



Metropolitan Chicago's Manufacturing Cluster: **A Drill-Down Report on Innovation, Workforce, and Infrastructure**

Summary Report, February 2013



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About this Cluster Report and GO TO 2040

Metropolitan Chicago is one of the world's great economic centers. While the region enjoys a diverse mix of industries, it also realizes significant gains through its economic specializations. These industry clusters create high-quality jobs, spur innovation, and generate growth among numerous interconnected industries. The second in a series of "drill-down" studies by CMAP, this report examines factors contributing to the strength of the manufacturing cluster in our seven-county region of northeastern Illinois.

GO TO 2040 — metropolitan Chicago's first comprehensive regional plan in more than 100 years — calls for strategic support of existing and emerging industry clusters to better compete in the national and international marketplace. The plan directs CMAP, with the support of its partners, to perform drill-down analyses into specific clusters such as freight, manufacturing, and biotech/biomed.

Why Manufacturing Matters in Metropolitan Chicago

Manufacturing has long been a cornerstone of the regional economy, helping metropolitan Chicago become the economic power that it is today. Even in this era of global sourcing, manufacturing remains a vital element of the region's economic health.

Manufacturing matters because it enhances the very qualities that distinguish metropolitan Chicago on the world stage. Employers draw on our region's deep pool of skilled workers, and the 580,000 currently employed in the regional manufacturing cluster ranks second largest in the nation. Manufacturing jobs also offer above average pay and benefits, contributing to the region's high standard of living.

Manufacturing leverages the region's location at the nation's freight crossroads. Few other global centers can emulate the concentration of freight flows and transportation infrastructure currently enjoyed by regional manufacturers to access both suppliers and distant customers. At a rate higher than the nation's other leading exporters, two-thirds of the region's exports come from manufacturing and bring billions of new dollars each year into the regional economy.

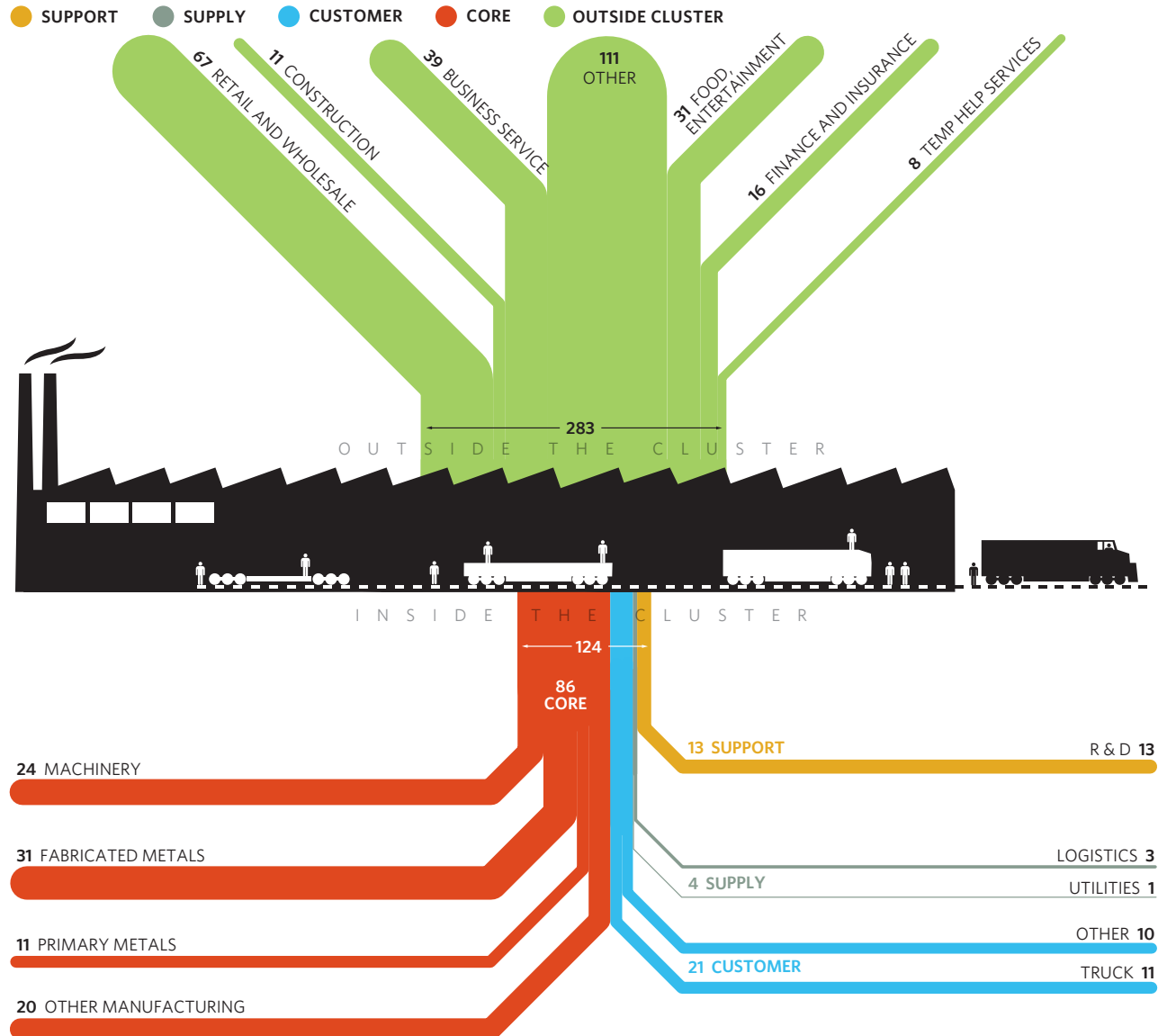
Finally, metropolitan Chicago's manufacturing cluster builds on strengths of the regional economy. Manufacturing output is highly diverse, spread among almost every major sector. Manufacturing fuels innovation in the region, as 85 percent of all private research and development (R&D) comes from the cluster. And manufacturing has a larger ripple effect than any other industry grouping: Each new manufacturing job created here supports at least two additional positions in the regional economy.

This report by the Chicago Metropolitan Agency for Planning (CMAP) explores the manufacturing cluster to identify major issues that influence the region's competitive advantage in this vital economic activity. It includes clear steps that the region can take to capitalize on this "manufacturing moment" in the early 21st Century. A companion technical document provides in-depth analysis as well as corresponding citations to support the conclusions of this report. The technical document can be found at <http://cmap.illinois.gov/policy/drill-downs/manufacturing>.

Metropolitan Chicago's Manufacturing Cluster

- Employs **580,000 workers**, second largest such cluster in the nation.
- Provides wages **27 percent higher** than the regional average.
- Fuels innovation — **85 percent** of all private R&D in the region.
- Generates over **\$65 billion annually**, second largest segment of the regional economy.
- Creates **largest ripple effect** of any industry (one manufacturing job supports at least two more in the region).
- Produces **two-thirds** of the region's exports.
- Leverages region's locational advantage as **freight hub** of the nation.
- Influences nearly **every major industry** in the region.

Economic multiplier from increase of 100 jobs in rail equipment manufacturing



Source: CMAP Analysis of EMSI Input-Output Model, 2012.

