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There is renewed emphasis on manufacturing as the U.S. hinges its economic future on restoring robust and sustained economic growth. Economic developers at the local, regional, and state level know that impactful growth will come from the manufacturing industries engaged in innovative and technology-driven production, universally known as advanced manufacturing. An advanced manufacturing growth strategy is especially important for regions with tight labor markets since high-tech manufacturing operations generally require few workers while generating significant output. To build a sustainable advanced manufacturing growth strategy, regions can look to the metros with the largest advanced manufacturing gross domestic products (GDP), Houston and San Jose, and they will find that the most important elements of an advanced manufacturing strategy are continual innovation and diversification.

According to the Brookings Institute, there are 35 manufacturing industries that constitute the advanced manufacturing sector. These 35 industries, combined with 15 services and energy generation industries, make up the advanced industries sector, which Brooking's refers to as the nation's "linchpin industries". These are the high-tech industries leading U.S. economic growth and tackling objectives of national and global importance.

Regional economic activity in advanced manufacturing is measured by evaluating the GDP, or value of goods,

originating from industries located within a metropolitan area. Nationwide, the advanced manufacturing economy accounted for approximately $1.37 trillion in GDP in 2016, about 7.5 percent of total U.S. GDP, and most of this activity took place in metropolitan areas.

Most states, if not all, are actively targeting advanced manufacturing for growth and development, while county and regional entities follow suit. Advanced manufacturers are oftentimes high-profile companies producing recognizable products, including aircraft and cars, medical equipment and pharmaceuticals, semiconductors and analytical instruments. Advanced manufacturers offer an attractive value proposition: large capital investments in machinery and equipment and high-skilled, high-paying jobs – all of which contribute substantially to a regional economy.

But with sub-five percent U.S. unemployment, and some county and regional rates even lower, fast growing regions must adapt their growth strategies, focusing on the ability to provide a highly-productive workforce if they want to attract advanced manufacturers. The MIT Technology Review reported that in 1980 it took 25 jobs to generate $1 million in manufacturing output in the U.S. and today it takes only five jobs. Focusing recruitment efforts on advanced manufacturing can mean a substantial shot in the arm to GDP without further straining the labor pool. It also means that there is a strong case for investment in skills development to ensure that the workforce is prepared to fill modern-day manufacturing jobs.

Advanced manufacturing is largely a decentralized collection of industries, located throughout the country though, as previously stated, primarily in metropolitan areas. The two largest advanced manufacturing economies in the U.S. are Houston-The Woodlands-Sugarland, Texas and San Jose-Sunnyvale-Santa Clara, California. The two metros each had over $60 billion in advanced manufacturing output in 2016, combining for about nine percent of the total U.S. advanced manufacturing GDP. Both metros provide a picture of what big metro, big talent regions offer advanced manufacturers: access to the talent, support industries, transportation assets, and intellectual tools necessary to drive global innovation. Where these regions differ is in the asset mix they offer and the industry diversification that has solidified them as major advanced manufacturing hubs.

Houston Houston's future was cemented in 1901 when oil was discovered at Spindletop in Beaumont, Texas and a shipping channel was funded the following year. Development of an energy industry around a natural resource (oil) and a natural, albeit engineered, waterway (Houston Ship Channel), built the city and the region. Houston is known as the center of the oil and gas industry with a significant presence in upstream energy, chemicals and refining. However, Houston's economy today is far more diversified, adding health care, corporate headquarters, and aerospace to the mix of industries driving the regional economy.

Contrary to perception, what makes Houston's economic strength in advanced manufacturing so striking is that it is well diversified. Energy has trended downward in the past few years, and Houston's GDP in advanced manufacturing has shrunk by 10.4 percent from 2012 to 2016. With the ebbs and flows of the oil industry, Houston's diversification has developed out of necessity. Health care and biotechnology industries have developed around the Texas Medical Center and research spillovers are driving organic growth. Johnson & Johnson Innovation JLabs opened a business incubator near the Texas Medical Center in 2016 to foster innovation in biomedical research. The JLabs announcement was a major win, supporting the notion of Houston as a biotech hub. Benefitting from the health care assets in Houston is pharmaceutical and medicine manufacturing, which has experienced triple digit growth (310.6 perccent) over the last five years with a total output nearing $1.9 billion.

