALLEY REGION

Fulton, Herkimer, Montgomery, Oneida, Otsego and Schoharie Counties

Unemployment Rates (Not Seasonally Adjusted)
Utica-Rome Metropolitan Statistical Area (MSA)

May 2016	April 2016	May 2015
4.4%	5.1%	5.5%

The unemployment rate in the Utica-Rome MSA decreased from 5.5% in May 2015 to 4.4% in May 2016. This marks the 40th consecutive month of over-the-year improvements in the jobless rate (The current unemployment rate series began in 1990.)

Source: New York State Dept. of Labor website 6.28.2016

ROLE OF INNOVATION

The tradition of welcoming immigrants and refugees into the community of Utica provided the community with an unintended catalyst of change in the revival of the city. The catalyst has prompted a realignment of workforce development strategy that was highlighted as such in a recent PBS documentary.[30]

With the election of current Mayor Palmieri in 2012, not only have refugees been part of a future growth strategy, the city of Utica and local institutions have aggressively sought outside funding to rebuild the community and promote innovation initiatives. Examples include:

- In 2013, the New York State Department of Health received an ATSDR Brownfield Opportunity grant to support local agencies in creating community gardens. The Oneida County Health Department partnered with the Refugee Center in Utica to build and farm several raised bed gardens.[31]

- The New York State Business Incubator and Innovation Hot Spot Program was enacted as part of the 2013-14 State Budget and provides significant financial support for business incubators in the state. Successful applicants were chosen based on their suite of services recognized as "best practices" as defined by the National Business Incubator Association. Mohawk Valley Innovation Hot Spot thINCubator in Utica was identified for funding.

- In 2014, the Workforce Investment Board of Herkimer, Madison and Oneida Counties located in Utica was awarded $3,000,000 by the US Department of Labor's Workforce Innovation Fund to expand and enhance innovative workforce development strategies in the region.[32]

- In September 2015, SUNY Poly CNSE Center for Advanced Technology in Nanoelectronics and Nanomaterials (CATN2) was awarded $9.2 million over ten years through the Empire State Development Center for Advanced Technology (CAT) Program. The Center's primary hub will be located at the Albany megaplex and include the SUNY Utica campus.[33]

In addition to funding mechanisms, other organizations have stepped in to assist small business entrepreneurs and sustainability efforts. Examples include:

- R2G (Rust to Green): Built into Utica's Consolidated Plan, this initiative stems from a network of Cornell academic partners that work with communities to identify and design innovative strategies and solutions addressing the unique problems and needs of New York's Rust Belt cities.[34]

- StartUpNY: This is an innovation-based economic development program that will create tax-free business sites for up to 10 years. The program operates out of the Mohawk Valley Community College (MVCC) in Utica and Suny campuses across the state of New York.[35]

- Mohawk Valley EDGE: The Economic Development Growth Enterprises Corporation is a nonprofit corporation that helps new businesses and startups to establish themselves in Oneida and Herkimer Counties.[36]

- In 2016, The Mohawk Valley Community College established a new program – the Advanced Institute for Manufacturing (AIM) - designed to assist small- to medium-sized manufacturing companies, in order to make their individual systems run more efficiently, increase profits, develop new innovative products, and create and retain jobs.[37]

The concerted efforts by local leaders to use a development strategy incorporating human assets and innovation have clearly placed Utica on the path of revitalization and renewal. Many of these efforts have been relatively recent and the long-term effects yet to be seen, but the confidence and energy created by success are giving hope back to the community and inspiring new collaborations across sectors.

LESSONS LEARNED FOR THE GREATER LIMA REGION:

1. The importance of exploring nontraditional options to solve common problems. In the case of workforce development, tapping into the refugee community helped to stabilize population loss and provide a skilled workforce for Utica.

2. The importance of Mayoral leadership. Like Chattanooga's Mayor, Utica's Mayor has played a significant leadership role in city revitalization efforts.

3. The importance of outside grants and funding.

4. Community Engagement and the role it plays in setting comprehensive goals for the community.

5. The importance of university-industry-government collaboration in bringing innovation projects to cities.

3.4 GREATER LIMA REGION, OHIO

Allen County and the surrounding seven-county region represent a hub of manufacturing activity in West Central Ohio. The region is in the midst of a regional rebirth as significant technological advances to many of its large sectors coupled with the development of the next generation of Abrams Battle Tank provide potential opportunities in a number of key industries. The region's leaders recognize this potential and have begun organizing to showcase the region's capabilities.

BACKGROUND

The Greater Lima Region began its life on the frontier of a new nation's westward expansion but did not truly find its place on the map of the nation's consciousness until the mid-1850's when the rail industry began to make a lasting impression on its landscape and workforce. The blip that appeared on the map became a beacon after 1885 when the discovery of oil would bring the first proper industrial boom to the region. The attention, investment, and prosperity brought by the intersection of transportation and commerce over the past one-hundred and fifty years have established the region as a center of manufacturing, energy, and agriculture.

The region underwent a significant transition over the years following World War II, beginning with the transportation of the Lima Agricultural Works to the Lima Machine Works and later the Lima Locomotive Works into the Lima Tank Plant in 1942. These industrial giants, along with strong regional ties to agriculture and the automotive industry defined the landscape of the region's economy throughout much of the twentieth century. While many of the region's large, traditional manufacturers closed during a period of industrial decline in the 1970's and 1980's, the region still boasts a strong and proud manufacturing base through the presence of global firms such as Ford Motor Company, Procter-Gamble, and Potash Corporation. This era of industrial prosperity was defined by a culture of civic investment and innovation.

SITUATION

Beginning in the late 1970's, the Joint Systems Manufacturing Center (JSMC), the successor to the Lima Tank Plant began the production of a number of Abrams Battle Tank variants, as well as production of the Stryker combat platform for the U.S. Marine Corps, the MK46 Naval Gun system, and the Namer-Merkava Armored Personnel Carrier for the Israeli Defense Force. More recently, expansion of production capabilities has occurred at the plant, as well as service to all five branches of the U.S. Military.

Despite the expansion of the product lines currently manufactured at the JSMC, overall production and staffing levels have decreased over the last decade. This is the consequence of a number of failed and cancelled projects, including the Crusader and Future Combat Systems heavy weapons programs for the U.S. Army and the Expeditionary Fighting Vehicle Program for the U.S. Marines. If approved, the work associated with the combination of these three programs among others would have allowed General Dynamics Land Systems to maintain peak staffing levels for the next several years. Their cancellation, however has cast uncertainty on the future viability of the JSMC and its role in the Greater Lima Region.

A 2005 Base Closure and Realignment review called for the realignment and idling of the JSMC. This would potentially result in the loss of thousands of jobs throughout the region and a significant share of the region's manufacturing revenue. The proactive outreach coordinated by a coalition of local, state and federal elected officials, economic development and business associations, labor organizations, media, and other community leadership effectively advocated for the facilities removal from the recommended actions list. This granted the JSMC with a reprieve, but also cast local and national light both on the facility and its importance as a key defense asset. This also triggered a community conversation regarding the importance and future of the facility as a leader in the region's manufacturing base.

ACTION/RESOLUTION

The uncertain status of the JSMC and the recession of 2008-2009, which impacted the region's automotive manufacturers and suppliers both led to the opening of a series of community dialogues regarding the future of these vital industries and the region's future prosperity.

In response, Task Force LIMA was formed in 2005 and represents a comprehensive community partnership organized to advocate for the JSMC and its capabilities to state and federal officials. It is a coalition of local, state and federal elected officials, economic development and business associations, labor organizations, media, and other community leadership. The inclusion of such a comprehensive array of partners is essential given both the scope of the facility as well as the nature of the challenge.

The leadership of the task force mirrors the unique nature of the JSMC as it has always been co-chaired by the mayor of Lima and the General Dynamics plant manager. This public-private partnership has been especially effective as it opens a constructive dialogue as to the needs of the JSMC and what community assets could be leveraged to support it. By engaging in an extensive public outreach and advocacy campaign, the task force was able to successfully reverse a 2005 recommendation to reduce the productive and physical footprint of the JSMC. Advocacy by Ohio's congressional delegation has resulted both in the extension of the M1 Abrams program, as well as a recent decision by the Department of Defense to commit $99 million in additional capital upgrades.

A similar dialogue framework has been opened under the leadership of Mayor David Berger in the formation of the Mayor's Automotive Task Force. This task force is represented by the region's education institutions and industry representatives. Conversations are ongoing regarding the expansion of the region's supplier base and critical workforce needs issues.

The discussion regarding workforce development and human capital needs has expanded in scope but narrowed in scale in recent years through the creation of the Link Lima/Allen County initiative. This initiative traces its development back to the publication of the Allen Economic Development Group's AEDG Workforce Vision 2018 in 2013. The initiative, which represents a partnership by large employers across several sectors and the small business community members of the Lima-Allen County Chamber of Commerce developed through the recognition of a shared need for the community to attract, develop, and retain a world-class workforce. This recognition is also shared by the West Central Ohio Manufacturing Consortium, as to the need to develop a more comprehensive and coordinated model to support the workforce needs of employers across multiple sectors.

A final effort to emerge in the region has been funded by the U.S. Department of Defense Office of Economic Adjustment, which provided the Allen County region with two rounds of Defense Industry Adjustment funding beginning in 2014. These awards, which total $3.2 million have provided the region with a forum to discuss the potential alignment of the economic and workforce development ecosystems and the importance of the development of a regional growth strategy. The grant has also provided a significant award to the Ohio Energy and Advanced Manufacturing Center to continue to serve as the nexus of innovation activity in the region.

ROLE OF INNOVATION

The region's most prominent innovation hub is the Ohio Energy and Advanced Manufacturing Center (OEAMC), a sophisticated and versatile commercialization center in Lima, Ohio. The center opened in fall 2014 and is currently accepting its first class of entrepreneurs. However, the story of the partnership that led to this development stretches back over the last decade.

The dialogue that led to the eventual formation of the OEAMC started in 2006 as community leaders engaged with faculty from Ohio Northern University and other research institutions and business leaders in the energy and manufacturing sectors to discuss the role of innovation as an economic development tool. These early conversations focused on the principle of Sustainable Agile Manufacturing as a development strategy for the region.

The OEAMC formalized its organizational structure in 2008 and initiated a campaign to raise capital for a commercialization research facility. The new facility was funded, in part through a $1.5 million Economic Development Administration grant and a total of $2 million in state grants and loans, OEA grant funding of $900,000 was dedicated to the commercialization of High Velocity Metal Forming (HVMF). This represents a significant public investment in the concept of innovation as an economic development strategy.

The success of the applied model of innovation development is largely driven by the synergies that are derived from collaborative partnerships among entrepreneurs and researchers. This is especially important in the case of the OEAMC as their stated intention is to develop applications to benefit firms in a national market. One key synergy has already been created as the organization has deliberately recruited leadership from both local manufacturing and energy firms. This represents the two key traditional industry strengths in the region.

The development of the OEAMC will require continued engagement from those key stakeholder groups already at the table, as well as new industry partners. It serves a vital role in the pursuit of a regional innovation strategy. The identification of a clear development process and defined markets has already differentiated it from similar initiatives in other communities. It rightfully represents one of the key assets to guide the Allen County region's economic future.

The future of the region's economic vitality hinges on the success of the OEAMC and other entities in directing innovation activities in the region. The region possesses significant potential to drive innovation in metal forming, paint and coatings, and advanced energy technologies, such as fuel cells. Many of these areas of innovation trace their history directly to the traditional strengths of the region's ties to the oil and automotive industries. There is some risk in maintaining too strong of a tie to these more traditional industry sectors without considering the role that innovation continues to play in driving technology and society forward. Rather the region's success is highly dependent on the ability of the region's leaders to develop effective partnerships and collaborative strategies to both guide innovation activities and meet the region's workforce development needs. A key partner in these partnerships is the region's education ecosystem, as the region's colleges and universities, such as Ohio Northern University and the Ohio State University possess significant research and commercialization potential. This could reposition the region as one of the Midwest's premier "brain belts."

KEY OBSERVATIONS:

1. The Greater Lima Region has proven successful in organizing and advocating in the face of significant public challenges.
2. The region has developed robust ecosystems in a number of key development areas, such as workforce development. This provides the region with ample grounds and a prime opportunity to more fully align these efforts around shared needs.
3. Innovation has a strong historical role in the region. It is crucial for the OEAMC and other visionary organizations to recapture and promote this.
4. The region has benefited from the leadership of a number of visionaries in the formation of efforts such as Task Force LIMA and the OEAMC. The efforts of these groups will be greatly enhanced through the implementation of a collaborative growth plan.

3.5 KEY IMPLICATIONS

- The most important lesson learned from the Newton, Iowa case study has to do with the importance of the local collaborative leadership network that took it upon themselves to steer the city from a one-corporate town model to one with a more diverse structure that grows more organically. With this openness and ability to pivot, the city was able to support a transition that both retained and retrained its skilled workforce to meet the needs of new industry and innovation, and place the city on the path to future prosperity.

- The primary lesson learned in the Chattanooga case study is in the purposeful creation of an innovation district by a Mayor with a vision that encouraged entrepreneurialism. By using the infrastructure available to the city through visionary public planning of the city's electrical system, the Mayor was able to vigorously pursue his plans to make the city a magnet for start-ups, business, and entrepreneurial support organizations, thus positioning the city for the future.

- The key lesson learned in the Utica, New York case study is in the openness of the community and leadership of Utica to welcome immigrants and refugees as a workforce development strategy. By providing the necessary start-up social and economic foundation to this skilled workforce, Utica has been able to revitalize its city and provide itself with a workforce to support increased municipal growth and innovation efforts.

4.0 RECENT INNOVATION TRENDS AND CAPACITY IN THE GREATER LIMA REGION

We have seen the resilience of the Greater Lima Region in its reinvention as an advanced manufacturing center over the past thirty years. Considerable investments have been made by a number of companies in the past five years, including Crown Equipment Manufacturing, Ford Motor Company, General Dynamics Land Systems, Potash Corporation to improve and expand their facilities to capitalize on market opportunities. The region's economic development community has considered a number of ways to creatively reuse assets while also gaining a considerable reputation as a prime business location.