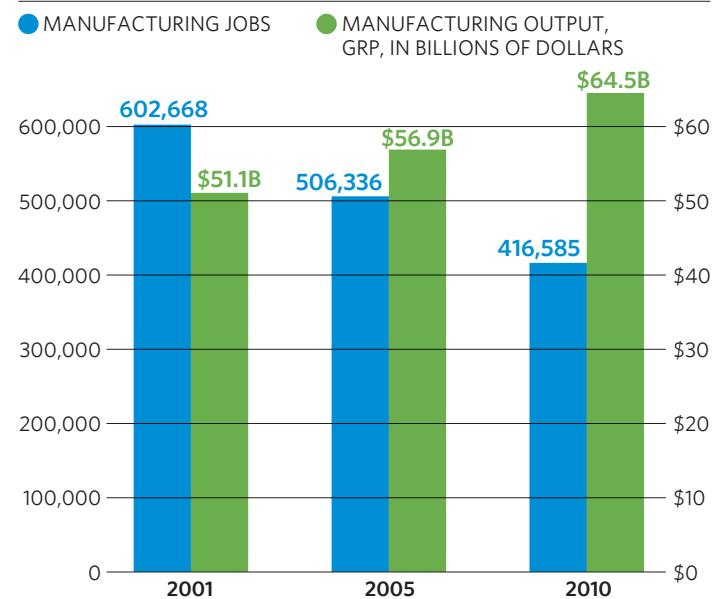
More than any other industry, manufacturing's expansion has a substantial domino effect in both the cluster and the broader economy. Each new manufacturing job supports at least two additional positions in the region. For specializations such as rail equipment manufacturing (shown in this chart), the multiplier effects are even stronger. One-hundred more jobs in this industry would support an additional 407 in the region, of which 124 positions would fall within the manufacturing cluster (depicted in red, blue, gray, and gold), with the other 283 outside the cluster (depicted in green).

Recent Challenges and Emerging Trends in Metropolitan Chicago's Manufacturing Cluster

In the late 19th Century, manufacturing pioneers helped transform Chicago from an isolated outpost into a bustling industrial city. By World War II, the region had become a focal point of research, development, and large-scale production across industries as diverse as primary metals, medicine, electronics, and food. The mid-20th Century was a transformational period when economic growth enabled workers to sustain life-long manufacturing careers with little more than a high school diploma.

Today's diverse economy is a result of technological change, trade policies, and the dissolution of geographic barriers, all of which have significantly altered the manufacturing landscape. Like other industrial centers around the nation, metropolitan Chicago saw its manufacturing employment fall by nearly a third in the past decade as firms shifted production abroad. At the same time, productivity in the cluster has increased as a result of advanced processes and higher-valued output. This trend toward high-tech products and processes calls attention to an important lesson of the last ten years: The region's competitive advantage lies not in low-skilled, labor intensive activities that are vulnerable to offshoring, but rather in manufacturing that leverages advanced skills, methods, and output.

Core manufacturing productivity and employment change in the Chicago region, 2001-10



Note: Output measured in nominal dollars.

Source: Bureau of Economic Analysis, EMSI, CMAP analysis for the tri-state region.

Today regional manufacturers produce more using fewer workers — even as employment has fallen, output continues to increase through a continued shift to high-tech products and processes. Some employment loss may be from firms' increased use of temporary workers to fill production positions.

Manufacturing cluster components

● SUPPORT INDUSTRIES

● CUSTOMER INDUSTRIES

● CORE INDUSTRIES

● SUPPLY INDUSTRIES



Source: CMAP analysis, 2012.

Metropolitan Chicago's manufacturing cluster consists of four components. Core industries transform materials into new products through mechanical, physical, or chemical processes. Support industries provide R&D services to the core. Supply industries provide inputs necessary for production. And customer industries move goods through supply chains and into the market.

The Cluster Approach to Manufacturing

To better understand the current state of manufacturing in metropolitan Chicago and how the industry has responded to globalization, this report looks not only at core production activities but also at the region's network of manufacturing suppliers, partners, investors, and customers. A cluster represents all these different components of manufacturing's value chain. The GO TO 2040 comprehensive plan calls for the region to strategically promote economic growth based on existing and emerging clusters. For manufacturing, this cluster approach reveals relationships between interdependent firms, calling attention to common resources and institutions while providing insights into the broader regional economy.

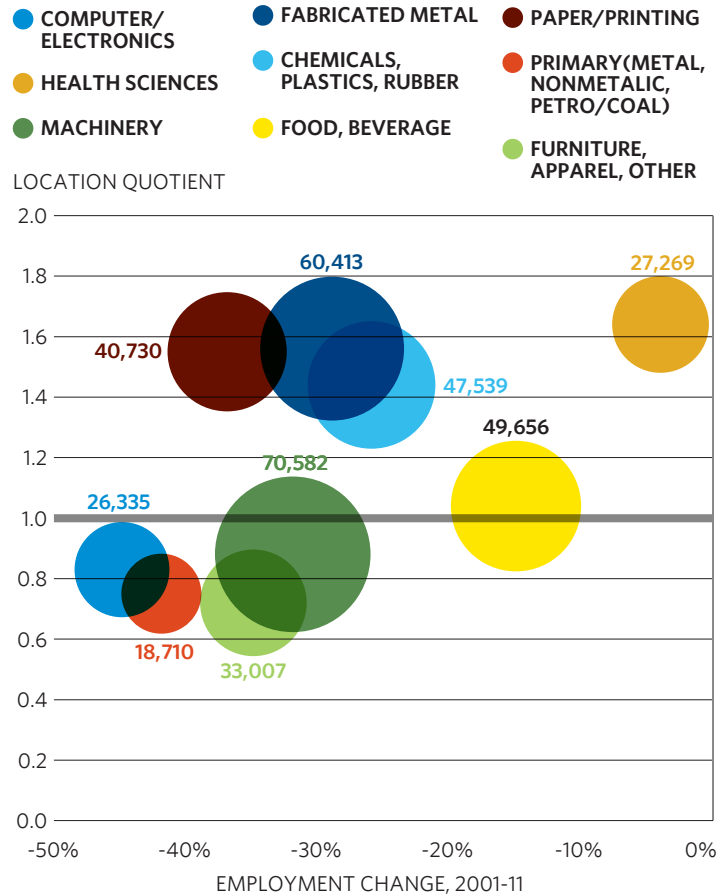
Core Manufacturing Industries

With about 375,000 workers, core firms remain the largest component of the regional manufacturing cluster, yet they were the hardest hit by globalization of manufacturing. The cluster's core consists of nine distinct sectors that range from computer and electronics to food and beverage. Compared to other U.S. manufacturing centers, metropolitan Chicago stands out because of its broad output across almost every core sector, whereas most metropolitan areas specialize in just a few manufacturing areas. For example, Seattle is known for airplanes and Silicon Valley for computers. Detroit's automotive specialization shows how overreliance on a single industry can be precarious in today's global economy. In contrast, no single core sector accounts for more than 19 percent of manufacturing employment in metropolitan Chicago.

Each of the region's nine sectors has faced declining employment over the last decade due to globalization and automation. Some of the fastest drops have been in sectors where the region is less specialized, including computer and electronics, furniture and apparel, and primary manufacturing, although the greater tri-state area has a large primary metals and petroleum concentration just across the border in northwest Indiana.

In contrast, the region's specializations in health sciences, chemicals/plastics, and fabricated metals experienced slower job loss. The region's largest sector – machinery – is split between transportation equipment and other industrial machinery. The region manufactures less in automotive and aerospace, but it maintains one of the nation's largest concentrations in electrical, industrial, and freight equipment.