Overall, Houston's advanced manufacturing economy contributes average annual wages of $106,301, 71.1 percent more than its overall average wage of $62,138. And the Houston metro is expected to gain about 6,500 advanced manufacturing jobs over the next 10 years. It would be remiss to not mention the economic impact of

Hurricane Harvey. Estimated total losses reported by Moody's Analytics as of September 2017 are around $97 billion, factoring $10 billion in lost economic output. The region's major sectors were impacted, but emerged largely unscathed. Recovery forecasts are positive, with Moody's Analytics projecting a drop in metro Houston GDP in fourth quarter 2017 with an increase above pre-Harvey levels in first quarter 2018. San Jose When one thinks of San Jose, they invariably think of Silicon Valley, technology, and innovation. Breaking with the stereotypical vision of Silicon Valley in the internet-age, there is still a great deal of manufacturing taking place.

In fact, GDP in advanced manufacturing grew 51.3 percent from 2012 to 2016, or an overall growth of over $21 billion. As the birthplace of the computing industry, Silicon Valley grew in large part because of its access to institutions of research, namely Stanford University. The clustering of innovative activities, human capital, and an entrepreneurial mindset drew more companies to locate, expand, and be created. The metro's largest advanced manufacturing industries are clustered within information technology and analytical instruments, including the production of computer and peripheral equipment, semiconductor and other electronic components, and navigational, measuring, electromedical, and control instruments.

Despite the growth in GDP, San Jose is expected to lose approximately 9,030 jobs in advanced manufacturing over the next 10 years. But the outlook is positive because of the diversification that is embedded in the region's reputation as an innovation hub. Described best by the City of San Jose in a report on manufacturing, "San Jose is a high cost/high value manufacturing location and has become specialized in supporting a new product introduction niche in the global manufacturing process." And here is where Silicon Valley's manufacturing positioning is so attractive. A fast-growing manufacturing sector in the San Jose metro is likely an operation conducting research and development leading to technological breakthroughs. Industries of all types are testing out their new products and production methods in this melting pot of knowledge transfer. San Jose's top-growing advanced manufacturing activities are in sectors as varied as audio and video equipment, iron and steel mills and ferroalloy, pesticide/fertilizer, and motor vehicle parts. While it is unlikely that there are steel mills being constructed in Silicon Valley, the locational linkages of information technology (IT) and business services that nurture research and development in the iron and steel mill and ferroalloy industry is growing in a manner that can only be accomplished in a technology-driven, advanced manufacturing metro economy like San Jose.