The region's ability to effectively collaborate in the wake of considerable challenges has been demonstrated in the improvement of the Husky Energy, Inc. Lima Refinery in the late 1990's and the region's response to the potential closure of the Joint Systems Manufacturing Center a decade later. In each of these instances, the region's key stakeholders have recognized that a collective solution is the best course of action. The same is true when considering the role of the region in promoting innovation. We have noted that the region has a number of considerable assets that may enhance innovation and entrepreneurial activities. This will be essential as the Greater Lima's most recent innovation record shows some progress but also considerable room for improvement.

We will discuss two specific indicators of innovation activity in this section – patent awards and applied research spending. Each is critical in the model of applied innovation proposed here as research is funded through a variety of sources but commercialization is typically incentivized through some form of intellectual property protections. The Greater Lima Region lags behind comparable benchmarks in each of these measures with a few exceptions. This does not necessarily indicate that the region is not innovative. Rather, it reinforces the previous assertion that a stronger regional commitment to developing a culture of innovation may be necessary.

4.1 PATENT AND INVENTOR ACTIVITY IN THE GREATER LIMA REGION

One of the primary metrics of innovation in any area are the number of discoveries that are considered unique and therefore worthy of patent protection. There are a number of other incremental innovations that may be used to improve a product or process, but these are more difficult to quantify in any meaningful sense. We will consider the importance of value-added processes separately. In this section we will discuss trends in regional patent activity over a fifteen-year period that coincides with the region's transition towards advanced manufacturing.

First, we know that a great deal of applied innovation occurs throughout the eight county region. This is demonstrated in Figure 12, which reports data from the U.S. Patent and Trademark Office.

Figure 12: Patents Awarded by County in the Greater Lima Region: 2000-2015

County	2000	2005	2010	2015	Total
Hancock County	8	7	12	15	207
Auglaize County	18	8	7	13	170
Mercer County	10	9	6	8	112
Allen County	4	3	3	5	62
Putnam County	5	3	2	4	51
Paulding County	3	1	2	4	35
Van Wert County	1	1	1	4	25
Hardin County	1	3	1	1	20

Source: United States Patent and Trademark Office

We see first that the region's patent activity is primarily focused in three counties – Hancock, Auglaize, and Mercer. We also know that patent activity varies with time, with the number of patents awarded increasing over the past five years. Allen County has lagged behind the region, registering only 62 patents over the fifteen-year period and no more than five in any year. This is largely a consequence of corporate research and development activities by Cooper Tire and Rubber Company and Marathon Oil in Hancock County, American Trim's operations in Auglaize County, and Crown Equipment Manufacturing in Mercer. Substantially less company-specific research and development activity occurs in Allen County or the other counties in the region. The rate of patent activity is also highly dependent on the specific industry composition of a region. It is again assumed that most of the innovation that occurs in the Greater Lima Region is incremental rather than disruptive, which explains this trend, in part.

Focusing specifically on patent activity in Allen County, we see that three firms – Plastipak Packaging, Honda Motor Company's two divisions, and American Trim were awarded patents over this period. Comparable information is not available for the other counties in the region. This points to a relatively small amount of specific innovation within the region, or at least that which has occurred in and around Lima.

Shifting our focus from patents awarded to potential innovators, Figure 14 presents the number of patent applications received over that same period by unique applicant. This presents a rough estimate of the number of inventors that have been active in the region over the past fifteen years.

There is a direct correlation between the number of patents awarded and the number of patent applications submitted. There were 1,378 patent applications prepared throughout the region over this period, but only 682 patents awarded. This suggests that the region has less than a 50 percent success rate in patent applications. This is substantially higher than the national average of 23 percent, indicating that those innovations that are presented for patent protection may be more fully developed and realized in the Greater Lima Region than those that could be considered to be more speculative. More importantly, the count of patent applications does indicate that there is a substantial base of potential innovators already active in the region.

We can next consider the types of patents awarded.

Figure 13: Patents Awarded by Company, Allen County, Ohio

First-Named Assignee	2000	2005	2010	2015	Total
INDIVIDUALLY OWNED PATENT	1	2	1	2	11
PLASTIPAK PACKAGING, INC.	0	0	0	0	10
HONDA GIKEN KOGYO KABUSHIKI KAISHA (HONDA MOTOR CO., LTD.)	0	0	2	0	8
AMERICAN TRIM, L.L.C.	0	1	0	0	7
HONDA OF AMERICA MANUFACTURING, INC.	2	0	0	0	7

Source: United States Patent and Trademark Office

Figure 14: Patent Applications Submitted by Unique Applicants, 2000-2015

County	2000	2005	2010	2015	Total
Hancock County	17	16	21	32	401
Auglaize County	38	20	20	27	399
Mercer County	18	18	15	31	270
Allen County	7	6	4	19	134
Putnam County	10	8	5	10	10
Paulding County	4	2	5	10	80
Van Wert County	2	4	2	5	46
Hardin County	2	7	2	1	38

Source: United States Patent and Trademark Office

The data presented in Figure 15 is again reflective only of Allen County. It represents all types of products or processes for which at least two patents were awarded over the past fifteen years.

We again see that there has been a variety of patent types awarded within the region over this period. This is reflective of the region's industry mix, with significant interest in testing equipment, metal forming processes, and plastic forming and treating. It is again likely that significantly more innovation activity is occurring in these and other areas throughout the Greater Lima Region. This is only an indication of that activity that was awarded patent protection.

There are relatively few benchmarks that could be used to place this level of activity in a national context. A 2004 Organization for Economic Cooperation and Development study estimated the number of patents awarded per capita in the United States at 630 per one million residents. This lagged significantly behind the 2,836 patents awarded per million residents in Japan. Scaled to the size of the Greater Lima Region, this benchmark suggests that the rate of patent activity in 2015 was comparable, but slightly behind this national benchmark (53 patents awarded per 100,000 residents compared to 63 per 100,000 nationally.) No single county comes close to matching the same rate of patents per capita, suggesting that innovation is truly a regional pursuit.

Figure 15: Patents Awarded by Type, 2000-2015

Class Title	2000	2005	2010	2015	Total (2000-2015)
Measuring and Testing	1	0	1	0	5
Plastic and Nonmetallic Article Shaping or Treating: Processes	0	0	0	0	5
Metal Working	1	0	0	0	4
Illumination	0	0	1	1	3
Metal Deforming	0	0	0	0	2
Gas and Liquid Contact Apparatus	0	0	0	0	2
Communications: Electrical	0	0	0	1	2
Hydraulic and Earth Engineering	0	1	0	0	2
Plastic Article or Earthenware Shaping or Treating: Apparatus	0	0	0	0	2
Card, Picture, or Sign Exhibiting	0	0	0	0	2
Tools	1	0	1	0	2
Land Vehicles	0	1	0	0	2
Electricity: Measuring and Testing	0	0	0	0	2
Rotary Expansible Chamber Devices	0	0	0	1	2
Games Using Tangible Projectile	0	1	0	0	2
DP: Generic Control Systems or Specific Applications (Data Processing)	0	0	0	0	2
ALL CLASSES	**4**	**3**	**3**	**5**	**62**

Source: United States Patent and Trademark Office

4.2 UNIVERSITY RESEARCH SPENDING IN THE GREATER LIMA REGION

University research is a second area commonly referenced by experts as quintessential to innovation. In exploring the potential impact of university and applied research on the Greater Lima Region, it is first important to note that the eight-county region does not serve as home to any research universities, as defined by the Carnegie Classification of Higher Education Institutions. These are distinguished as doctoral institutions that devote considerable resources to student and faculty research.

The region is home to a number of universities, including Bluffton University, the University of Findlay, Ohio Northern University and the University of Northwestern Ohio (UNOH) as well as two-year institutions such as the Ohio State University – Lima, Rhodes State College, and an extensive vocational-technical education system. We will discuss the role that these institutions play within a prospective innovation framework in a future section. These institutions do engage in some applied research but lack the graduate support to do so at a considerable scale.

There are a number of research universities in relative proximity to the Greater Lima Region, including two of the most prominent in the country. Many of these institutions are currently engaged in some capacity with companies and other organizations in the region. Figure 16 details the spending growth of the six universities that are most proximate to the region.

We see that these six institutions, led by the Ohio State University spent a total of $1.4 billion on applied research in 2014, with Ohio State accounting for 58 percent of this spending. Spending over a ten-year period increased by 29.4 percent, with the University of Toledo experiencing the most significant growth of 87.6 percent. This growth is tied to significant investments in Health Science and Materials Science research at the university. It is not certain as to how much of this spending has been directed specifically within the Greater Lima Region, though we know that extensive partnerships do exist with regional firms. What is more significant is the volume of spending that may be available to continue the development of a stronger innovation culture.

It is also important to note that there are a number of other academic and research institutions that enjoy a significant relationship with organizations in the Greater Lima Region. The University of Michigan – Ann Arbor, which is the second largest research university in the country enjoys a substantial relationship with the automotive manufacturers in the region. Other partnerships have been established with Oak Ridge National Laboratories. The magnitude of these relationships vary from informal to heavily structured but the fact does remain that the region lacks a significant local research presence.

We can gain additional insight into the research activities of the universities in close proximity to the region by considering the areas where research spending occurs. The data in Figure 17 presents the spending areas by institution for the 2014-15 academic year.

There are several interesting items of note here. First, we see that the majority of funding (60.2 percent) is spent on life science research. This closely matches the research portfolio of each of the largest institutions on this list, including the Ohio State University, Case Western Reserve University, and the University of Toledo. The Greater Lima Region does have a number of small biomedical and life science firms and a number of firms in the chemical manufacturing sector enjoy strong linkages to medical and pharmaceutical applications. This suggests that some of the research performed in this area may have benefit beyond direct application in the region's medical centers.

The second largest, but perhaps the most applicable spending area for the region is the $304 million spent

Figure 16: Institution Spending Growth

Rank	Institution	2005	2010	2014	2005-2014 Change
19	Ohio State U.	643,283	755,194	815,075	26.7%
51	Case Western Reserve U.	324,502	418,164	419,011	29.1%
156	U. Dayton	70,178	93,309	86,881	23.8%
175	U. Toledo	33,002	70,399	61,900	87.6%
328	Bowling Green State U.	10,542	8,124	8,861	-15.9%
345	Indiana U.-Purdue U., Fort Wayne	NA	8,523	7,882	
	Total	**1,081,507**	**1,353,713**	**1,399,610**	**29.4%**

Source: United States Patent and Trademark Office

Figure 17: Institution Research Spending by Subject Area, 2014

Rank	Institution	All R&D Expend.	Env. Sci.	Life Sci.	Math and Comp. Sci.	Phys. Sci.	Psych	Social Sci.	Science	Engin.	All non-S&E Fields
19	Ohio State U. Case Western	815,075	11,517	472,312	34,646	35,413	8,109	18,106	20,141	152,592	62,239
51	Reserve U.	419,011	843	341,879	1,082	10,341	1,754	6,166	918	54,453	1,575
156	U. Dayton	86,881	165	989	2,423	1,370	16	40	261	78,165	3,472
175	U. Toledo	61,900	3,349	24,257	101	11,023	31	250	0	17,699	5,190
328	U. Indiana U. - Purdue U.,	8,861	942	1,239	1,571	2,970	226	1,622	0	60	231
345	Fort Wayne	7,882	11	2,453	60	108	319	479	21	1,197	3,234
		1,399,610	**16,827**	**843,109**	**39,883**	**61,225**	**10,455**	**26,663**	**21,341**	**304,166**	**75,941**

Source: National Center for Engineering and Science Statistics, Higher Education Research Data

on engineering research. This constitutes more than one-fifth of all research activity at these institutions. In comparison, engineering research spending constitutes 26 percent of all research activity at the University of Michigan – Ann Arbor. Numerous companies and organizations such as the OEAMC have fostered active relationships with the research engineering faculties of the Ohio State University most specifically over the past decade. This again suggests that significantly more capacity exists for further partnerships and a stronger research presence.

Another potential area of future collaborative work is the development of additional Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) through a number of federal government agencies, such as the Department of Agriculture, Department of Defense, National Institutes of Health, and Small Business Administration. The success of these partnerships again requires the presence of a strong university presence and the collaborative spirit that is being fostered throughout the region. These programs can enhance the applied research currently being conducted by providing the funding and support to bring more of these discoveries to market.

4.3 BENCHMARKING THE GREATER LIMA REGION'S INNOVATION CLIMATE

We have considered the role and volume of innovation activity within the Greater Lima Region, finding that the region compares favorably to national benchmarks of patent activity but lacking considerable university resources. These measures play an important role, but they do not tell the entire tale of the region's innovation climate. Innovation requires a number of factors in order to be both successful and sustainable. Most of these are contained in the condition and character of an inventor and an idea, but others can be found in the community that supports this.

There are a number of well-known indices that measure innovation activity and supportive factors at the state and national level, including the Kauffman Index and Bloomberg Index. Comparable data is more difficult to find at the local level largely due to a disparity of activity in places of different sizes. It is difficult to compare any region to the seven counties that comprise the Silicon Valley region in northern California, for example as innovation volume in this region is between 200 and 300 times the national average.