Major industry groupings of the manufacturing cluster
Circle size indicates number of jobs per industry

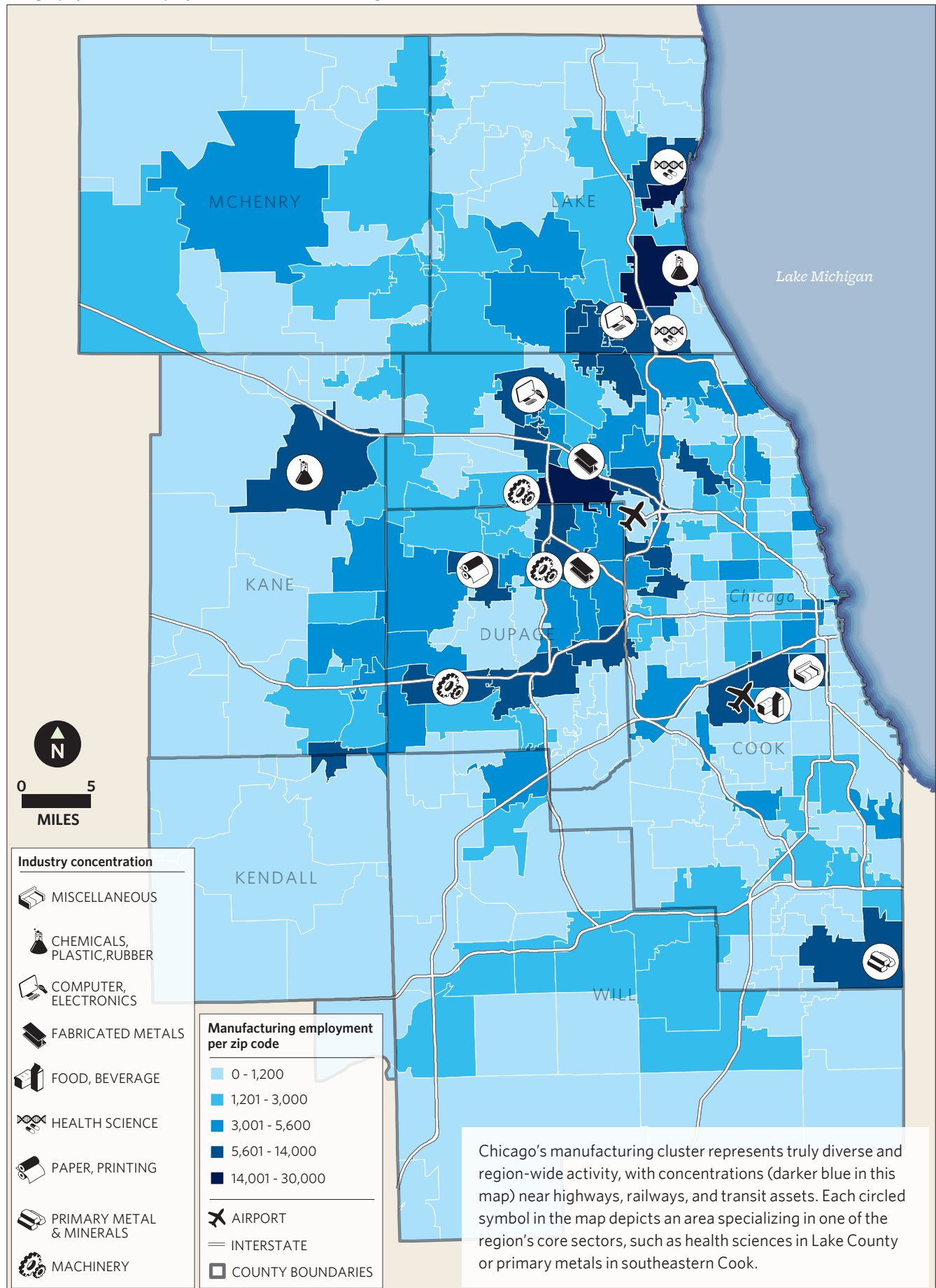


Source: CMAP analysis of EMSI data, 2012.

This chart illustrates recent trends and current status of core industries across three metrics: current employment, employment change, and location quotient. Circle size indicates total current employment in each core industry. Horizontal axis is the percentage of regional employment change, while vertical axis is the sector's location quotient compared to other U.S. regions. Location quotient below one is lower than the national average, while above one indicates a strong regional concentration.



Geography of Core Employment in the Manufacturing Cluster



Source: Chicago Metropolitan Agency for Planning.

Manufacturing concentrations by region



Source: CMAP analysis of BLS data, 2012.

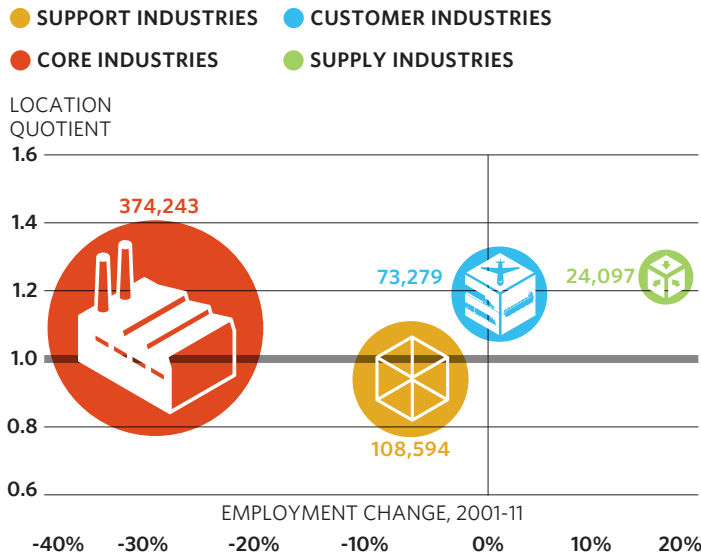
No single industry in metropolitan Chicago accounts for more than 19 percent of manufacturing employment. This diversified manufacturing core has both limitations and advantages. Regions that specialize can concentrate on supporting a few industries and related supply chains, but overreliance on a single industry can leave a region vulnerable in today's economy. A region's diversification helps it to mitigate risks of global competition.

Support, Supply, and Customer Industries

Core manufacturing industries do not operate in isolation. As part of a larger cluster, they share common resources, rely on similar institutions, and are affected by similar trends. The cluster's core production firms receive important research and design services from the region's support industries. Supply industries provide energy, materials, and logistics to core firms. And customer industries—truck, rail, air, and water freight carriers—enable regional supply-chain moves and connect production firms to final consumers.

Each component of metropolitan Chicago's manufacturing cluster has had a different response to heightened global competition. Supply and customer industries have utilized regional freight assets to sustain growth. In contrast, private R&D support, once a strength of the cluster, has declined so much over the past ten years that now our region under-specializes in this vital function.

Manufacturing cluster components at-a-glance



Source: CMAP Analysis of EMSI data.

Each of the cluster's four components contributes to regional manufacturing productivity. Core industries produce goods from raw materials and intermediate parts. Support industries offer valuable R&D services to fuel future innovation. Supply industries provide the core with inputs necessary for production such as raw materials, energy, or logistics. Finally, customer industries provide the freight link between manufacturers and consumers.

Spotlight Industry: Logistics & Supply-Chain Management

Manufacturers must master complex supply chains consisting of raw materials, intermediate components, and discrete parts that often converge from across the globe for just-in-time production. Firms in metropolitan Chicago's manufacturing cluster can draw on the region's impressive strengths in logistics to enable complex supply-chain moves. CMAP's freight cluster report (www.cmap.illinois.gov/policy/drill-downs/freight-cluster) shows how employment in regional logistic providers has increased this past decade to reach almost 20,000. With a location quotient of 2.63, the Chicago region is the nation's leading logistics center, home to innovative firms such as Coyote and Echo Logistics.

Supply and Customer Industries: Leveraging Freight Assets

The region's supply and customer industries have taken advantage of such assets as location and infrastructure to support expansion. Manufacturing cluster employment remains highly concentrated in the customer component, and freight carriers saw slight employment increases over the last decade. The most pronounced growth area of the cluster has been in logistical supply industries. This smallest component of the cluster is also the most specialized, and its employment rose 16 percent between 2001 and 2011. The region's superior options for supply-chain management and freight help manufacturers reduce logistical costs and gain access to new markets. Indeed, while metropolitan Chicago is the nation's third largest exporter for all types of products (raw materials, manufactured goods, and services), it is the second largest for manufacturing exports specifically. In 2010 close to two-thirds of all the region's exports came from manufacturing, a higher rate than the nation's other top exporting regions. Together, these supply and customer industries build the link between freight and manufacturing, distinguishing the region from many other peer manufacturing centers.

