



Nebraska MANUFACTURING Competitiveness

*Prepared for the Nebraska Chamber Foundation by Economic Leadership
January 2024*





Fellow Nebraskans,

As we prepare for the next decade, strengthening and advancing Nebraska's economy starts with identifying the new challenges and opportunities facing our state, with the ultimate goal of ensuring Nebraska's competitiveness and success. This effort must be driven by facts and informed by data.

The Nebraska Chamber Foundation is committed to non-partisan research advancing economic growth in Nebraska. We have created an on-going steering committee of 40+ business leaders from across the state. These forward-looking individuals will help identify the issues Nebraska's economy and communities face and anticipate. From there, the Foundation will work to make sure there is more meaningful data in order to define the issues and identify solutions that will move the needle.

Our inaugural studies set the stage for where Nebraska's economy stands and they provide data and analysis that will help Nebraska lead the effort to strengthen our economy in their own communities and regions.

These 2024 studies can be found at www.nechamber.com/foundation and include:

- **Nebraska Economic Competitiveness Assessment** - which measures Nebraska's economic standing with peer states
- **Nebraska Manufacturing Competitiveness** - which provides an industry breakdown of one of Nebraska's top performing industries
- **Immigration and America's Workforce Shortage: A Nebraska Challenge in Need of a National Solution** - which defines Nebraska's workforce shortage and outlines the opportunities posed by legal immigration reform

It is our hope that Nebraska leaders will collaboratively leverage the data found in these studies to find regional and statewide solutions to ensure that we strengthen and grow our economy for years to come.

Sincerely,



Tera Norris
President
NE Chamber Foundation

Thank you to our NE Chamber Foundation INVESTORS



Nebraska Manufacturing Competitiveness Report

January 2024

Introduction

This report focuses on a key segment of Nebraska's economy: manufacturing. This sector provides a \$20 billion annual contribution to the state's gross domestic product (GDP), representing 12 percent of total state GDP as well as ten percent of all non-farm employment. Manufacturing is important in all regions of the state, with 17 counties having 1,000 or more people employed in the industry.

Nebraska is ranked as having the nation's 11th strongest manufacturing environment in Economic Leadership's 2023 competitiveness index, with its greatest relative strength in the area of workforce.



However, the state faces significant barriers to growth during the global shift to Industry 4.0, or advanced manufacturing. The state's manufacturing sector is characterized by a chronically tight labor market with concerns over "not enough people" as well as those with the needed technical and mechanical skills. Manufacturing leaders in the state also worry about falling behind in the movement to automate and increase productivity. Barriers to automation and innovation include access to capital, strategic expertise, and workers trained to interact with new and emerging technologies. Smaller firms and those located outside of the major metro areas have a particularly hard time identifying appropriate resources.

Despite the state's success in manufacturing, the competition around the United States and the globe is formidable. Nearby competitor states like Utah, Idaho, and Texas are experiencing stronger population growth and receive higher marks for their innovation environment.

This report analyzes Nebraska's strengths and weaknesses in manufacturing and identifies the primary challenges to greater success in advanced manufacturing. It recommends a targeted set of strategies to increase Nebraska's competitiveness, which will improve prospects for businesses across the state, add quality job opportunities, and increase prosperity for state residents.

This report augments the Nebraska Competitiveness Assessment and includes additional data specific to manufacturing. Taken together, the reports provide a more complete picture of overall manufacturing competitiveness in the state.

What is Advanced Manufacturing?

The website *manufacturing.gov*, produced by the Advanced Manufacturing National Program Office in Maryland, defines advanced manufacturing as the:

“Use of innovative technologies to create existing products and the creation of new products. Advanced manufacturing can include production activities that depend on information, automation, computation, software, sensing, and networking.”ⁱ

The manufacturing supplier information firm, Thomas, writes that this definition is “intentionally vague,” because what constitutes advanced manufacturing can differ from one subsector to another.ⁱⁱ Thomas suggests that traditional manufacturing uses mechanized and manual fabrication techniques to transform raw materials into finished products, especially in well-established subsectors like steel and automotive production.