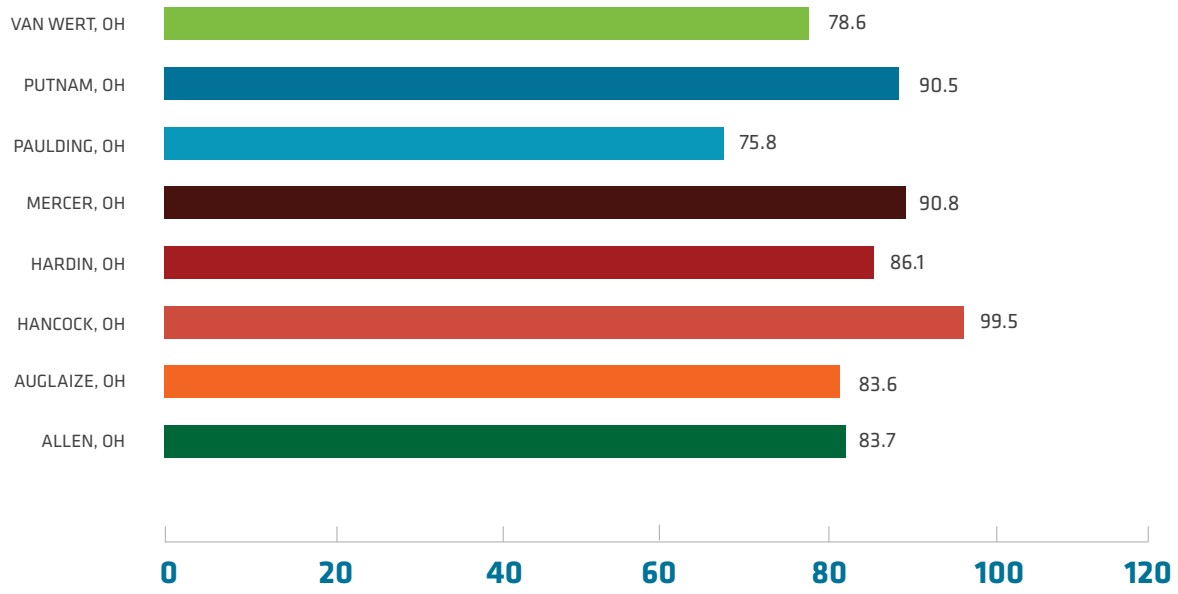
The U.S. Department of Commerce's Economic Development Administration, through their StatsAmerica partnership with Indiana University has created a multi-faceted Innovation Index as a means of filling this gap.[38] The index includes more than 100 metrics in a series of community assets and dynamics, such as:

- Business Dynamics
- Business Profile
- Economic Well-Being
- Employment and Productivity
- Human Capital and Knowledge Creation

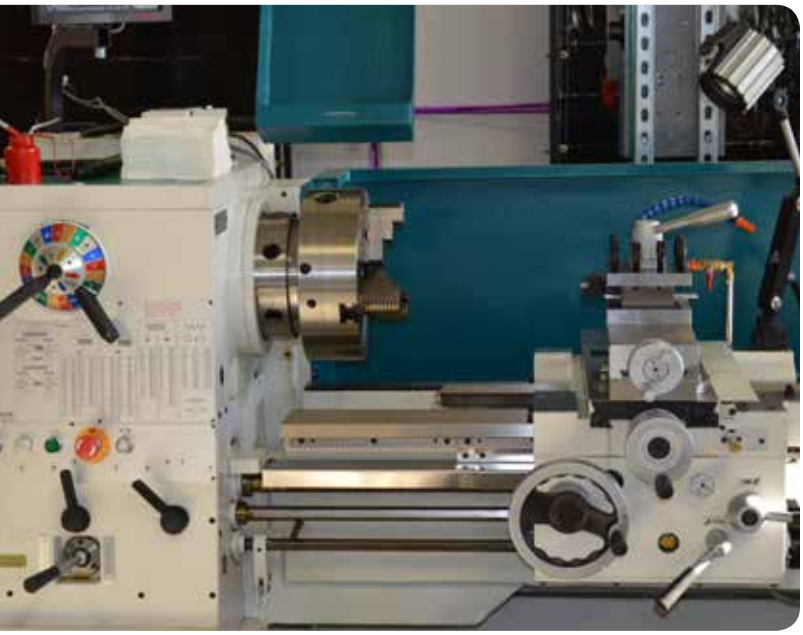
These metrics are further disaggregated along lines of innovation inputs, outputs, social capital assets, and state context and are intended to provide some context as to how innovative or supportive of innovation a region is in context. We will consider how the eight counties in the Greater Lima Region rate in order to appreciate the value of these measures. The analysis that follows uses measures from the second edition of the index, which was released in August 2016. As a point of reference, each index measure is rated against a national benchmark value of 100.

The first measure presented in Figure 18 represents an index of indices and presents a high-level assessment of innovation cultures. We see that the region generally measures favorably, with the exception of Paulding and Van Wert County, with Hancock County scoring closest to the national benchmark. This aligns quite closely with the patent data that was discussed earlier in the analysis. The index values are also very strongly influenced both by population size and business density, suggesting part of the reason why some counties may have rated lower than others.

Figure 18: Headline Innovation Index for the Greater Lima Region



Source: U.S. Department of Commerce, Economic Development Administration



The research team at the Indiana Business Research Center who developed and maintain the index methodology encourage regions to consider the impact of various index components as a means of both understanding the role that they play in fostering an innovation culture and to identify benchmarks that a region could seek to improve. We will consider some of these lower level metrics next in two key areas – business dynamics and employment dynamics.

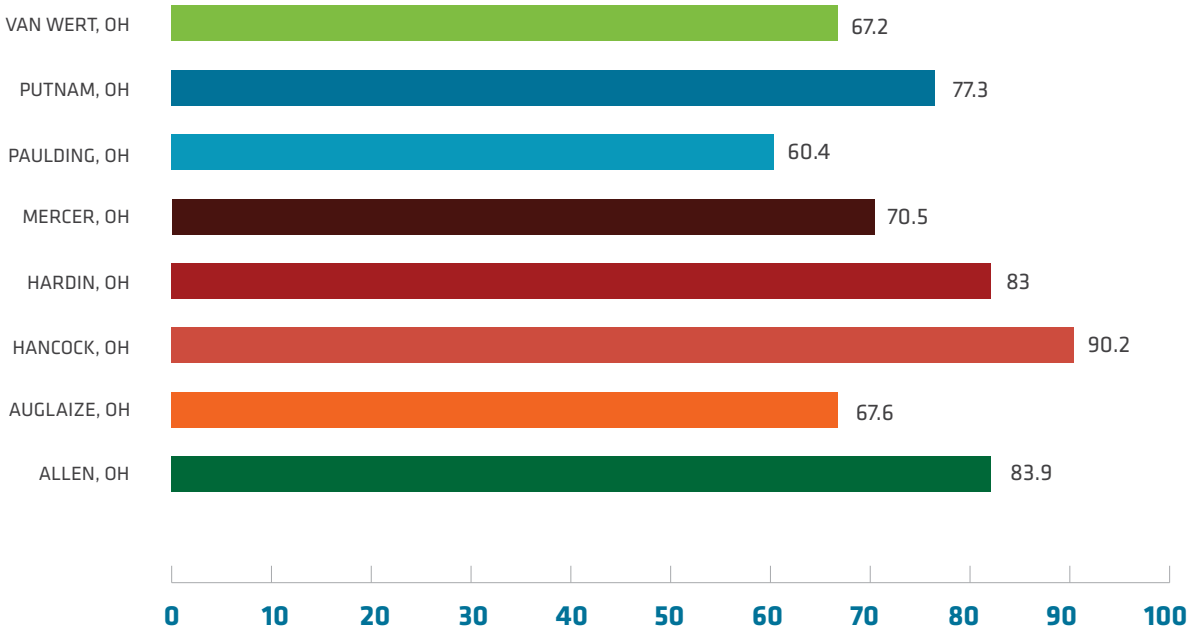
BUSINESS DYNAMICS

The dynamics of the Greater Lima Region's economy have been extensively documented in a number of reports produced through this initiative, including the Regional Asset Inventory and Readiness Analysis (Future iQ Partners, April 2015). The regional economy is dominated by a focus in manufacturing and health services and has demonstrated substantial resilience over the past thirty years. The innovation index includes two measures of the region's business community – a profile rating and a dynamic rating.

driven by the impact of large firms. This makes intuitive sense given the counties position on the I-75 corridor and growth in distribution facilities, for example. The influence of proprietor activity is much more strongly felt in the region's smaller counties. The proprietorship rate index in Hardin County is the highest in the region, for example (91.8).

In addition to the profile of the existing business community, the index rates the level of dynamism within the region. Figure 20 presents these index ratings, which include venture activity, firm births, and the growth of traded sectors.

Figure 19: Business Profile Index Ratings for the Greater Lima Region



Source: U.S. Department of Commerce, Economic Development Administration 2016

Figure 19 presents the Business Profile Index ratings for the region's counties. This index measures such factors as Foreign Direct Investment, strength of infrastructure, and measures of new business formation and proprietor activity. We see again that the region's largest counties – Allen and Hancock register the highest ratings while smaller, more rural counties lag behind. Both counties especially attractive to Foreign Direct Investment (91.1 in Allen County and 94.8 in Hancock County) and are

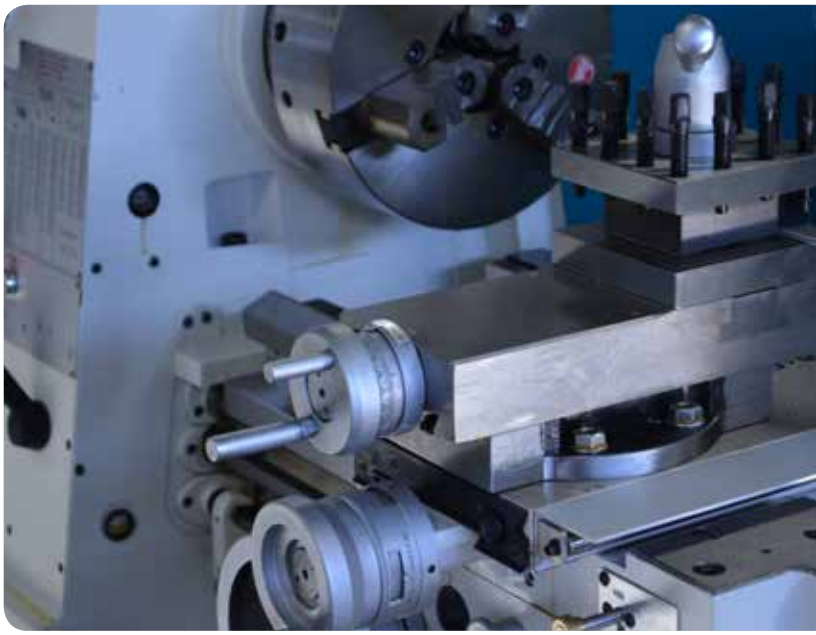
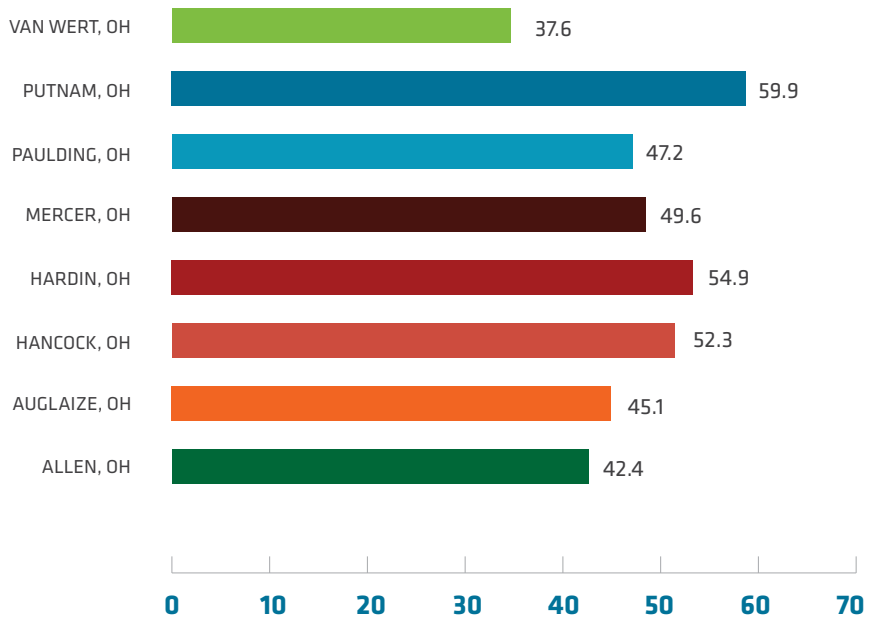


Figure 20: Business Dynamics Index Ratings for the Greater Lima Region



U.S. Department of Commerce, Economic Development Administration 2016

We see that the index ratings for all counties are significantly lower than the business profile measures. This is largely due to the lack of venture capital activity that is a common theme throughout the region. There is no venture capital or funding activity data registered for any of the eight counties in the 2016 index revisions. This lowers the index ratings for each of the counties, leaving us to measure each county solely on the basis of employment and revenue growth. Here we see that a number of counties register index ratings above 50, indicating that traded sector growth is statistically significant. The index also again points to the importance of new business formation and proprietor activity as an opportunity for new innovation.

In general, the business profile and dynamics indices for the counties in the Greater Lima Region indicates that much of the innovation culture in the region is driven by investment from two sources – proprietors and foreign-ownership. The findings also cement the need for a more expansive understanding of economic development in the region to embrace the needs of new and existing businesses.