Support Industries:

Addressing a Decline in Private R&D

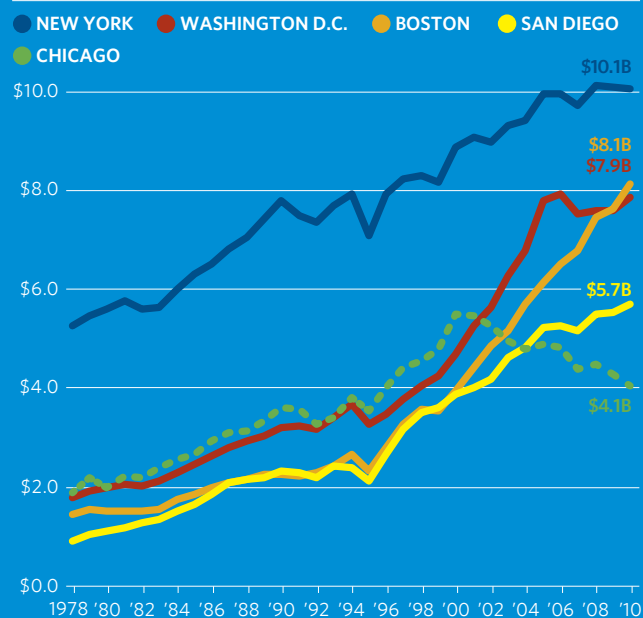
The cluster's support industries include over 100,000 workers spread across industrial design, computer support services, and R&D. While industrial and computer support industries grew slightly in the past decade, the region lost almost half of all jobs in its private R&D firms (though regional universities increased expenditures in basic research). This decline in primary R&D firms corresponds to the internationalization of research. Almost 90 percent of research in electronics, for example — once a specialty of the region — now occurs in Asia. Yet other domestic centers have been able to sustain private R&D growth by building on regional strengths, such as biotech in San Diego or Boston.

At the same time that primary R&D has fallen, the region's patent output — one of the most common indicators of innovation — has not kept pace with other regions. While in 2000 the region produced the fourth most patents in the nation, by 2010 its rank had dropped to eighth. As manufacturing relies on R&D support to fuel next-generation technologies and productivity gains, the region's R&D decline contributes greatly to challenges that the cluster faces today. The region has struggled somewhat in commercializing technologies: Strengths in basic research haven't always translated into marketable products, and small firms are especially hard-pressed to adopt product or process improvements. Nationally, manufacturing accounts for two-thirds of all private R&D and 90 percent of all patents. Reduced R&D support makes it harder for metropolitan Chicago's manufacturing cluster to stay ahead of the innovation curve and compete in global manufacturing.

Spotlight Industry: Research and Development

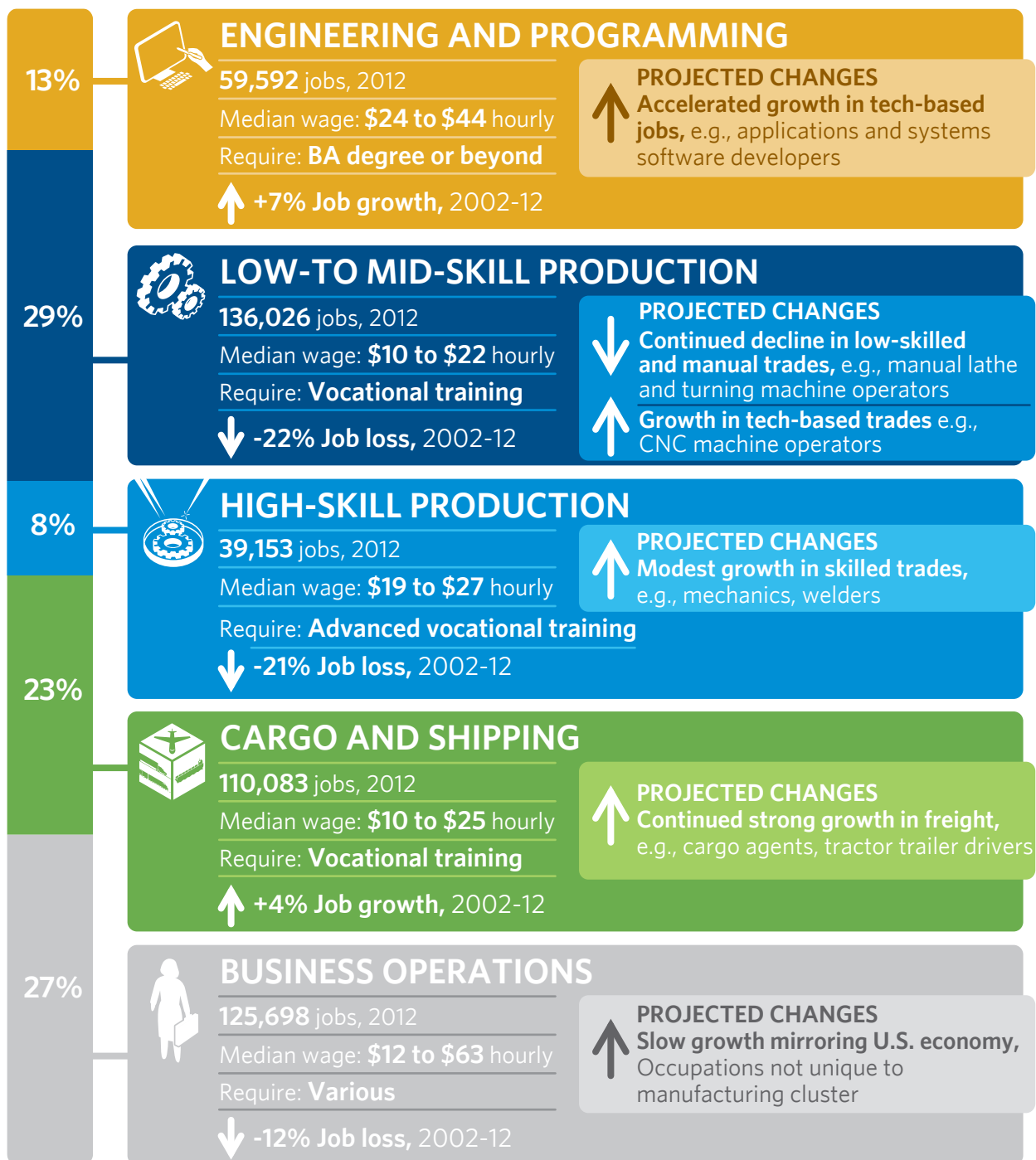
Historically the Chicago region has been one of the nation's top R&D manufacturing centers. Between 1980 and 2000, the region's private R&D tripled, and it was ranked consistently as the nation's second largest research center. Since 2000 that trajectory has flipped, and ground is being lost to other innovative regions. For example, in 2000 the region's private R&D output was 40 percent larger than Boston's; ten years later, Boston's output doubled that of the Chicago region.

R&D contribution to gross regional product, 1980-2010, in billions



Source: Illinois Innovation Index, 2012.

Manufacturing cluster: current status and anticipated growth for top 75 occupations



Sources: EMSI, CMAP analysis.

This graphic shows key characteristics of the cluster's top 75 occupations across several major categories: employment in 2012, range of hourly median wages in 2012, employment change from 2002-12, training and education required, and employment projections and openings for 2012-22. Openings reflect retirement and turnover projections in each occupation. Vocational training required for occupations in Production and in Cargo and Shipping can take place on the job or in a variety of academic or community-based settings.

Globalization and the Regional Workforce

The past ten years have seen transoceanic shipment, increased international investment, and technological advancement help to spread manufacturing across the globe. Workers in metropolitan Chicago's cluster now must compete not only with other advanced economies, but also with developing countries that have an inherent labor cost advantage. In response to globalization and rapid technological advances, metropolitan Chicago's manufacturing workforce contracted by a third as firms introduced more automated machinery and processes into factories or moved labor-intensive production offshore.