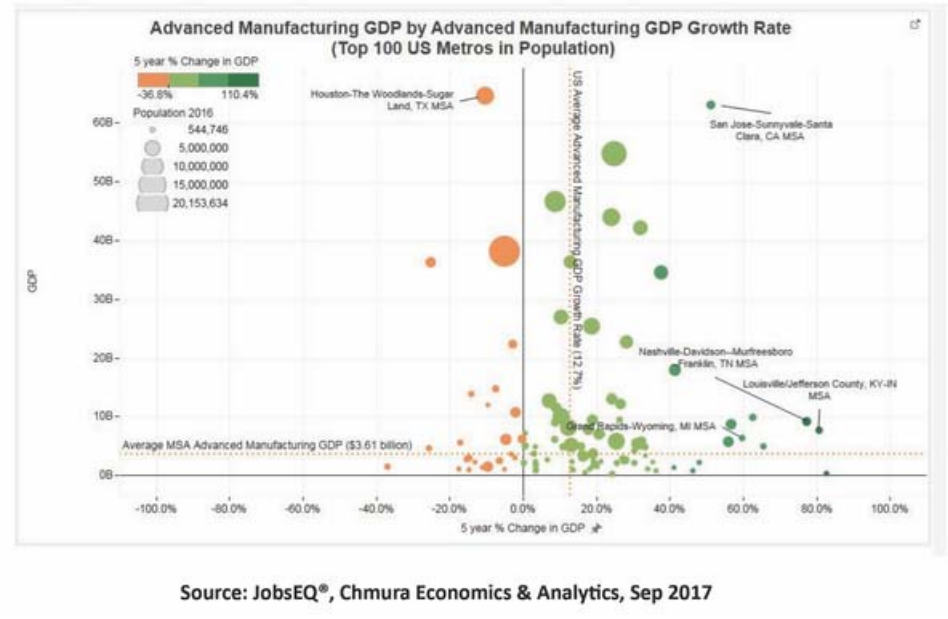
The cost of doing business is one of the greatest challenges in high-tech/high-amenity locations attempting to grow a diversified and sustainable advanced manufacturing economy. The San Jose-Sunnyvale-Santa Clara, California region's advanced manufacturing average salary exceeds $200,000, compared to California's average at $121,542 and the nation's at $80,977. The economic activity that drives the region to be attractive synchronously drives up labor costs and demand for housing and real estate, leading to higher costs of living and operating a business. Perhaps the most telling outcome of this problem is the 2017 announcement that Lockheed Martin would be relocating its Fleet Ballistic Missile program within its Space Systems business out of Sunnyvale, a major cost savings to the company, and major loss to the San Jose region. Diversification Strategy The takeaway for mid-sized metros working to develop advanced manufacturing strategies is clear: regions that have specialized advanced manufacturing economies must work to diversify if they wish to experience sustained growth. Both Houston and San Jose grew rapidly out of a specialization in a single industry and diversification has helped lessen the burden of economic contractions. The experiences of these two metros can be applied to mid-sized metros like Grand Rapids, Nashville, and Louisville, all with significant advanced manufacturing economies around the automotive industry. Like Houston and San Jose, these metros have found success in growing a tech-minded workforce and are targeting industries that also seek this talent pool, like IT and life sciences in Grand Rapids, and health care and corporate operations in Nashville. Louisville's strategic focus on advanced manufacturing has been less overt, leaving opportunity for the region

to present itself more strategically to new industries. Focusing on innovation linkages with existing advanced manufacturing sectors, automotive and home appliances, is a good place to start.

Even smaller metros like Waco, Texas or Grand Forks, North Dakota can learn from the experiences of Houston and San Jose and develop diversified advanced manufacturing economies around existing assets. Waco is home to Baylor University with proximity to Fort Hood and already has a strong manufacturing presence. Strategic development of a former U.S. Army munitions plant and Naval Weapons Industrial Reserve Plant in nearby McGregor led to the attraction of a SpaceX rocket development and test facility, and there is more industrial land available for development. The Waco MSA's advanced manufacturing economy grew 68.8 percent over the last five years with a total annual output of $2.3 billion.

Though smaller in population, Grand Forks' five-year growth rate of 80.1 percent is significant and attributed to aerospace assets like the Grand Sky Air Park, an FAA approved unmanned aerial systems (UAS) test site. Grand Forks is also home to aviation manufacturing, with Duluth-based Cirrus Aviation's production of composite and carbon-fiber components. Grand Forks is building an advanced manufacturing strategy around the high-tech assets that helped to develop the aerospace industry. LM Glasfiber (now LM Windpower, a General Electric company), a wind blade manufacturer, located in Grand Forks in 1999 and continues to expand, contributing to the metro's 114.5 percent GDP growth rate in engine, turbine, and power transmission equipment manufacturing. This move towards diversification stands out amongst small metros targeting advanced manufacturing.

As the nation works to sustain substantial economic growth, targeted strategies to develop advanced manufacturing economies at the metro level will be crucial. Both Houston and San Jose offer case studies for how regions can build diverse and sustainable advanced manufacturing economies, and exemplify the results of major investment in disruptive technologies of the time, and continual innovation towards diversification. Their efforts are a lesson to mid-sized and growing metros seeking to solidify their place in the advanced manufacturing ecosystem.



Source: JobsEQ®, Chmura Economics & Analytics, Sep 2017

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Footnotes: 1 Brookings Institution, America's Advanced Industries (2015), https://www.brookings.edu/wp-content/uploads/2015/02/AdvancedIndustry_FinalFeb2lores-1.pdf

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