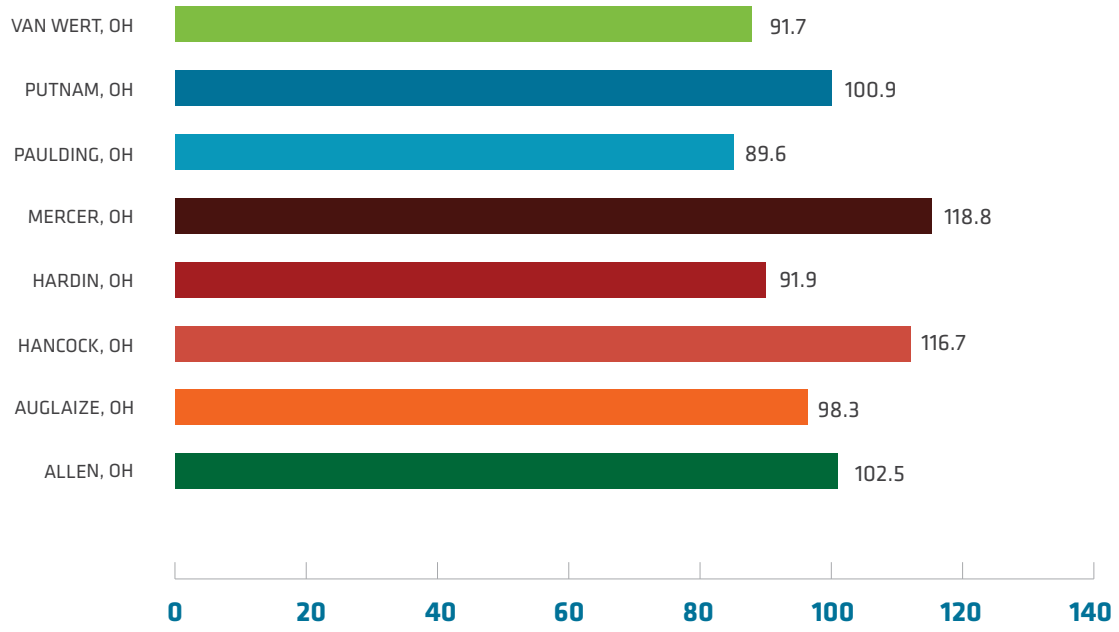
EMPLOYMENT DYNAMICS

The nature of future changes in the Greater Lima Region's workforce have been discussed at some length in the *Regional Workforce Needs Analysis (Future iQ Partners, August 2016)* and are currently being addressed by the work of *Link Lima/Allen County*, the *West Central Ohio Manufacturing Consortium* and other stakeholders. The innovation index recognizes the importance of the contribution of the current workforce and the development of the workforce of the future. This is reflected in two complementary indices – an employment and productivity index, and a human capital and knowledge creation index.

Figure 21 presents the index ratings on employment and productivity for the eight counties in the Greater Lima Region. This index measures employment growth and revenue generation as well as intellectual property formation.

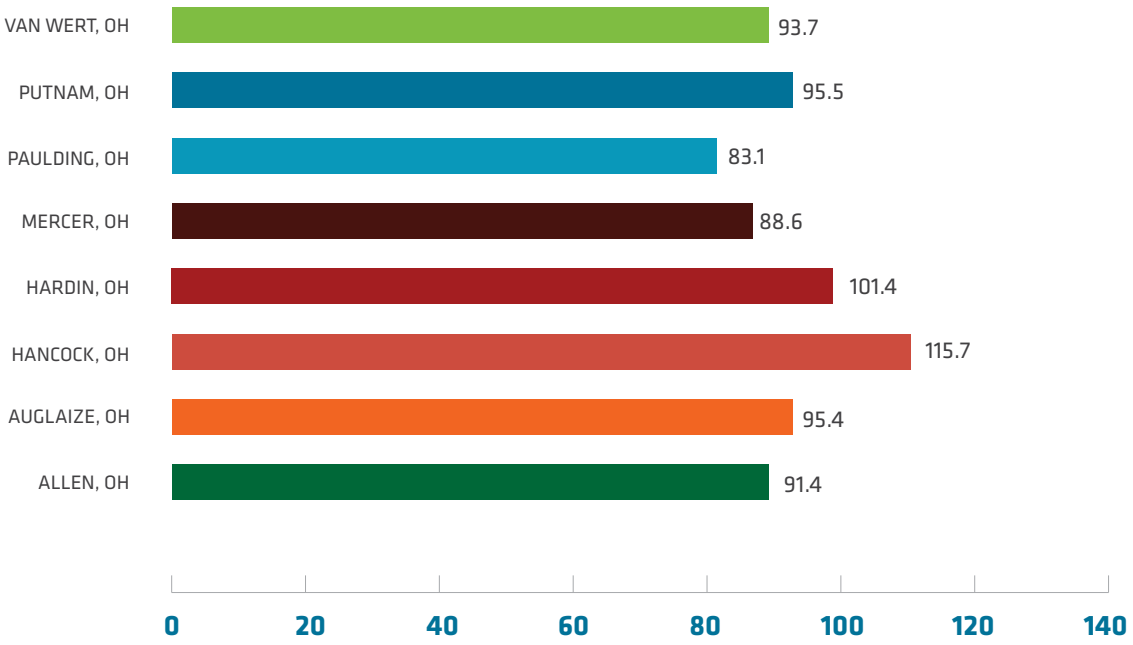
We first see that the index measures here are much closer to and, in some cases exceed the national benchmark for each of the region's county. This again makes strong intuitive sense as the region has experienced robust employment growth over the past several years and has observed a declining unemployment rate over the same period. Further, productivity, as measured as gross domestic product per worker, greatly exceeds the national average in each of the eight counties. What distinguishes each county are variations in patent metrics, which we have already discussed elsewhere in this analysis.

Figure 21: Employment and Productivity Index Ratings for the Greater Lima Region



Source: U.S. Department of Commerce, Economic Development Administration 2016

Figure 22: Human Capital and Knowledge Creation Index Ratings for the Greater Lima Region



U.S. Department of Commerce, Economic Development Administration 2016

Figure 22 presents the index ratings for each of the eight counties in human capital and knowledge creation. We again see that all of the counties measure more favorably here than in the business indices. Hancock County again exceeds each of the other eight counties, largely on the strength of a high concentration of STEM and high-value technology employment. This is tied to the presence of the corporate headquarters that have been previously discussed.

There are also significant variations in the educational attainment of the region's populations. We have already discussed this to some extent in other analyses. This is especially important in Allen County, where the index of bachelor degree holders (78.7) indicates that its concentration of these knowledge workers is significantly lower than a county of comparable size. This is partially a function of industry composition and historical patterns, but is an area of ongoing concern.

A number of other index measures have been assessed, allowing the region to quickly and frequently benchmark itself against any comparable region nationally. Taken as a whole, the analysis suggests that, while the region lags slightly behind national benchmarks in innovation culture and activity, it is driven by the strength of its workforce. This only emphasizes the need for the region to develop innovative solutions to the workforce challenges that have been presented in other work.

4.4 ASSESSMENT OF CURRENT INNOVATION CLIMATE

The Greater Lima Region has a long history of innovative problem solving. In many instances, these solutions have led to new businesses fueled by new and unique solutions. Many of these innovations have been bred out of practical need, such as the need to develop new processes and products to take advantage of a large reserve of petroleum to ways to apply traditional methods to a new industry sector. The region has developed a niche in providing specialized manufacturing services to a global marketplace. This, coupled with additional regional strengths in food processing and health sciences provide a fertile ground for additional applied innovation.

The volume of innovation that occurs within the region has been confirmed by a rather robust patent and inventor ecosystem. This compares favorably to available national benchmarks for a region of this size. However, what distinguishes the region from other advanced manufacturing regions is the fact that much of the research and development activity that currently occurs within the region is restricted to a handful of firms that have a strong corporate presence in the region, such as Cooper Tire and Rubber Company and Marathon Oil. This follows a national trend of siting most research and development activities with other corporate functions rather than co-locating these functions with production operations. This

has the impact of removing product development from the factory floor, but provides companies with greater ability to deploy these innovations throughout an organization.

The same general pattern exists with respect to applied academic research activity in the region. There are a number of universities that enjoy substantial partnerships with companies and other organizations in the region. Many of these universities are proximal to, but not located in the Greater Lima Region. This has the benefit of leveraging the resources of a host of world-class institutions to benefit local firms. The downside is that these institutions lack the local presence to respond quickly to company needs. It also makes it less likely that those research faculty and students who may consider eventual commercialization of their discoveries will do so in the region.

What results is a region where a number of new and innovative products and processes are currently being applied to support a robust manufacturing base, but where few of those innovations are actively developed there. This model is sustainable in the medium-term as it follows established business strategy. However, the region will need to consider pursuing a concerted effort to both increase the pace of innovation and new business formation if it wishes to retain its position as a national leader in advanced manufacturing. This is necessary to maintain the pace of growth of the sector.

This is especially true given the large number of small to mid-sized businesses in the region. These firms present an interesting and important test base for a range of new advances. However, it is unlikely that these firms possess either the capacity or the resources to invest in research and development activities themselves. As such, a coordinated regional strategy is required to leverage those resources that do exist and expand upon the capacity that has been identified.

The innovation roadmap that follows in the next two sections attempt to address some of these challenges. It begins with a discussion of two institutional structures that will play a vital role in an innovation framework. It continues with a proposal for a regional innovation roadmap that leverages and coordinates a number of key assets. It concludes with an analysis of the opportunities and the potential risks of action and inaction in a number of prominent industry sectors. Taken as a whole, the framework recognizes the legacy of the region's innovation history and greatly expands its reach.

4.5 KEY IMPLICATIONS

There are a number of potential implications that have a substantial bearing on the potential success of the proposed innovation framework throughout the Greater Lima Region, such as:

- The Greater Lima Region has a robust innovation ecosystem as measured by patent applications and patents awarded. Much of this can be attributed to a small number of innovative firms, such as Cooper Tire and Rubber Company and Marathon Oil.
- A number of prominent institutions, including the University of Michigan – Ann Arbor, and the Ohio State University have significant research relationships with firms in the region. The lack of a research institution with a prominent local presence significantly limits potential commercialization activity among research faculty.
- There are a number of potential new partnerships that could form, funded in part by federal sources. These programs, such as SBIR and STTR will be of critical importance to the numerous small to mid-sized firms in the region.

5.0 BUILDING AN INNOVATION CULTURE

One of the necessary pre-conditions for the establishment of an innovation framework in the Greater Lima Region is the formation of an innovation culture. There is a strong sense of innovation as a driving principle in many of the region's companies though few make this explicit. Similarly, the region enjoys a long tradition of creative problem solving. The future success of the region's innovation framework depends on the ability of the region's stakeholders to create a culture that is both more visible and collaborative.

There are two principle components of the innovation culture that is suggested as part of this framework. These are:

- Development of a comprehensive Maker culture
- Expansion of university-industry partnerships building from the principles of the Centers of Excellence model. Each is important to link the needs of business to the innovation base that can both solve problems and develop applications.

Section 5.1 presents a comprehensive analysis of the characteristics and components of a successful Maker Culture. It presents a series of best practices to build upon much of the excellent progress already made through the efforts of the OEAMC and Link Lima/Allen County.

5.1 MAKER CULTURE AND THE MAKER MOVEMENT

Being a Maker means building things, being creative, having fun, solving problems, doing social good, collaborating, and learning.[39] Why is the Maker Movement, or Maker Culture, so important to U.S. industry and public policy? "The rise of the Maker Movement represents a huge opportunity for the United States. Nationwide, new tools for democratized production are boosting innovation and entrepreneurship in manufacturing, in the same way that the Internet and cloud computing have lowered the barriers to entry for digital startups, creating the foundation for new products and processes that can help to revitalize American manufacturing. (Kalil & Miller, 2014)"[40] This section will examine the elements of Maker Culture and the Maker Movement, its significance, and highlight the various ways that industry and municipalities are encouraging its success throughout the country.

DEFINING MAKER CULTURE

Maker Culture is a global movement emerging from advances in technology that have occurred since the invention of the computer and the resulting leveling of access to people and digital tools across society as a whole. Technology has had a democratizing effect on the realm of creating things, and people the world over are using and sharing information like never before. In the words of Chris Anderson (2012), "Basically, the Maker movement is what happens when the Web meets the real world. It's the combination of the Web's innovation model with a new generation of computer-controlled desktop manufacturing tools that have a democratizing impact, much like the PC and the Internet did a generation ago."[41]

Maker Culture is an approach to learning that celebrates a "learning by doing" attitude as well as a life-long appreciation for the capacity to learn.[42] Makers are do-it-yourself (DIY), do-it-with-others (DIWO), hobbyists, tinkerers, builders, creators, hackers, entrepreneurs, and people who just like to take things apart and put them back together to see how they work. "But the Maker Movement isn't just about learning to use a new tool or building cool things in a workshop. It's about developing agency, starting with the physical world, through the use of platforms and technology that make it easier to connect, learn and collaborate."[43]

COMPONENTS OF MAKER CULTURE

The technological innovation that is occurring as a result of a growing Maker Culture has the potential to cause tremendous disruption to the traditional "making" of things and ideas across all industries. "Accordingly, some indicators suggest the maker movement could potentially impact the traditional supply-chain manufacturing paradigm."[44] As public officials and industry leaders are realizing the growing impact of the Maker Culture, some are opening their doors and encouraging the new creative spirit inherent to the movement. What are the components that support and give life to Maker Culture? Lee Martin (2015) describes the Maker movement as requiring three basic elements: digital tools, community infrastructure, and the maker mindset.[45]

Digital tools, meaning access to computers, labs with rapid prototyping tools (for example 3D printers or laser cutters), as well as microcontrollers, have revolutionized our capacity to make and create things. Computers have broken down barriers to creativity by enabling experimentation, sharing, play, collaboration, and most of all failure – in ways that in the past were difficult to allow except in certain circles.

Computer-controlled tools provide incomparable advantages to the Maker, including:

- Newcomers are able to produce products with a high level of finish,
- Compared to hand-crafted products, making multiple identical or nearly identical items is easy and fast, and
- Digital design files are easily sharable allowing for collaborative efforts, both between designers as well as between designers and consumers or people hoping to replicate the design.[46]

Microcontrollers, or small electronic microprocessors, are little computers on a chip that may be programmed with bits of code to do all sorts of things. They may be attached to sensors, switches, Bluetooth or wireless modules (among other things) and made to control various devices including motors, LEDs, screens, speakers, solar panels, and can save data to a memory card or webpage. The most popular options today are Arduino, BeagleBone and Raspberry Pi.[47] An example of a popular use of microcontrollers is to attach them to Lego and robotics creations.