Even with these employment trends, the region continues to increase productivity through higher-valued output as it shifts toward high-tech products and processes, which GO TO 2040 refers to as "advanced manufacturing." Although advanced manufacturing has created rewarding new career paths, many people continue to perceive manufacturing jobs as unsatisfying — perhaps even as menial or dirty work associated with factories of the 20th Century. While past generations viewed it as an avenue to the middle class, contemporary jobseekers and students often eschew the field, greatly limiting the pipeline of future manufacturing workers.

At the same time that manufacturing employment has declined, productivity continues to increase. This underscores how firms now rely on their skilled workers and advanced technology to outcompete cheaper global labor: A leading effect of the past ten years has been the "up-skilling" of the region's manufacturing workers, whose jobs increasingly require training for tasks not traditionally associated with the field. The skills gap has been particularly acute in production roles such as Computer Numerically Controlled (CNC) machine operators (which require vocational training and experience) and engineering positions (which require postsecondary education). If unaddressed, this mismatch between available jobs and the skills of the labor force could limit future manufacturing expansion. Analysis of the cluster's largest occupations shows that the fastest anticipated growth is in high-skilled production and programming positions, with continued decline likely in low-skilled manual production occupations.

State of Illinois Fiscal Problems Affect the Manufacturing Business Climate

Manufacturers want to invest in an environment they deem stable in the long term. Significant upfront costs in facilities and equipment mean manufacturers often pay back investments over many years. The state's current fiscal uncertainty has stifled some appetite to invest in the region. For example, the increasing budgetary stress caused by unfunded pension obligations inhibits the State's ability to dedicate funding to transportation infrastructure, workforce development, and education. Restoring fiscal solvency would both convey stability for private investment and better position the State to make the investments needed to support the manufacturing cluster. Other current policies in Illinois compound the state's negative business climate. For example, worker compensation laws and unemployment insurance are higher than elsewhere in the Midwest and U.S., which puts Illinois at a competitive disadvantage.





Looking Forward: Advanced Manufacturing in the Chicago Region

The next decade of manufacturing will look fundamentally different from the last. After decades of global sourcing, many manufacturers are realizing that production in developing countries can introduce imprudent risks when the marketplace requires greater customization and faster turnarounds between design and production. Moreover, the vulnerability of intellectual property and increasing cost of wages and energy, especially in China, are erasing some of the cost advantages of producing overseas. As a result, more manufacturers are reinvesting and expanding operations in the U.S., which creates significant opportunities for the economy of metropolitan Chicago.

To capture this manufacturing moment, the region must embrace the type of manufacturing that best capitalizes on regional strengths. The last decade has shown that low-skilled, labor intensive positions are especially vulnerable to offshoring but also that the region continues to produce increasingly sophisticated products using more complex techniques. Nurturing the rise of this advanced manufacturing — not only in terms of final products, but also the processes and requirements for a more skilled workforce — holds the key to reverse recent job losses and to build on productivity gains.

CMAP Advanced Manufacturing Scorecard

While many agree that advanced manufacturing will be essential for success in the 21st Century economy, few have defined or measured exactly what advanced manufacturing entails. Through an extensive review of national, state, and regional studies on advanced manufacturing as well as interviews with key stakeholders and business leaders, CMAP has developed a “3P approach” — **Product**, **Process**, and **People** — to define the following characteristics of advanced manufacturing:

PRODUCT

Advanced manufacturing products are complex, innovative, and difficult to replicate.

PROCESS

Advanced manufacturing processes (regardless of end product) are continually improved to achieve new efficiencies and cost savings.

PEOPLE

Advanced manufacturing workers have specialized skills that maximize the commercial impact of these products and processes.

Using these 3P indicators, CMAP has created an Advanced Manufacturing Scorecard to rate the regional cluster’s core industries. The Product indicator, based on work from the Brookings Institution, combines five metrics ranging from patent output to R&D intensity to show which industries are innovation leaders. The Process indicator uses the concept of “value added” to assess how much of a product’s value comes from the manufacturing process instead of simply from raw materials or intermediate inputs. (A limitation of the Process indicator is that it may not capture all improvements achieved by lean manufacturers operating more as distributors and less as production firms.) Finally, the People indicator uses wages as a proxy for skills to show which industries demand high-skilled workers.

Results of the CMAP Advanced Manufacturing Scorecard

The scorecard illustrates how some industries are especially poised to be leaders in advanced manufacturing. Due to metropolitan Chicago’s great manufacturing diversity, the region has a unique mix of all types of industries. Rather than emphasize direct competition with other global regions’ strengths, our region would be better served by focusing on its own advanced manufacturing specializations. While other regions may over-specialize in a single field, the broad output of metropolitan Chicago enables it to draw on strengths across multiple industries.

At the sector level, key regional specializations poised to lead in advanced manufacturing include Pharma/Medical Supply health sciences; Chemicals, Plastics, and Rubber; and Fabricated Metal. And for Machinery, the region manufactures less in automotive and aerospace but remains among the national leaders in electrical and industrial equipment, with strong linkages to the freight cluster.

While Computer/Electronics scores high on advanced manufacturing indicators, the region is much less specialized in this industry compared to competitors such as Silicon Valley. With a location quotient below one, the region lacks some advantages of clustering, such as well-developed regional supply chains. Therefore the industry may not be as primed for regional growth compared to other advanced manufacturing industries.

The CMAP Advanced Manufacturing Scorecard rates each core manufacturing industry based on its Product, Process, and People score. The overall rank combines all three indicators, with a score of one being the most representative of advanced manufacturing characteristics. Because the scorecard aggregates to the industry level, it does not capture all variations between firms within the same industry. Even in the industries scoring lowest on the scorecard, some individual companies will continue to exhibit and adopt the 3Ps of advanced manufacturing. ►

Advanced manufacturing scorecard

RANK	PRODUCT	PROCESS	PEOPLE	OVERALL RANK
1	COMPUTER/ ELECTRONICS 	PHARMA/ MEDICAL SUPPLY 	PHARMA/ MEDICAL SUPPLY 	PHARMA/ MEDICAL SUPPLY 
2	PHARMA/ MEDICAL SUPPLY 	COMPUTER/ ELECTRONICS 	COMPUTER/ ELECTRONICS 	COMPUTER/ ELECTRONICS 
3	MACHINERY 	FABRICATED METAL 	PRIMARY (METAL, NONMETALIC, PETRO/COAL) 	MACHINERY 
4	CHEMICALS, PLASTICS, RUBBER 	PAPER, PRINTING 	MACHINERY 	CHEMICALS, PLASTICS, RUBBER 
5	PAPER, PRINTING 	FURNITURE, APPAREL, OTHER 	CHEMICALS, PLASTICS, RUBBER 	FABRICATED METAL 
6	FABRICATED METAL 	MACHINERY 	FABRICATED METAL 	PAPER, PRINTING 
7	FURNITURE, APPAREL, OTHER 	FOOD, BEVERAGE 	PAPER, PRINTING 	PRIMARY (METAL, NONMETALIC, PETRO/COAL) 
8	PRIMARY (METAL, NONMETALIC, PETRO/COAL) 	CHEMICALS, PLASTICS, RUBBER 	FOOD, BEVERAGE 	FURNITURE, APPAREL, OTHER 
9	FOOD, BEVERAGE 	PRIMARY (METAL, NONMETALIC, PETRO/COAL) 	FURNITURE, APPAREL, OTHER 	FOOD, BEVERAGE 

Source: CMAP analysis, 2013.