The second component of Maker Culture is the community infrastructure supporting the culture. This aspect is critical to Maker Culture as if focuses on the importance of community engagement and partnerships within a community – not just within the confined notion of a geographical area, but also the broader web-based community of global groups and communications. This infrastructure includes person-to person meetings, workshops and engagements, Maker Faires, and social networks. "Participating in these community spaces, both in person and online, centers topically around making, but is otherwise similar to other communities: people socialize, read, share project details, watch videos, joke around, and engage in other forms of hanging out and geeking out (cf. Ito et al, 2010; Kafai & Peppler, 2011)." [48]

Maker Culture also requires a third component, that of the maker mindset. According to Dale Dougherty (2013), the origin of the Maker Movement is found in "experimental play."…."makers are exploring what …things can do and they are learning as well. Out of that process emerges new ideas, which may lead to real-world applications or new business ventures. Making is a source of innovation."[49] This type of innovative thinking involves deeply delving into the solution to a problem before developing a range of different solutions, and iteratively improving the most promising ones.[50]

At the heart of this mindset are four elements as described by Lee Martin (2015):

1. **Playful**: Building on Dougherty's notion of "experimental play", Martin describes the playful learning environment of maker culture as encouraging of experimentation and experience of variation – prerequisites for the development of conceptual knowledge and adaptive expertise (Hatano & Inagaki, 1986).

2. **Asset- and Growth-Oriented**: Ingrained in the maker mindset is the notion that anyone can learn the skills necessary to make things. The belief that intelligence is muscle-like and can grow with exercise, and that failure is interpreted as an indicator that more effort is required rather than a cue to disengage, are important pieces of the maker mindset.

3. **Failure-Positive**: Within the maker mindset, failure is celebrated. The importance of failure to the creative process and in one's personal and professional development (Branwyn, 2009) are critical elements in learning how to become stuck and "unstuck" and is at the heart of tinkering (Petrich et al., 2013).

4. **Collaborative**: The maker mindset supports a knowledge-building community. Sharing, helping and collaborating are critical in the open exchange of ideas inherent in maker culture. "People share to exchange information, to educate others, to get feedback and to feel connected (Kuznetsov & Paulos, 2010)."[51]

It is important to note that makers are often seeking an alternative to being regarded as consumers and reject the idea that people are defined by what they buy. Instead, makers have a sense of what they can do and what they can learn to do[52] and this is foundational to their impact on the traditional supply-chain manufacturing paradigm. By using the digital tools available to them, makers are able to create, produce and sell individualized products in quantities that could significantly disrupt traditional production and supply chains. This future may call for companies to find ways to act as platforms to connect consumers with products they desire or design products and services in collaboration with the people who will benefit from them.[53]

EDUCATION AND YOUTH MAKERS

One of the primary ways to build maker communities is through the field of education – through K-12 outreach and in-school programs, and on university campuses. Schools often define places allocated for maker activities as makerspaces, hackerspaces or innovation spaces that typically are located in libraries, computer labs, or other locations on campus. Dedicated programs require resources, an interdisciplinary perspective, leadership support for a variety of activities, and a shared space for making, hacking, and co-working in one centrally located site.[54]

The following are examples of well-established educational maker communities at U.S. Universities:

- The Think [Box] at Case Western Reserve University
- The Invention Studio at GeorgiaTech
- SPARK at the University of Colorado
- POP Shop at Cornell University
- The SHED at the University of California, Berkeley
- Innovation Hub at the University of Florida

University-community engagement and partnerships are also expanding to include activities such as outlined in the Makeschools Higher Education Alliance, State of Making Report, June 2015:

- Maker Faires and involvement in local makerspaces
- Opening campus makerspaces to community members (e.g. University of Illinois-Urbana Champaign MakerLab and FabLab are open to community)

- K-12 outreach programs (e.g. Tennessee Tech's "FAB Fridays", where children use university facilities; or Sonoma State University's maker credentialing program for K-12 teachers)

- Entrepreneurship and start-up ecosystems (e.g. SCU-Northridge's advanced manufacturing and entrepreneurship program)

- Design competitions and challenges (e.g. Intel-Cornell Cup, a national embedded design competition that promotes professional design towards real world problems, FIRST Robotics Competition, FIRST LEGO League)

- Industry and government partnerships (e.g. America Makes Consortium, to promote research and education in advanced manufacturing, convened by Youngstown State; Texas State University, engineering senior design projects are sponsored by local companies, and agencies including Toyota, Emerson, and NASA)

INCORPORATION STRATEGIES AND CITIES SUPPORTING MAKER CULTURE

Forward-looking cities and industry might seek to incorporate the maker movement into their long-term plans, recognizing that the local economy could benefit from the creative freethinking approach that is often limited in large-scale manufacturing.[55] This year, the National League of Cities (NLC) published a 2016 report on How Cities Can Grow the Maker Movement. It both outlines various makerspace incorporation strategies that may be used to grow the maker movement and cites examples of cities that are doing just that. Below is a summary of these two aspects of the report:

INCORPORATION STRATEGIES:

- Link the maker movement to local manufacturing growth by donating unused public buildings for new workspaces or offering low-interest loans or rent-ceiling guarantees for maker startups.

- Allow heavy machinery into traditionally non-commercial zones.

- Rezone areas for industrial use and amending existing city ordinances to reduce bureaucratic red tape.

- Incorporate the maker movement into larger development strategies involving economic revitalization plans.

- Strategically group makerspaces and entrepreneurial services adjacent to each other to encourage innovative local growth to create "innovation districts" (also known as "cluster innovation").

Synopsis of the NLC 2016 notable cities that support Maker Culture:

- Albuquerque, NM: Local government has provided the impetus for strong public and private involvement. The opening in 2010 of Quelab was Albuquerque's first non-profit maker- and hacker-space. In addition, "Innovate ABQ" is a collaborative city initiative between the University of New Mexico, the Science and Technology Corp at UMN, city and county government, and the business community. The hope is to create a cluster of innovation in the heart of Albuquerque.

- Austin, TX: The city has built on its creative nature as being the "live music capital of the world." It has seen a growth in makerspaces after the University of Texas opened its own makerspace, Innovation Station. The Austin Chamber of Commerce started the Innovation Austin initiative which supports the maker movement and opportunities for community individuals to get involved with the movement. Beyond maker spaces such as TechShop, Austin has focused on public makerspaces and educational programs.

- Boulder, CO: The three national laboratories within Boulder's city boundaries play an important role in the city's maker movement. The University of Colorado-Boulder's "Idea Forge" is an important part of the innovation culture in Boulder, as is Boulder's own "The Foundry". Neighboring communities of Brighton's "Anythink" initiative in their public libraries and Longmont's "Tinkermill" - Colorado's largest makerspace – all serve to invigorate the maker ecosystem within the area.

- Burlington, VT: Given the rural nature of Vermont, maker programs are implemented at the municipal level. Key to the success in Vermont are the collaborative efforts between the VT Department of Libraries, VT makers, the University of VT, the VT Library Association and CMF Innovations.

- Chattanooga, TN: As highlighted in Future iQ's case studies, Chattanooga is known as the "gig city" because it has the fastest and least expensive broadband speeds in the U.S. This has opened the doors to a new population of computer programmers, entrepreneurs, investors and techies. In 2012, the

Chattanooga Public Library renovated a floor of the library and dedicated it to makerspace; the city now has six public makerspaces to its name, including the famous ChattLab. The city also hosted its first Maker Faire in 2013.

- Eugene, OR: There are two types of makers in Eugene: hobbyists and entrepreneurs. The hobbyists tend to be highly educated engineers, aged 30-50, who are joining the maker movement for fun. The entrepreneurs are highly educated engineers and programmers, aged 20-40, who are deliberately seeking to create products to sell commercially. The Eugene Office of Business and Economic Development plays an active role in supporting the maker movement by coordinating among entrepreneurs, incubators, schools, business, and the state government. As one example, in 2014 the city notably sold an unused building for $1 to be renovated and converted into a co-working space, an incubator, and a fabrication workshop.

- Louisville, KY: Created in 2010, LVL1 was one of the first makerspaces in Louisville. It started with only 6 members and now has 80+ members including the Mayor, a strong supporter of the maker community. Businesses have been welcoming of the movement, especially GE Appliances, who with the help of Local Motors, makerBot and TechShop, launched a hackerspace called "FirstBuild". As ideas and concepts are developed in the hackerspace, creators can team up with GE designers to build prototypes. FirstBuild facilitates a limited production run, and depending on the success of the product, GE then chooses whether to move it into mass production.

- Madison, WI: Madison hosts two makerspaces, Sector 67 and Bodgery. The University of WI-Madison hosts a research testing facility of its own, Fab Lab, known as a biotech testing facility. The city recently announced a plan for its Starting Block facility, moving Sector 67 to a larger building while also paring it with important entrepreneurial and incubation services. The city has committed significant funding of the project in conjunction with multiple public and private partnerships.

- Philadelphia, PA: The maker movement has grown organically from Philadelphia's urban manufacturing core. Its neighborhoods host diverse educational institutions promoting art and design programs, many specializing in different aspects of DIY techniques. The many universities of Philadelphia produce high numbers of candidates to join the maker movement. Additionally, in 2013, the city created the Mayor's Manufacturing Task Force charged with the goal of providing the city with an industry-led roadmap to increasing Philadelphia's competitiveness.

- San Francisco, CA: Calling itself the "Innovation Capital of the World", San Francisco was the host of the first Maker Faire in 2006, and now actively promotes the growth of the maker movement. The Mayor's Office of Civic Innovation and the Office of Economic and Workforce Development help coordinate several innovative programs that help to build San Francisco's maker movement cluster. SFMade, a nonprofit partly funded by city grants, also supports makers and entrepreneurs with information on how to secure financing and manufacture locally.

5.1.1 WHERE THE GREATER LIMA REGION'S MAKER CULTURE STANDS

There are several common threads in this analysis that point directly back to steps that the Greater Lima Region has already taken to build a Maker Culture. Several organizations that have been especially active in this regard are Allen Economic Development Group (AEDG) through its Link Lima initiative, the Apollo Career Center, and the Ohio Energy and Advanced Manufacturing Center (OEAMC). These are examples of innovation initiatives throughout the region, many of which will be discussed throughout this analysis.

Link Lima has already embraced and advanced the concept of a Maker Faire through the promotion of MakerFest, a community event that will be celebrating its second iteration in October 2016. This event highlights and celebrates both the innovative manufacturers and other firms in the region, but also speaks to the importance of key innovation and manufacturing skills in securing the region's economic future.

The event hosts manufacturing skills competitions for regional high school students. It also brings those students into contact with companies throughout the region, exposing them to career opportunities and discussing how these opportunities align with their educational goals. The event also exposes members of the community and job seekers to these same opportunities, meeting the workforce needs of today and building the workforce of tomorrow. This promotes the innovation culture of the Greater Lima Region by both showcasing the firms that are driving innovation forward and pointing to the skills that will accelerate that growth.

The Ohio Energy and Advanced Manufacturing Center (OEAMC) supports and enhances the model of a Maker Space by promoting applied innovation throughout the region. It offers an array of product development and research services to companies through the region and builds partnerships with research centers and universities. The center also has considerable potential to expand the scope of its maker activities in future iterations.

5.2 AN INNOVATION HUB CONCEPT

A second component of the innovation culture that is being proposed for the Greater Lima Region is the development of an innovation hub mindset. An innovation hub is defined first by the limit of its scope and then by the expanse of its reach.

5.2.1 BUILDING INNOVATION HUBS

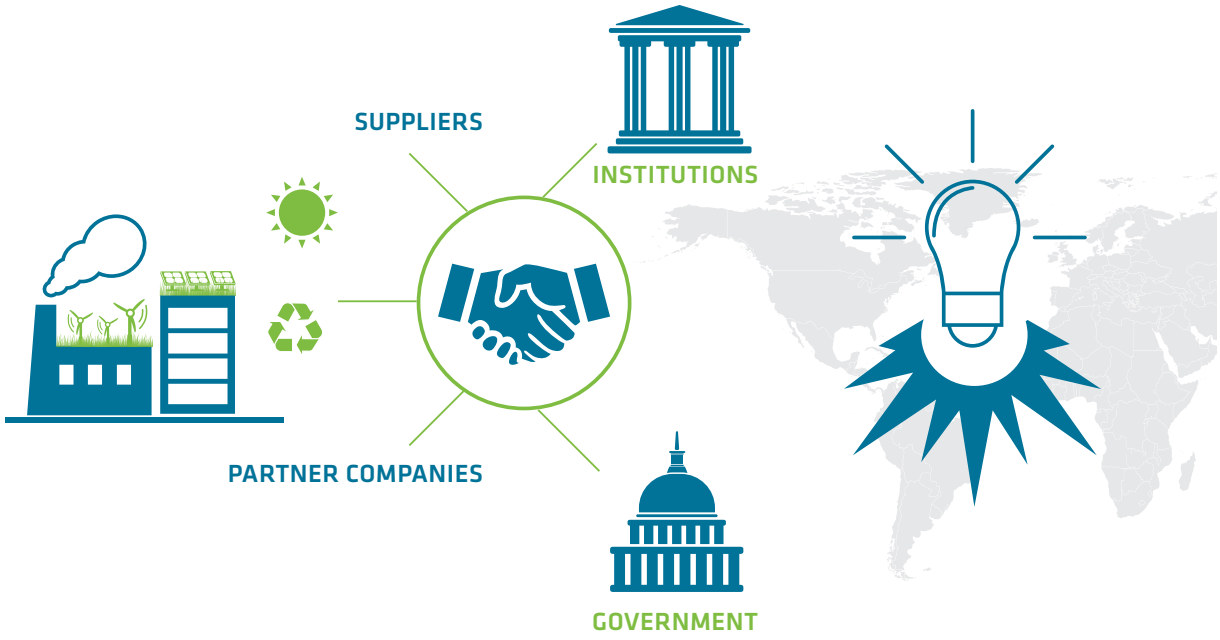
It is viewed that AEDG can provide a key role to convening stakeholders and building innovation hubs and consortiums around key topics or industries.