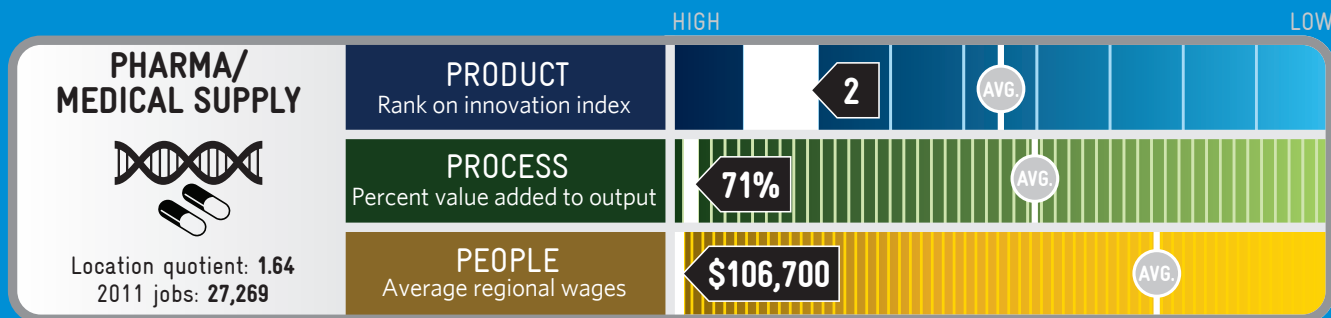
Spotlight Industry: Surgical Instruments

While other manufacturing industries have shed jobs, regional employment in surgical instrument manufacturing—one of the industries scoring highest on the Advanced Manufacturing Scorecard—increased by a quarter over the past decade. Like other components of Pharma/Medical Supply manufacturing, surgical instrument makers — one of nine industries comprising this sector — can draw on the region's biotech cluster concentrated in Lake County.

The scorecard below shows how Pharma/Medical Supply industries rank much higher on each 3P advanced manufacturing characteristic compared to the average. These industries rank second of all manufacturing sectors for Product innovation and first for Process and People. For the Product indicator, a rank of one would reflect the most innovation, while higher numerical values in both Process and People indicate more advanced characteristics. The farther left each score is on the spectrum, the better it measures on the advanced manufacturing scorecard.

As the individual scorecard shows, the sector contributes 71 percent to value-added output, compared to the manufacturing average of 45 percent. And with its average regional wages above \$100,000, the sector is much higher than the core average of \$61,000. The scorecard's black arrows highlight the sector's Product, Process, and People score on the manufacturing spectrum. The left side of the individual scorecard depicts the sector's location quotient and current employment for reference. The technical document provides individual scorecards for each core sector.

LOOKING FORWARD: Leveraging the region's strength in the surgical instrument industry can create the type of high-tech manufacturing resistant to offshoring. Despite current strengths, more work needs to be done supporting future innovation, as recently the region's private R&D and patents in the field have not kept pace with other metropolitan areas.



Next Steps: Strengthening Innovation, Workforce, and Infrastructure

To support advanced manufacturing across all its diverse industries, the Chicago region can draw on the same competitive advantages that fueled growth a century ago — economic innovation, infrastructure assets, and a deep pool of skilled workers. Reestablishing the region as a leader in manufacturing innovation will help firms build expertise in the next generation of advanced manufacturing technology. Addressing negative perceptions and acute skill shortages will ensure that our region has the necessary workforce to compete with any region of the globe. Finally, investing in infrastructure will capitalize on the region's freight and logistics strengths and provide regional manufacturers access to new markets for their advanced goods.

While external forces will continue to have an impact on manufacturing in metropolitan Chicago, each area of innovation, infrastructure, and workforce represents ways the region can support the cluster. Policy development in each area should not only support opportunities but also ensure that the region is not at a disadvantage compared to competitors. The remainder of this report highlights how a focus on innovation, workforce, and infrastructure will help our region to capitalize on the continued shift to advanced manufacturing.

Innovation

Emerging technologies such as bio-manufacturing, nanotech, and additive manufacturing will improve existing production lines and open new markets to advanced manufacturers. Building expertise and capabilities in these innovations will help address metropolitan Chicago's decline of private R&D relative to other regions. It will also give the region a competitive edge in the global economy.

To establish the region as a leader in new manufacturing technologies, metropolitan Chicago can draw on its existing public R&D assets to increase technology transfer. Few regions anywhere can rival our combination of universities and national laboratories. The region is home to Northwestern University, the University of Chicago, the University of Illinois at Chicago, the Illinois Institute of Technology, and other world-class universities, which conduct basic research that can fuel manufacturing applications. Unlike many peer regions, metropolitan Chicago also houses two federal research facilities (Argonne National Laboratory and Fermi Lab) that attract top international talent. Yet the region should be more successful than it has been at commercializing the results of this research.

Spotlight Industry: Next-Generation Technology

Among several examples of next-generation technology, Chicago-based machine tool manufacturer Microlution is developing a bio-manufacturing material to block bacterial growth in hospital machinery. Applied Material and Systems Engineering in Schaumburg combines composite materials with nanotechnology that has applications for space exploration. And Biomedical Acoustics Research Company in Evanston is researching an early-detection device that measures changes in low-frequency chest wall vibrations to prevent heart failure.

LOOKING FORWARD: All three companies illustrate how emerging technologies already shape regional manufacturing activities. The cluster must continue to integrate advanced manufacturing technologies into existing production lines to outcompete other global centers.

Spotlight Technology: Nanotech

Of all its emerging manufacturing innovations, the region's nanotechnology sector may be best positioned. Based on materials with beneficial properties at the atomic or molecular scale, nanotechnology research in Illinois is ranked fourth in the entire world. These strengths are anchored by Northwestern University, as well as Argonne's Center for Nanoscale Materials, the University of Chicago's The James Franck Institute, and specializations downstate at the University of Illinois.

LOOKING FORWARD: Translating the region's nanotech research expertise into commercial innovations could help distinguish the cluster in the 21st Century. Nanotechnology has broad applications across almost every manufacturing industry, which corresponds well with the region's diverse output.

Better integrating these drivers of innovation with industry will start to address the region's challenges in restoring private R&D. While investments in basic research at universities and labs bring significant regional economic benefits, they have maximum impact when applied to commercial products that create marketplace value. Private firms also have greater incentive to invest in research when the path to commercialization is clear.

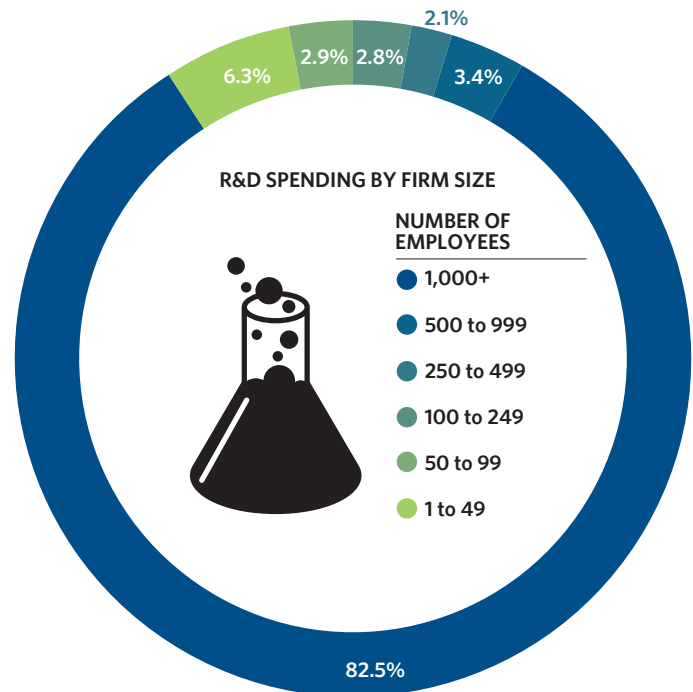
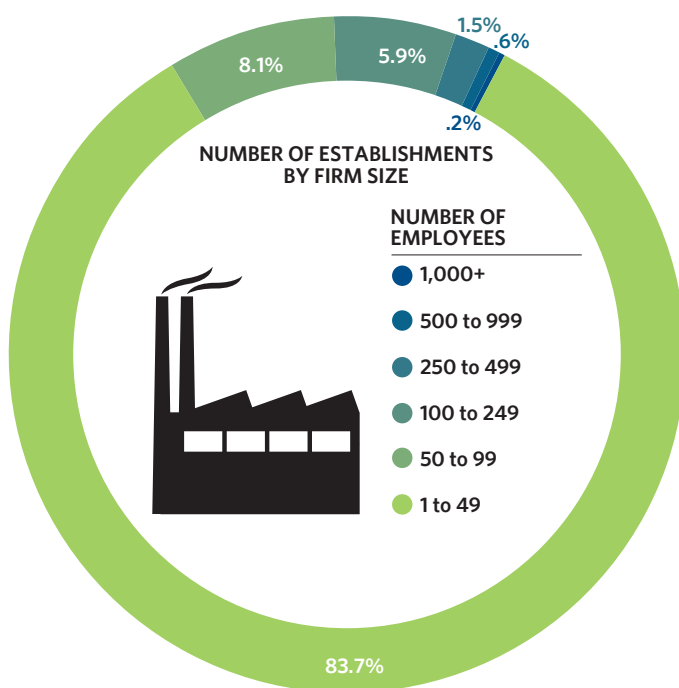
While stronger collaboration between the public and private research sectors can help spur commercialization of new technologies, the most promising technologies will also need venture capital. Overall, the region's financing firms maintain a close connection to manufacturing, but they focus primarily on scaling up operations in existing firms. By helping to secure more financing for innovative manufacturing startups, the region can ensure that novel ideas are transferred into production more frequently.