A good example of how this can be done is the OEAMC. The Ohio Energy and Advanced Manufacturing Center has developed over the past decade to be one of the emerging centers of innovation in the Greater Lima Region. The center has grown from the vision of Mayor David Berger and local industry leaders to a facility with significant innovation and commercialization potential. The history of the OEAMC traces its roots to conversations among many of the region's industry leaders regarding how to expand innovation at the Joint Systems Manufacturing Center and elsewhere and resulted in the formation of a 64-acre research and development park. Development of the park beyond the current OEAMC facility remains an important part of the Center's Board of Director's strategic plan. The Center has been rather successful in securing funding from state, federal and philanthropic sources to promote their mission. This has established a sound foundation that establishes the OEAMC as a hub of potential innovation activity in the Greater Lima Region.

The principal activity of the OEAMC to date is to foster strong relationships with several entities, including a series of National Laboratories, research universities led by the Ohio State University, and the pursuit of collaborative funding to demonstrate proof of concept on a promising metal forming technology. Many companies such as American Trim, General Dynamics Land Systems, and Husky Energy, Inc. have held extensive conversations with the OEAMC and other companies are represented on the Center's board.

Recent work has included testing the viability of an advanced technology (High-Velocity Metal Forming), commercial applications of the same. The has also been a recent study to explore the feasibility of a high-quality analysis laboratory to serve the Joint Systems Manufacturing Center and other regional firms. The proposed laboratory would

Figure 22: Key Actors in an Innovation Hub Framework



feature a wide range of instruments and equipment to facilitate advanced testing of water quality, metals failure, DNA testing and more.

5.2.2 A SHOWCASE FOR THE FUTURE OF MANUFACTURING

An essential function that AEDG could play in both fostering and supporting the innovation hubs and consortiums is to help create a regional showcase for the technologies and trends that will drive the Future of Manufacturing. This will again build upon a best practices approach by connecting companies in the region with global innovators and industry leaders. This can include, but is not limited to:

- Expert Symposia on Emerging Technologies, such as Additive Manufacturing, Automation, or Nanomaterials
- Forums that would expose students to the linkage of gaming and innovation through a series of competitions.
- New Equipment and Product Demonstrations
- Supplier and Vendor Matchmaking Services
- Technology Days that expose the public to new company advances

It has also been suggested that the region consider convening a manufacturing symposium of prominent firms to discuss potential product and process advancements over the next five to ten years. This could be built upon the model of the Lima Regional Information Technology Alliance (LRITA). Filling this role will greatly enhance the visibility of the Greater Lima Region and actively support many of the bright ideas that will be presented throughout the analysis.

5.3 IMPLICATIONS

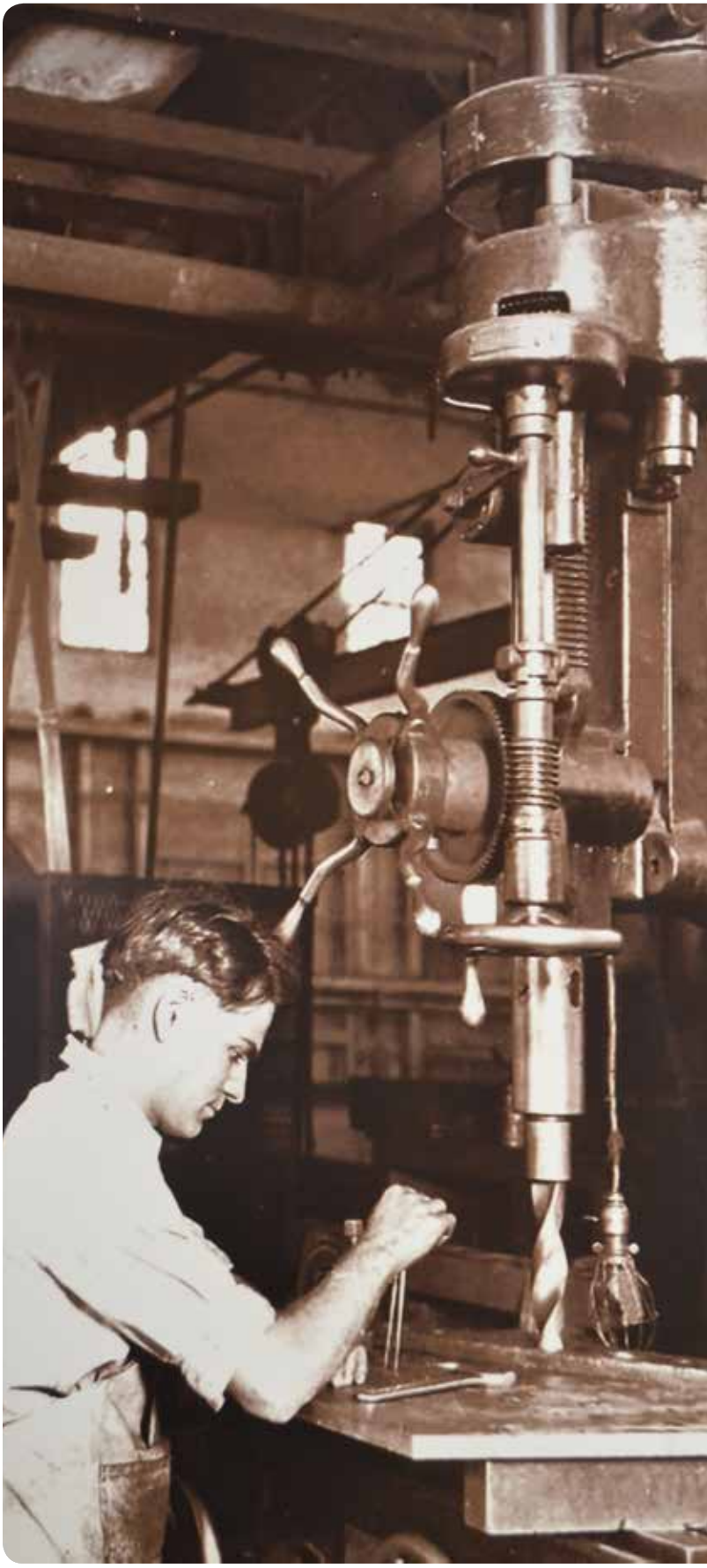
The approach identified in this section carry several potential implications, including:

MAKER CULTURE AND THE MAKER MOVEMENT

- For Allen County, AEDG is viewed as the natural lead organization to build and support such a maker culture and movement. This central role for AEDG has been identified through the stakeholder engagement process.
- There is the critical element of resources – including financial support, and the physical space to house makerspaces and events. Organizations like OEAMC and Apollo Career Center offer potential quality facilities.
- The importance of the link between education and industry. For example, a concerted effort to grow maker programs in K-12 public schools and link them to local industry (such as the existing MakerFest).

AN INNOVATION HUB CONCEPT

- The formation of innovation hubs, under the umbrella of the Allen Economic Development Group, would allow the region to concentrate on a series of specific opportunities.
- AEDG should continue to pursue strategic partnerships with groups like OEAMC and Apollo Career Center to create and strengthen to the Innovation Hub mindset and concept.
- The Greater Lima Region's prominent firms could be encouraged to play a stronger and more visible role in supporting collective innovation activities in the region.



6.0 AN INNOVATION ROADMAP FOR THE GREATER LIMA REGION

Now that we have considered both the current state of innovation in the Greater Lima Region and the two critical enhancements to the region's innovation culture – a Maker mindset and Centers of Excellence framework, we can now place these as guideposts on an innovation roadmap. The roadmap analogy is especially apt as any innovator will agree that innovation is a journey of discovery marked by multiple iterations, dotted with an array of possible off-ramps, and propelled by an idea. The path is rarely a straight line, just as the growth of a number of regional firms have bobbed and weaved through the challenges of a competitive market.

The roadmap that we propose here presents a number of ideas as to how the region may foster more innovation without suggesting specifically what that innovation may be. We have some idea as to the trends that will most strongly affect the Greater Lima Region in the next twenty years and know that these will present challenges that demand innovative solutions. However, we cannot begin to predict the creativity of the innovative minds are work now and in the future. What is more important is that the climate is developed that both encourages that creativity and allows it to flourish.

The roadmap that is presented in this section is structured as a series of bright ideas. These are all goals that Future iQ Partners reasonably believes that the region can accomplish in the next ten to twenty years. The ideas follow a number of common themes, ranging from stakeholder engagement, organizational alignment, and market opportunities. The format that this section follows is action-oriented while recognizing the context of each proposal. Each idea is described, along with the assets that are currently engaged in the region, those additional opportunities the region needs to capitalize, and the risks of inactivity. The focus of each bright idea is how to promote a greater climate of applied innovation in the Greater Lima Region.

This last point is especially important as inaction, or maintenance of the status quo is always assumed to be an alternative. The Greater Lima Region could quite likely continue to maintain its position as a center of traditional and some advanced manufacturing activity for the next decade. However, doing so would leave the region increasingly vulnerable to external macro trends, such as the impact of climate change or increased adoption of automation technologies, for example. As such, the bright ideas presented here, when taken together, will guide the region towards a future that is plausible while leaving the region in a much more proactive posture.

6.1 BRIGHT IDEAS TO PROMOTE AN INNOVATION CULTURE IN THE GREATER LIMA REGION

The growth of an innovation culture falls on a number of shoulders when considering the role that the communities in the Greater Lima Region play in a comprehensive strategy. The best practices surrounding the growth of Maker cultures in the United States call for a significant public role. Similarly, there are a number of organizations that are currently active in promoting aspects of the preferred culture, such as Link Lima/Allen County, the Lima Automotive Task Force, the Ohio Energy and Advanced Manufacturing Center and other regional assets that must be better aligned to promote a cohesive message. Finally, the development of an innovative culture in the Greater Lima Region is invariably linked to the further development of the services and amenities of the communities in the region in order to present an image of a region that is both receptive to and supportive of entrepreneurs and innovators. The bright ideas presented all relate to the importance that culture plays in an innovation strategy.

6.1.1 BRIGHT IDEA #1: CREATE A YOUTH-DRIVEN INNOVATION PIPELINE

Creating an innovative mindset begins at the earliest age. Many communities have recognized the role that exposure to career exploration activities, such as MakerFest, and STEM/STEAM skills competitions such as Lego Leagues play in encouraging young minds to spark innovation and creativity, for example. Fewer communities have considered the importance of developing a comprehensive and progressive strategy to expose students to skills and experiences that build on each other at all levels. The regions that will succeed in the future will place an added importance on the development of innovation skills in all of its residents.

Proposal

The Greater Lima Region needs to develop a comprehensive innovation and career exploration strategy for its K-16 education systems. The region has had considerable success through the creation of Link Lima and the promotion of MakerFest as an annual community event. Considerably more must be done to develop the innovative workforce pipeline that the region's employers need.

- The event and the outreach of MakerFest is generally targeted both at high school and college students as well as members of the general public. The event also has a significant focus on manufacturing skills and careers. These all meet with the objectives of the community.
- Significant potential to expand this model exists and may include a parallel event focused on middle school students, to be hosted in the spring. This will encourage students to consider career options entering their high school years. The objective of this initiative should be the expansion of exposure to include all sixteen of the career pathways as defined by the U.S. Department of Education.[57]
- In addition, the region can build upon the partnerships formed in the Link Lima framework to expand the effort throughout the Greater Lima Region. The focus of this expanded effort will be to introduce new students, stakeholders and employers into the framework as well as to expand the number of career exploration and innovation skill building opportunities offered to students throughout the region.
- A best practice of an expanded and comprehensive approach can be found in the work of the Northeast Wisconsin Manufacturers Alliance, whose coordinated outreach and exploration initiative includes a series of products developed by a robust and active K-12 Education Committee.[58]

Assets

The region's greatest asset in building an innovation talent pipeline is its K-16 institutions and the Link Lima framework. The region also has a number of active and complementary not-for-profit institutions. These assets need to be aligned in a comprehensive and structured manner.

- A dedicated Talent Pipeline Partnership (TPP) should be developed as a component of an expanded regional Link Lima framework. This committee would be staffed by representatives of the region's K-16 institutions, including teachers, career counselors, and employer representatives. This group would be responsible for coordinating all innovation building and career exploration activities in the region with the exception of Makerfest, which would continue to be a collaborative effort.
- Each of the proposed industry cluster organizations included in this roadmap should establish a K-16 committee to encourage awareness of opportunities and the provision of career exploration opportunities, such as company tours, speakers, job shadows, and internships.
- The Greater Lima Region should consider the development or acquisition of a regional platform to administer and coordinate career exploration activities.

Opportunities

The Greater Lima Region has the potential to develop a talent pipeline that embraces creativity, innovation, and problem solving as core principles. These skills can be introduced in a variety of ways as early as Kindergarten. This talent pipeline will have a strong awareness of local opportunities and will be able to align skills and interests around those opportunities. This will greatly increase the rate of retention of young professionals among the local population.

Risks

The risk of continuing to focus solely on the short-term needs of current employers in talent development is the potential that the region may be ill-prepared to meet the anticipated future needs of the region. Many students today will be engaged in careers that have not yet been defined in the workplace. The region's talent development system needs to be flexible and responsive to these changing needs. Failure to do so will result in an increased perception that opportunities are not available in the Greater Lima Region and continued out-migration of the region's young adults.

6.1.2 BRIGHT IDEA #2: DEVELOP A REGIONAL MAKERSPACE NETWORK

A second vital component of the formation of an innovation culture in the Greater Lima Region is the establishment of spaces where innovators and thinkers can collaborate. These are generally referred to as either Makerspaces, or Fab Lab's in a more commercial and educational sense. These spaces have been particularly linked to the growth of additive manufacturing as 3-D printing is the technology most commonly associated with them. What is more important is that these spaces foster creativity and collaboration, signaling to the region and beyond that the Greater Lima Region is open for innovation.

Proposal

The Greater Lima Region has the opportunity to establish a comprehensive Makerspace Network to meet the needs of innovators of all ages and skill levels. The proposed approach here meets youth, community, and commercial needs by leveraging a number of assets.