Connecting the region's smaller firms to the regional innovation system can also rebuild the cluster's R&D standing. Small firms with fewer resources are hard-pressed to incorporate, let alone stay abreast of innovations that are shaping manufacturing. In metropolitan Chicago almost 84 percent of all manufacturing firms employ less than 50 workers, yet R&D is concentrated almost exclusively in a few larger firms. The region can take steps to accelerate innovation by helping small firms adapt to advanced manufacturing.

“Investors put money in what they know. Investors here in the middle of the country have in many cases come from the manufacturing sector. They're comfortable in a manufacturing environment.”

Illinois Venture Capital Association

Manufacturing R&D spending by size of firm



Source: CMAP analysis of NSF data, 2007.

A few large firms conduct most of the cluster's private R&D even though the vast majority of manufacturing firms employ fewer than 100 workers. Overcoming this R&D gap for small manufacturers would help accelerate innovation.

Illinois Discontinued Matching Funds for Small Business Innovation Research Grants

Until 2008, the State of Illinois provided matching funds to recipients of the federal Small Business Innovation Research (SBIR) grant. This highly competitive grant sponsors small firms that have the best innovation and commercialization potential, and about 90 percent of last year's regional recipients' research had manufacturing applications. The discontinuation of the State's matching grant puts the region's cluster at a disadvantage compared to other states such as Indiana and Wisconsin that still offer such funds. Moving forward, Illinois can help support innovation by reorienting economic development strategies toward manufacturing and other clusters that account for a majority of the region's innovations.

University of Illinois Plans to Create Chicago-Based Manufacturing Institute

The University of Illinois at Urbana-Champaign (U. of I.) is renowned for its engineering, computer science, and other disciplines that relate to manufacturing. The university has taken steps recently to increase research funding and to leverage private investment for the development and application of technologies that can benefit advanced manufacturing industries. In February 2013, Governor Pat Quinn announced the creation in Chicago of an Illinois Manufacturing Lab that will combine expertise and resources from U. of I., its National Center for Supercomputing Applications, and the private sector to help enhance the competitiveness of the region's manufacturing cluster.



Next Steps to Reestablish Region as Leader in Manufacturing R&D

- Increase technology commercialization to bridge the gap between the region's basic research assets and the private market.
- Develop capabilities in emerging manufacturing technologies such as nanotech to capture the next generation of advanced products and processes.
- Augment early-stage financing opportunities for the most innovative manufacturers.
- Provide R&D support, especially for small manufacturers, to better link the majority of the cluster to the innovation ecosystem.
- Reorient economic development strategies toward the cluster to capitalize on manufacturing's dominant contributions to innovation.

Workforce

The demands on manufacturing workers have evolved dramatically. Technology continues to remake the factory floor, and advanced manufacturing requires a new generation of trained workers to meet these ever-changing needs. Skills in high demand include not only math, reading, and critical thinking, but also an understanding of materials, physics, chemistry, electrical engineering, and computer programming. Workers are charged with much more complex tasks — for example, they may need to produce components that are precise down to fractions of a millimeter or to intervene when highly complex machines malfunction.

Several important initiatives are underway to help the region's workforce acquire requisite manufacturing skills. Industry, training providers, and educators are working together to build a pipeline of advanced workers by improving the quality of science, technology, engineering, and mathematics (STEM) curricula and incorporating employers' needs into relevant credentials and coursework. For example, the City Colleges of Chicago takes a sector-based approach to provide specialized training and has designated Daley College to focus solely on advanced manufacturing.

At the same time, the region's workforce system must also prepare people already working in or just entering occupations in the cluster. Increasingly, workers can use "stackable" credentials to demonstrate mastery of specific skills that are transferable amongst firms. These industry-recognized credentials are being standardized across a number of production careers to address existing skills gaps. Promising efforts at the national level seek to identify how military specialties transfer into credentials so that veterans can demonstrate their ability to apply armed forces training to the needs of civilian manufacturing. All these developments can help ensure that our region has the manufacturing workforce necessary to meet acute and long-term workforce needs.

No two manufacturing firms are identical, so even though most manufacturers rely on cross-cutting skills like precision measuring, many also demand competence in firm-specific machinery or processes. Getting students quickly onto the factory floor through apprenticeships and internships helps to develop these job-specific skills and to build trust with the employer. Manufacturers are wary to hire even the most qualified applicant until they feel comfortable trusting that person to run multimillion dollar machines.

Apprenticeship opportunities have long been hallmarks of successful manufacturing training in other countries. In Germany, industry works closely with educators to provide workers with rigorous academic training linked to their skill-building experiences in the workplace. This type of experience also helps dispel misconceptions about the nature of advanced manufacturing, showing career paths that are stimulating, inspire life-long learning, and provide better pay than equivalent service-sector jobs. Reinstating apprenticeships to educate current students about the career opportunities in advanced manufacturing will help ensure a healthy future labor supply for the cluster.

"These aren't stereotypical factories anymore.

It's high-tech manufacturing using state-of-the-art equipment that requires good math and computer skills as well as critical thinking."

Ken Ender, President of Harper College

Sub-Regional Partnership Helps to Meet Local Industry and Workforce Needs

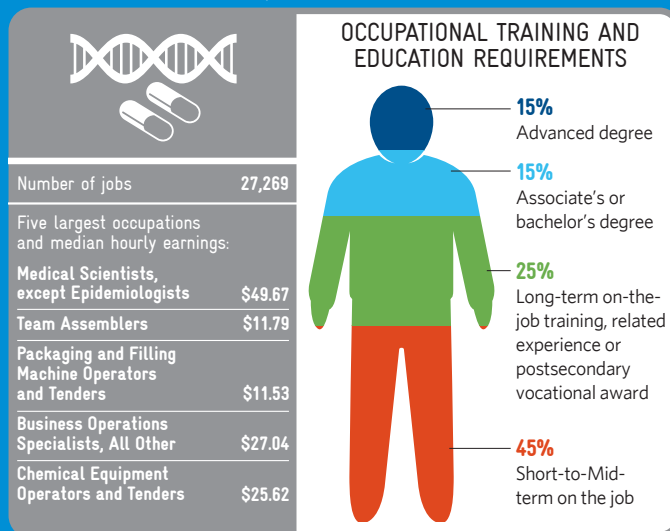
The Elgin area's robust workforce partnership matches industry need with curriculum development to improve worker training. Led by Elgin Community College, the Elgin Area Chamber, and Elgin Unified School District #46, the collaboration engages stakeholders across industry, government, and nonprofits. This has developed into a tight network in which manufacturers talk with educators about how their workforce is performing and what gaps need to be filled. This partnership demonstrates a best practice in which industry leaders engage in curriculum development to help drive training programs that ensure what students learn will be applicable in the workplace.