- The region's employer base should partner to ensure that every high school and career center is equipped with a Fab Lab, as specified by the MIT Center for Bits and Atoms.[59] This may accompany an expanded effort for each institution to adopt the full Project Lead the Way curriculum or similar alternatives. 3-D Printing and design capabilities should also be available at the middle school level.
- Every community in the region should utilize an unused public or private space in their downtowns to develop a community Makerspace. This could follow the model of Johnstown, Pennsylvania's Creator Square.[60] This will encourage greater collaboration among entrepreneurs and foster greater downtown development by local and artisanal producers.
- The Ohio Energy and Advanced Manufacturing Center should lead the development of commercial-scale Makerspaces on their respective campuses. The objective of these facilities will be to offer rapid prototyping and product development services for new and existing companies.

Assets

The OEAMC and other regional institutions have already worked to instill the Maker mindset in the region. MakerFest and Link Lima/Allen County have also built community awareness of these needed skills. A community-driven Makerspace network will enhance these efforts by:

- Connecting makers with technical experts,
- Providing needed product development capabilities, and,
- Instilling maker skills beginning at an early age.

The region's innovation organizations could encourage utilization of these spaces by sponsoring occasional events and competitions such as hacking weekends.

Opportunities

The establishment of a regional Makerspace network will spark creativity and innovation in its youth, its entrepreneurs, and its companies by providing them both the means and the tools to collaborate. When students are exposed to design principles and given the means to bring those ideas into reality they can consider the direct application of other lessons learned. When these tools are given to a community, ideas that may be sketched on the back of an envelope could become the next big product.

The Greater Lima Region has the opportunity to continue its tradition of innovation through tinkering by developing these Makerspaces, which are the next generation of the backyard garage.

Risks

The risk of inaction is the perpetuation of the disjointed dialogue on innovation that currently exists in the region. The findings of the social network mapping exercise conducted in the region this spring (May / June 2016) suggested that few individuals were actively discussing the role of innovation and even fewer still were connected in any meaningful way. The development of this network of creative spaces will provide a place for those innovators to meet and build more significant connections. Absent this network, it is likely that the Greater Lima Region will continue to depend on innovators outside of the region to advance its prominent industries.

6.1.3 BRIGHT IDEA #3: FORMATION OF THE GREATER LIMA REGION TECHNOLOGY MENTORS GROUP

The Regional Workforce Needs Analysis (August 2016) identified a large cohort of manufacturing workers that will be exiting the workforce in the next decade. These workers, representing the end of the Baby Boom Generation carry an extensive body of experience in advanced manufacturing processes and skillsets garnered from a lifetime of work. The typical retiring manufacturing worker will carry an average of 28 years of experience into retirement.

Many of these workers, as well as those in a number of other industry sectors possess valuable skills and an interest in continuing to contribute to the region in retirement. One possible way to utilize this talent pool is through the formation of a regional contingent workforce strategy, as was proposed in the Regional Workforce Needs Analysis. Another way is to connect these individuals to the proposed Makerspace Network in a mentorship capacity.

Proposal

The Greater Lima Regional Makerspace Network, once established should form a Technology Mentors Group. This group will be composed of retired workers in skilled manufacturing and other trades. This group will serve the following roles in a voluntary capacity:

- Provide staffing to the community Makerspaces,
- Provide technical support and mentorship to support the school-based Fab Labs,
- To work with community members to supplement needed skills, such as machining knowledge, welding skills, and project management to support maker projects,
- Serve as technical resources and judges of maker events such as hacking weekends,
- Be available in a paid capacity to consult with regional companies on needed projects.

The Technology Mentors Group will also play a vital role in providing technical advice to prospective entrepreneurs by working to translate old methods to new technology.

Assets

- The Greater Lima Region's labor unions, such as the United Auto Workers and others are strongly engaged in the region and have a great deal of awareness of their membership and their interests. These organizations can serve to identify prospective members and to sponsor events.
- The region's career centers, such as Apollo Career Center and Vantage Career Center can also connect the members of the Technology Mentor Network with needed training and laboratory space to both enhance and transfer their skills.
- Finally, facilities such as the OEAMC can connect mentors with prospective entrepreneurs to provide technical support and foster other business relationships.

These organizations can also build their own capacity by engaging this untapped talent base.

Opportunities

One of the topics that has captured the attention of a number of regions is the implication of an aging workforce. Communities throughout the Midwestern United States have started to experience labor shortages. This concern is also strongly related to the skills shortages that have been discussed over the past several years. By engaging retiring workers in a more meaningful way, the Greater Lima Region can tap into and more effectively transfer a tremendous base of knowledge. This may also spark additional entrepreneurship as these workers also have a keen understanding of their former industries and employers and may develop additional solutions.

Risks

The risk that many regions in the Midwestern United States face in failing to engage their retiring workforce in innovation and mentorship is that this disengaged population will disconnect from their communities and consider opportunities elsewhere. The downside is a population where some individuals may move and others will age in place. This will leave a large untapped potential that will simply exit the economy and will not contribute in any meaningful sense.

6.2 BRIGHT IDEAS TO INSPIRE INNOVATIVE COMPANIES IN THE GREATER LIMA REGION

The development of an innovative framework for the Greater Lima Region requires participation from a number of actors. The promotion of an innovation culture based on Maker principles will provide a sound context to support idea formation and business development. A second facet of the proposed framework is a structured and more significant system for company engagement in the innovation process. A number of companies are already involved in research and development activities, but the region possesses significant potential for further growth. The bright ideas in this section present significant opportunities to both further the development of innovation in the region and generate significant economic value.

6.2.1 BRIGHT IDEA #4: FOSTER GREATER COLLABORATION THROUGH COOPERATIVE PROBLEM SOLVING

The innovation analysis has identified a number of potential areas for additional collaboration around innovation, such as greater engagement with the OEAMC, the development of a system of innovation hubs, and the promotion of a regional Makerspace network. Each of these opportunities will depend on significant participation from companies in the region. Before doing so, however, the region must foster a greater sense of cooperation among those same employers to express shared concerns and develop collaborative solutions.

Proposal

Companies in the Greater Lima Region need to foster a greater sense of collaboration around issues of innovation by contributing to and utilizing the partnerships and organizations currently and actively promoting innovation activities.

- Each prominent manufacturer in the Greater Lima Region should consider contributing to the OEAMC through an expansion of their organizational structure. Both organizations have active and engaged boards of directors. Greater company engagement will expand the scope of conversation around potential ideas.
- The region should establish new innovation hubs in Metal Forming, Measuring and Testing Technologies, Manufacturing Automation, and Additive Manufacturing under the leadership of advisory boards of local industry experts.
- The OEAMC should create a Director of Industry Partnerships position to complement the CEO and President and Technical Director. The focus of this position, which will be filled by an individual with significant industry experience will be to first secure company sponsorship of center activities and second to represent the center in providing technical assistance services.

Assets

The Greater Lima Region is home to a number of innovative companies, such as American Trim, Cooper Tire and Rubber Company, Husky Energy, Inc., Ineos, and Marathon Oil, among others. These companies have and will continue to take a leadership role in promoting further innovation in the region. The region also has an innovative facility in the OEAMC that are structured to facilitate applied innovation. Many regional companies also have significant engineering and design talent that can be utilize in more collaborative ways through the proposed Makerspace network and elsewhere.

Finally, the region is host to a number of industry sectors, including the automotive, chemical, food processing, and plastics industries that have demonstrated considerable potential for the application of innovations in additive manufacturing, automation, data sciences, and materials sciences. The region has the potential to display significant leadership in adopting these technologies and developing commercial applications in a number of markets.

Opportunities

The Greater Lima Region is positioned to continue as a market leader in a number of key industry sectors and processes, including transportation equipment manufacturing, paint and coating processes, metal forming, and petroleum byproduct production. This will require continued innovation by firms in the region. A collaborative commitment to support those individuals and institutions engaged in this work will provided needed capacity and ensure that the region establishes itself as a leader in applied innovation.

This collaborative solution extends to the supply chains associated with many of these key sectors as firms in the region support innovation and industry leadership throughout a global value chain. By continuing to innovate, these firms also become more attractive to a larger market share.

Risks

Innovation in many of the leading industry sectors currently occurs outside of the Greater Lima Region. While the innovation framework proposed here does not suggest substituting all of this work with local alternatives, additional innovation activity is needed to ensure that not all innovation is considered external to the region. Similarly, industry leaders in the region understand the risks posed by growth in electric vehicle sales, climate change, and other factors at a local scale. Firms in the region must be poised to provide innovative solutions to these challenges.

6.2.2 BRIGHT IDEA #5: SPONSOR COMPETITIONS TO DRIVE REGIONAL INNOVATION

Many of the firms in the Greater Lima Region's manufacturing sector can trace their histories to humble beginnings as small, family-owned firms that provided a needed product or service to a local market. In each case, these firms developed as an innovator recognized a problem and developed a solution. Companies continue to be formed in the same manner and the firms in the region can play a critical role in foster new firm growth by serving as the source of problems in search of solutions.

Proposal

Firms in the region can inspire creativity and innovation among their staff, suppliers, and regional entrepreneurs, by opening some of their common challenges up to competition. Most firms are reticent to do this due to intellectual property concerns. The framework presented here alleviates some of these concerns by creating partnerships within a network setting.

- Firms in the region should sponsor quarterly competitions to identify solutions to common problems. These competitions would be hosted by the OEAMC and Makerspace Network and engage innovators throughout the region. The competitions could be hosted in conjunction with MakerFest to maximize visibility and participation.
- Competitions would be built upon the "hackathon" model popular among digital organizations.[61] A problem statement would be made available to interested parties a month before final presentations.
- A panel of industry experts would judge solutions for quality, effectiveness, and cost.
- The winning team would then work further with the sponsoring company to implement the solution and negotiate any product ownership.
- Competitions of this type will build the visibility of young professionals and their capabilities. This has the potential to be a significant selling point to millennials considering moving to the region.
- The region could consider the Michigan Center for Materials Characterization (MC^2) as a potential model.

Assets

The competition framework will require significant engagement from companies in the region, innovation facilities such as the OEAMC and the development of many of the other facets in the framework. The region has the potential to sponsor a robust competitive environment but further asset development is needed.

Opportunities

The Greater Lima Region has the potential to develop the next generation of innovative manufacturing firms. These firms will have an established connection to existing firms and will serve a critical market need. Promoting competition will also inspire existing companies to fully consider their needs and consider innovative solutions. This has the potential to be recognized as a first-in-class and best-in-class practice.

Risks

Innovators frequently lack access to and knowledge of potential markets. This causes many inventors to locate in more dense markets to access as many potential venues as possible. Absent this density, regions such as the Greater Lima Region will again be dependent on the limited innovation occurring among existing firms to advance the region.

6.2.3 BRIGHT IDEA #6: BUILD REPUTATION OF THE GREATER LIMA REGION AS EARLY ADOPTER

Companies in the Greater Lima Region enjoy partnerships with many of the most innovative equipment and tool manufacturers in the world. Some of these relationships exist within the region, such as the partnership between Grob Systems, Inc. and Ford Motor Company or Diamond Manufacturing of Bluffton and General Dynamics Land Systems. The Supply Chain Gap Analysis also revealed a significant inflow of machines and other equipment into the region. This purchasing power and market position may create opportunities for firms in the regions to form significant technology partnerships with these firms by serving as the test base for new product and process advances.

Proposal

In order to advance the standing of the Greater Lima Region as an early adopter, companies in the region must:

- Prosper relationships with significant vendors by demonstrating ways that their products are used to advance innovational solutions.
- Work with the region's universities and career centers to become training sites for equipment vendors. An example of this can be seen in the University of Northern Ohio's Technology Studies program.
- The region's economic development organizations should work within the same framework to attract distributors and subsidiaries of international vendors.

These partnerships will form the basis for a system of applied innovation as the region builds the reputation as home to companies that develop best practices in the use of innovative technology.

Assets

The region's career centers and universities have already fostered significant partnerships with a number of firms to demonstrate their technology and train others on their use. The OEAMC is also positioned to contribute in this effort as it is already participating in a number of proof-of-concept projects. The more significant engagement will come from the region's industry sectors who will be better able to identify potential partner firms.

Opportunities

The region can position itself as a developer of best practices and commercialization applications for a number of new and emerging technologies. The technical knowledge base in many firms can be used to assist equipment manufacturers and other innovators develop a range of uses for their products and to troubleshoot unseen problems. This will lead to the region becoming a destination for others to learn about these technologies.

Risks

Inaction will again leave the region dependent on others to both develop innovations and to prove their value. This may leave the region vulnerable to vendors who are less responsive to specific needs. The region will also continue to carry the reputation of being more reactive than proactive.

6.2.4: BRIGHT IDEA #7: LAUNCH INDUSTRY CLUSTER ORGANIZATIONS TO CONTINUE THE CONVERSATION

The Greater Lima Region is host to a number of long-standing and successful industry organizations. Examples include the Lima Automotive Task Force, Task Force Lima, and the West Central Ohio Manufacturing Consortium. Each of these organizations formed in response to a specific challenge and their missions are closely aligned around addressing those challenges. Similar organizational structures are needed to discuss and promote innovation throughout the region. This topic was covered in the Supply Chain Analysis Report (August 2016), and these recommendations are expanded below.

Proposal

The Greater Lima Region, under the coordination of the Allen Economic Development Group or other organization should form a series of new industry cluster organizations composed of firms in key target areas, such as:

- Food Processing Sector
- Energy, Chemical, and Plastics Manufacturing Sector
- Paper and Printing Sector
- Machinery Manufacturing
- Health Care and Health Sciences Sector
- Transportation and Distribution Logistics

This recommendation expands upon a similar recommendation offered in the Supply Chain Gap Analysis by recognizing that considerable innovation is occurring in health sciences and multimodal transportation technologies.

These clusters should draw from the relevant ecosystems and be modelled from best practice industry cluster examples, and should work collaboratively with existing 'cluster' groups such as the defense cluster (Task Force Lima) and automotive component manufacturing (Automotive Task Force).

The focus of each of these organizations will be to:

- Provide a forum to discuss shared challenges and develop best practices,
- Build new and expanded business opportunities within the sector,
- Promote the image and standing of the sector in the region and nationally,
- To promote learning and professional development in the sector by sponsoring expert speakers,
- To promote career opportunities and build talent pipelines in cooperation with Link Lima.