Spotlight Industry: Pharma/Medical Supply Occupations

Pharmaceutical/medical supply industries require a variety of technically specialized workers. Of the industry's top twenty occupations, 55 percent require long-term training, a bachelor's degree, or an advanced degree. The largest occupation, medical scientists, must hold a doctoral degree. This occupation is expected to grow 23 percent in the next ten years. Other growing occupations like biomedical engineers, psychiatric technicians, and pharmacy technicians, all require advanced degrees. In the region, research intensive firms that evolve quickly offer many opportunities for growth — for instance, Abbott Laboratories recently founded AbbVie, a biopharmaceutical company. Workers need advanced training because they must be equipped to implement and lead continuous innovation and improve products.

LOOKING FORWARD: Advanced firms and industries, like pharmaceuticals and medical supply, are poised for growth and more rapid change as they cultivate a highly skilled STEM workforce that can utilize new processes, materials, and use the vast amounts of data now readily available to innovate and flourish.

PHARMA/MEDICAL SUPPLY



Note: For 20 largest occupations in regional firms.
Source: EMSI Covered Employment - 2012, CMAP analysis.



Next Steps to Train the Advanced Manufacturing Workforce

- Strengthen and scale-up coordination between industry, educators, and training providers to match skills development with industry needs.
- Increase STEM attainment and prepare students for high growth occupations.
- Improve pathways into jobs and apprenticeships to build trust between employers and lower-skilled workers.
- Plan for the workforce on subregional and local levels to tailor services towards local industries, institutions, and workers.

Infrastructure

Transportation infrastructure remains vitally important for manufacturers in metropolitan Chicago. Even in today's globalized economy, most manufacturing flows still are regional: Half of all manufactured goods in the U.S. move less than 50 miles, underscoring the importance of regional supply chains. And in advanced manufacturing, regional supply chains will likely play an even more prominent role, as firms increasingly specialize in niche markets. In interviews with CMAP, regional manufacturing firms stressed how transportation infrastructure allows complex regional supply-chain moves, grants access to distant export markets, and gets skilled workers to the factory, yet they also noted how congestion threatens to undermine current transportation advantages. Like other parts of the country, the region is finding it more difficult to finance infrastructure improvements. Moving forward, it must continue to invest in the transportation system that has been a source of growth and competitive advantage for the manufacturing cluster and overall regional economy.

While all regions face challenges financing transportation infrastructure, metropolitan Chicago can take proactive steps to preserve its status as a global freight and transportation hub. GO TO 2040 recommends targeted strategies that include prioritized investments, innovative financing, and improved freight governance. First, the region needs to invest strategically in major capital projects that have the greatest benefits for regional mobility and accessibility. For example, the Elgin-O'Hare Western Access would improve throughput and reliability on corridors serving the region's major manufacturing and freight centers. Prioritized investments can be supported by innovative financing such as congestion pricing that builds regional revenue yet also helps manage traffic and gives drivers more choice. Finally, system coordination can be improved through freight governance to guide investments and reduce redundancies in the system.

“Between a quarter and a third of all freight tonnage in the U.S. originates, terminates, or passes through the Chicago Region.”

CMAP Freight Cluster Drill-Down

Spotlight Industry: Rail Engine Manufacturers

Fifty percent of all the nation's rail traffic moves through the Chicago region. Supporting this impressive freight flow is an extensive infrastructure system — metropolitan Chicago is the only region served by six of the seven major railroads, and its intermodal terminals also grant access to seven interstate highways and the nation's second busiest international cargo airport. The region's rail engine manufacturing industry complements this existing infrastructure. The industry has 87 percent more regional workers than would be expected given the national average, growing eight percent in the last decade. Kane County has a particular concentration in the industry given its population size.

***LOOKING FORWARD:** Future growth in engine and other rail components seems likely as fuel prices continue to fluctuate and more high-speed rail projects move forward.*

In addition to transportation, the region must address land use to make better use of infill stock and reevaluate zoning mechanisms that could promote new advanced manufacturing. CMAP estimates that over 184,000 acres of underutilized land near existing transportation infrastructure is poised for infill development. Since much of this land benefits from existing transportation connections, it could be highly valuable for manufacturers looking to take advantage of the region's location.

Cook County also presents its own unique challenge for industrial investment, because it is the only county in the state that assesses commercial and industrial properties at a percentage of market value higher than residential properties' percentage. As a result, municipalities in Cook County have much higher effective property tax rates for industrial properties, creating a regional discontinuity in development patterns.

Finally, manufacturing still consumes more energy in Illinois than any other sector does. Particularly in energy-intensive industries such as smelting or refining, the cost and availability of energy can be a large factor of profitability. Illinois has a slightly higher cost of key energy sources delivered to industry compared to the national average. Firms can respond by increasing energy efficiency. Combined heat and power (CHP) cogeneration systems transform heat that most systems waste into useful energy and also reduce energy lost in transmission. The state's potential for industrial CHP systems totals four times the current installed capacity. Moving forward, manufacturing firms could utilize that potential to increase energy efficiency and reliability.

Private Firms Increase Energy Efficiency

Unlike traditional power plants, combined heat and power (CHP) systems transform the heat created during power generation into useful energy. CHP systems also improve efficiency by generating onsite, eliminating the energy lost through distribution. Regional firms have used CHP to not only save money but also improve reliability. The steel giant ArcelorMittal, for example, installed a CHP system at its East Chicago plant, using the heat from North America's largest blast furnace to produce more annual energy than all the existing wind turbines in Illinois and Indiana combined. In South Elgin, Hoffer Plastics' CHP system ensures that their production will continue, even if the overall grid is down. This security gives the firm an edge over competitors and helps reassure prospective clients that orders will always be met on-time.



Next Steps to Enhance Competitive Advantage in Infrastructure

- Make strategic investments in the region's transportation infrastructure, implement congestion pricing and innovative financing, and improve freight governance to preserve the region's locational advantage.
- Encourage infill growth in areas served by existing transportation assets to maximize existing land availability.
- Phase out Cook County property tax assessment classification on industrial/commercial properties to address this regional discontinuity in taxation.
- Incentivize CHP systems to increase energy efficiency.



Conclusion

Manufacturing is and must continue to be a thriving component of the region's broad economy. While global offshoring may have characterized the last ten years of American manufacturing, the next ten could instead be defined by reinvestments in domestic clusters. Supply-chain vulnerabilities, exacting quality requirements, accelerated shifts in consumer demand, and rising international labor costs have eroded prior cost advantages of producing overseas, leading some production to return. Nurturing the type of advanced manufacturing that leverages metropolitan Chicago's competitive advantages will best position the region to benefit from this manufacturing moment. Achieving a balance of private and public solutions to innovation, infrastructure, and workforce challenges will be the key to maintaining metropolitan Chicago's status as a leader in modern manufacturing and global commerce in the 21st century.

CMAP has prepared a companion technical document that provides further details and documentation supporting the conclusions of this report. Please see <http://cmap.illinois.gov/policy/drill-downs/manufacturing>.



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The Chicago Metropolitan Agency for Planning (CMAP) is the region's official comprehensive planning organization. Its GO TO 2040 planning campaign is helping the region's seven counties and 284 communities to implement strategies that address transportation, housing, economic development, open space, the environment, and other quality of life issues.

See www.cmaphillinois.gov for more information.