The organization of these cluster organizations around specific industries is intentional as it fosters a climate of trust as members share common issues, common language, and can focus on areas of critical need.

Assets

The region has demonstrated the ability to successfully organize around industry needs. As such, firms in the region are generally familiar with the concept and organizing principles. Where this model differs is in its dependence on private sector leadership. The Greater Lima Region is home to a number of visionary leaders who should be approached to guide these organizations and recruit membership.

Opportunities

The development of additional and expanded industry cluster organizations in the Greater Lima Region will build the critical mass for support of both the innovation framework and Collaborative Growth Plan. This will foster meaningful conversation of critical challenges in specific contexts. The organizations will promote further collaboration in the region in support of the bright ideas presented here.

Risks

The disassociation of the Greater Lima Region's major industry sectors will potentially continue to promote a "dog eat dog" mentality as firms continue to compete for talent and market share. This creates a zero sum game that favors the region's largest firms and will lead to the closure and consolidation of small firms if collective solutions are not found. This will weaken the regional business climate and send a negative signal to firms considering location or expansion in the region.

6.3 BRIGHT IDEAS TO FOSTER INNOVATIVE COMMUNITIES IN THE GREATER LIMA REGION

6.3.1 BRIGHT IDEA #8: DEVELOP DOWNTOWN SPACES FOR COLLABORATION AND VITALITY

Downtown spaces in many rural Midwest communities, including those in the Greater Lima Region, have lost significant vitality since the postwar period. Successful communities are investing substantial efforts into bringing new events, businesses and activity into these downtown areas. Because of their unique architecture and importance to the community fabric, downtown spaces can fulfill a new role by being repurposed for imaginative new uses. As well as retail, entertainment and leisure experiences, downtowns can become locations for Maker centers.

PROPOSAL

It is proposed that innovative ways be found to connect downtown locations to the Maker culture emerging in the region. Some of the possible ways this could occur include:

- MakerFest, hosted in the downtown Lima Convention Center could become a permanent fixture in close-by underutilized buildings.
- Build new public and private partnerships to harness resources to build such facilities. This will require partnership between public entities and private companies.
- Leverage the Rhodes State proposed downtown campus with close-by maker spaces, and support efforts for the campus to progress.
- Explore the potential for downtown Healthcare training facilities, given the close proximity of the hospital complex.

ASSETS

The region has some significant large employers who could support such partnerships. In addition, the proposed Rhode State Campus in downtown Lima offers a catalytic opportunity to bring new vitality and youth to the downtown precinct. There has already been considerable investment in redevelopment, and there is energy and momentum with the Downtown organization.

OPPORTUNITIES

The opportunity exists to clearly link the Maker culture and Maker space concepts to the downtown location. This offers an attractive option for many communities, given the close proximity to other key community and Government facilities. Multi-use developments and smart planning practices have been used to spur population and business growth in a number of other industrial communities, such as Pittsburgh, Pennsylvania. These communities have used a coordinated approach that links business, housing, and transportation development with amenities formation. This is also a primary consideration of Millennials and young professionals who seek communities that link the concept of live, work, and play.

RISKS

The key risk is the loss of vitality and momentum in Downtown redevelopment. Such redevelopment initiatives take considerable time and resources. However, the connection between the key economic driver of manufacturing, and downtown redevelopment would be mutually beneficial.

6.3.2 BRIGHT IDEA #9: CULTIVATE DIGITAL NATIVES THROUGH COMMUNITY TECHNOLOGY INITIATIVES

A primary focus of many of the bright ideas presented in this roadmap speak to the importance of exposing people of all ages to innovation principles to spark creativity and drive economic growth. This is as true of the students who would benefit from an expanded Link Lima initiative to those retired workers who take part in the Technology Mentors Network. The growth of an innovation culture requires an "all hands on deck" approach.

One way that the communities of the Greater Lima Region can further expose residents to an innovation culture is through improved access to technology. Many similar technology initiatives have primarily focused on improving broadband internet access. This is an important, though not as pressing concern in this region than elsewhere. Rather, the bright idea presented here represents a significant and sustained investment in the digital lives of all of the region's citizens

Proposal

The communities of the Greater Lima Region should collaborate and combine resources from the corporate, philanthropic, and other funding communities to launch an ambitious Community Technology Initiative whose primary objective is improving access to computer and digital technology for all residents. The principal features of this initiative include:

- A sustained pledge to provide every 1st grade student in the Greater Lima Region with a personal digital device, such as a tablet, Chromebook, or laptop PC. These devices would be upgraded or replaced on a three-year basis to ensure that students would have access to some of the newest technology. These would be made available through high school, with every student receiving a new device upon graduation.
- This technology would be incorporated into all aspects of school life, including instruction and after-school activities. Support for this technology would also be made available through the Makerspace Network and community organizations.
- The Community Technology Initiative would also work to fund and support community computer labs at a series of community sites, such as the YWCA, public libraries, and other locations. These would be accompanied by a lending library, where any resident could access the same quality of technology used in the school initiative.
- A team of educators and community leaders connected to the initiative would document successes and challenges in order to demonstrate best practices and encourage other communities.

Assets

The region may not have as significant of an asset base to pursue this initiative as is the case in a number of other bright ideas. However, the Greater Lima Region does have the educational infrastructure and the organizational ecosystem to support each aspect of the proposal. Further, and perhaps more importantly, we know that the region places a strong value on the high quality of its educational systems. This will serve as an important driving principle to move the initiative forward.

Opportunities

There has been an extensive body of literature in the education community written regarding the importance and benefits of digital literacy. Computers and other digital devices have become ubiquitous in society and are becoming more essential to aspects of every industry and occupation. As a consequence, digital literacy skills are perhaps more important in one's working life than in other aspects of life. This is of critical importance to the Greater Lima Region as the region has the opportunity to develop citizens of all ages that are digital natives, thereby ensuring that innovators and the region's companies have the skills to immediately and extensively embrace new technologies and applications.

Risks

Failure to encourage digital literacy throughout the region will constrain the number of potential innovators to those who are committed to gaining these skills on their own. This may also limit the adoption of new technologies in industries where opportunities are available as firms may not be aware of possibilities or have less confidence in the success of implementation. This will again impact both the perception and business climate of the region.

6.3.3 BRIGHT IDEA #10: INTEGRATE THE INNOVATION THEME INTO THE REGIONAL BRANDING STRATEGY

Innovation is emerging as a key strategic theme for the Collaborative Growth Plan. This theme provides the potential to unify the region behind a major strategic direction that plays well to existing and emerging competitive advantages. It has been well documented that applied innovation is at the heart of many successful revitalization approaches for rural and regional manufacturing economies. The Greater Lima Region has the opportunity to leverage this approach via the current communication strategy development, as part of the OEA grant. It also can effectively build on the Allen County 'Real American Strength' brand.

PROPOSAL

The proposal for this 'Bright Idea' is to build the innovation theme and story as front and central in the Regional branding and communication strategy. This approach will help focus the message, and offers significant reputational upside. Technology is driving economies and society towards adaption and creation of innovative ideas. The Greater Lima Region has the potential to position itself at the forefront of applied innovation.

ASSETS

The key assets are the current OEA grant resources allocated to the communication strategy. In addition, there are exciting innovation ventures underway, such as the OEAMC facility and its cutting edge technology.

OPPORTUNITIES

Building innovation as a key message platform will help reshape the region's reputation, and attract new outside interest. The level of applied innovation within the region offers great opportunity to tell this story.

RISKS

Failure to capitalize on the innovation theme, will likely represent a lost opportunity. The emerging manufacturing landscape in rural USA is increasingly looking like a competitive environment between regions as they compete over skilled workers and the talent pool. Strategies to attract and retain talent will require clearly focused communication plans that build the right reputation and narrative about the direction and potential of a region.

6.4 OVERALL IMPLICATIONS

The innovation roadmap presented in this section builds upon many of the key findings and bright ideas discussed throughout the innovation analysis. We have discussed the importance of strong leadership in guiding a collective vision for the region. This is especially true in pursuing many of the bright ideas presented here. Success depends on engagement and participation of a wide variety of partners working towards a common goal. This will increase the role and importance of institutions such as the OEAMC as well as organizations such as AEDG and Link Lima.

The implications of the bright ideas presented in this roadmap are numerous, but the key guiding themes are:

- The Greater Lima Region has a number of robust innovation assets. However, these assets need to be coordinated in order to maximize their effectiveness. This will lead to greater collaboration through engagement in structures such as Centers of Excellence and Industry Cluster Organizations.
- The growth of innovation in the Greater Lima Region depends on the promotion of a broader innovation culture. This must take an intergenerational approach to spark creativity in young and old alike.
- Innovation depends on a strategic mix of collaboration and competition. Companies in the region must understand that introducing strong innovation principles in their operations will drive economic prosperity and increase market share.

7.0 CONCLUSION

The innovation analysis and roadmap presented here represents a mix of best practice research and strategic foresight. It recognizes the significance of applied innovation as a key business strategy to promote economic growth in the Greater Lima Region. The region does have an extensive history as one that has promoted manufacturing excellence and leadership. The spirit of innovation that led to the birth of many of the region's firms remains in a new generation of inventors and tinkerers. The region must support a strong climate of innovation and creativity to support and cultivate these and the next generation of business leaders.

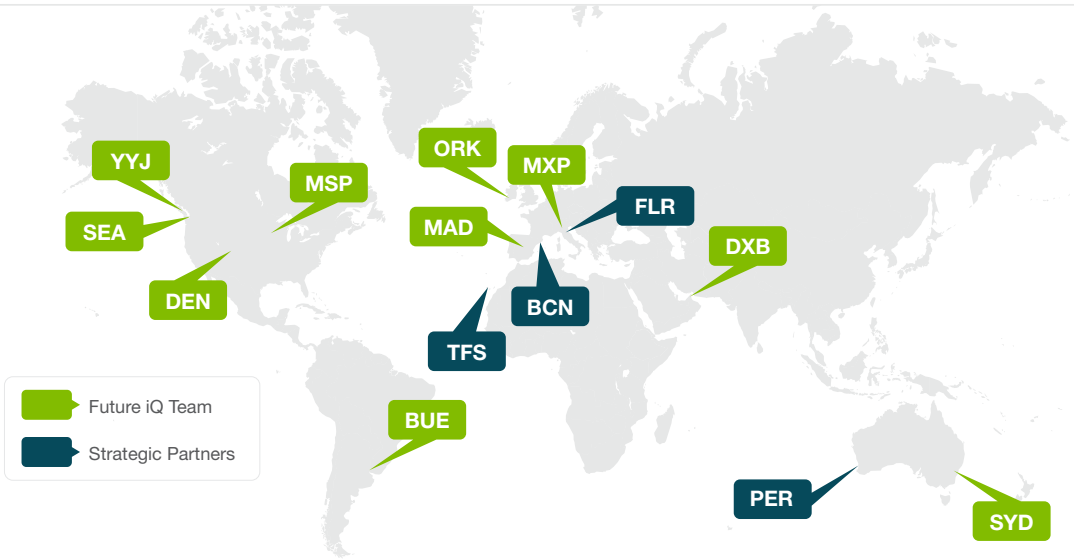
The bright ideas presented in the innovation roadmap are generally considered to be longer term endeavors. Some, such as the Regional Makerspace Network and Community Technology Initiative will require significant community investments, whereas others, such as the formation of additional Industry Cluster Organizations have many assets already in place. The success of many initiatives will require some collective prioritization by regional leaders.

Readers may note that little was written in this analysis regarding the potential for new business development in the Greater Lima Region. The pace of innovation certainly indicates that some potential exists for the formation of 5-7 new firms per year. Substantial venture capital resources ranging from the Millstream Angel Club to the State of Ohio programs exist to assist those entrepreneurs mature into second stage growth firms.

The intent of the innovation roadmap presented is to build many of the necessary pre-conditions for successful new business formation from identifying innovators and ideas, providing technical and industry support, to providing qualified markets through the proposed industry competitions. Each of these facets of development is essential to building the innovation culture that will position the region as a hub of applied innovation and thereby support significant business growth among new and existing firms. This represents a robust and sustainable growth path for the Greater Lima Region.

8.0 ABOUT FUTURE IQ PARTNERS

Future iQ Partners is a market leader in the development and application of scenario planning; network analysis, industry and regional analysis, and community engagement and capacity building. We specialize in applying innovative tools and approaches to assist organizations, regions and industries shape their economic and community futures. We take a practical, hands-on approach to working with groups and communities. With over a decade of business experience, the company has grown to have a global clientele spanning three continents. To learn more about Future iQ Partners, and our recent projects visit www.future-iq.com or by email at info@future-iq.com



9.0 ABOUT AEDG (ALLEN ECONOMIC DEVELOPMENT GROUP)

The Allen Economic Development Group (AEDG) is a public/private partnership that was formed in 1993 as a facilitator for countywide economic development. This cooperative effort of the public and private sectors has been a significant catalyst for the economic growth in Lima/Allen County. AEDG staff have been instrumental in supporting the studies as part of the Comprehensive Growth Plan project.

For more information regarding AEDG, please contact:

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10.0 ABOUT THE ALLEN COUNTY COLLABORATIVE GROWTH PLAN

This study is one of many to be produced under an award issued by the U.S. Department of Defense Office of Economic Adjustment to assist Allen County in developing strategies to develop a regional Collaborative Growth Plan. This includes ensuring the economic health and vitality of the Joint Systems Manufacturing Center and the broader region.

For more information regarding Allen County OEA, please contact:

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FOR MORE DETAILS, AND TO ACCESS COPIES OF ADDITIONAL REPORTS, PLEASE VISIT:

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Asset Inventory
March 2015

Scenarios of the Future
April 2015

Strategic Action Plan
May 2015

Comprehensive Gap Analysis - Part 1
August 2016

Comprehensive Gap Analysis - Part 2
August 2016

Comprehensive Gap Analysis - Part 3
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