Even then, it says that high-tech equipment in those fields has “muddied the waters” between traditional and advanced manufacturing. Advanced manufacturing is more dependent on cutting edge research and development, the skill sets of workers, and



production that is more dynamic, flexible, and customized. Advanced manufacturing is also closely associated with industries such as aerospace, medical devices, electric vehicles, and pharmaceuticals.ⁱⁱⁱ

Economic development consultant Camoin Associates lists some of the important differences between traditional and advanced manufacturing in the adjoining table.^{iv}

The goal of advanced manufacturing – sometimes known as Industry 4.0 – is to produce goods or services that are of better quality, more customized for the user, built faster, and/or at a lower cost. Put simply, it should make a manufacturing business more competitive. Thomas believes that advanced manufacturing could help level the playing field between small and large companies, with success

Characteristic	Traditional Manufacturing	Advanced Manufacturing
Production Strategy	Mass production	Customer-focused, customized
Labor Supply Needs	Abundant labor	Supply of skilled, technical labor
Skill Requirements	Unskilled, semi-skilled	Semi-skilled and technical skills
Education	High school, vocational school, On-the-job training	College technical degree
Labor Force Ratios	3 semi-skilled workers per 1 skilled worker	4 skilled workers per 1 semi-skilled worker
Production Technologies	Casting, welding, molding, machining	3D printing, robotics, laser welding, nanotechnology
Innovation & Investment Focus	Invest in production	Re-invest revenues into R&D

more dependent on system design using the latest technologies, rather than the number of employees or volume of manufacturing space.

In addition to the production technologies listed in the chart above, other technologies that are being adopted by advanced manufacturers include the following:

- **Big Data Processing and Analysis:**
Analyzing large amounts of data in order to better understand the customer (and alter products or services accordingly), monitor product quality, adjust workflows, and more
- **Artificial Intelligence (AI) and Machine Learning:**
To automate aspects such as machine maintenance, quality control, and inventory control

- **Internet of Things (IoT):**
Using sensors and software to provide real-time feedback throughout the product development and manufacturing processes
- **Augmented Reality (AR):**
AR has applications in product design (to review design issues even before prototype development), quality control and testing, and employee training
- **Advanced Materials:**
Composites, or blends of materials used for specific purposes and to improve product performance. These include blends of ceramics, glass, plastics, metals, and others.^v

Advanced Manufacturing Challenges in the United States and Nebraska

Despite recent trends, such as the reshoring of manufacturing operations to America since the COVID-related manufacturing shutdowns in China, it is generally acknowledged that the U.S. has much work to do to reclaim leadership status in this sector. In a fall 2023 article by David Adler and William Bonvillian, they argue that there has too long been a disconnect between research, innovation, and the actual production of hard goods. Innovation has been robust in software, I.T., and biotech. But when there are ideas for new physical goods, these have been outsourced to other countries for production. Adler and Bonvillian claim that the U.S. must now “shift to advanced manufacturing methods to get the kind of productivity and efficiency gains needed to compete....”^{vi}

There are many hurdles to overcome to reconnect innovation with manufacturing. At least two of the greatest challenges can be affected at the state and local levels, and these are summarized below:

1. Workforce Education and Training

Compared to Germany, America has a “broken workforce-education system, with a deep disconnect between the education system and workplaces.”^{vii} To rebuild this connection, all players must change. Community colleges should adopt more advanced manufacturing curricula, offer more short-term programs to upskill existing workers, offer stackable certificates around specific skills that build toward degrees, and improve low completion rates. The federal government should accelerate efforts to expand registered apprenticeships. Manufacturing firms must “collaborate with each other and with community colleges to build new training and apprenticeship programs, including youth apprenticeships starting in high school.”^{viii} Public K-12 schools must strive to offer much more career awareness and work experience opportunities for their students, in cooperation with regional industries.

2. Financing for Manufacturing to Scale Up

Venture capital has been critical for scaling up innovation in service industries and biotech, but it is largely absent from “hard tech” – innovations that are manufactured.

As a result, much work in prototyping and production occurs in China and other foreign nations. This has led to the share of “young” manufacturing firms (less than five years old) in the U.S. steadily declining over the past three decades. State support for manufacturing venture capital and scale-up of innovative product makers could provide an important missing piece in the chain that connects innovative design to large-scale production.^{ix}

Thoughts on the Future of Advanced Manufacturing

The World Economic Forum developed *The Future of Manufacturing* series in 2023, with advanced manufacturing leaders from across the globe contributing their input on key topics. Among their thoughts that are applicable to the challenges facing Nebraska manufacturers:



- Jay Lee, director of the Industrial AI Center at the University of Maryland, highlights the importance of bridging the gap between promising technologies and actual implementation in manufacturing. He stresses that there needs to be a clear purpose when adopting new technologies. What is the specific challenge to be addressed? It could be improving product quality, production efficiency, or supplier integration. Innovation that maximizes the value of technological advancements requires “strategic planning, collaboration, and continuous improvements.”^x
- Kathy Wengel of Johnson & Johnson emphasizes that the key to improving operational efficiencies is “the human and automation interaction.” For example, shop floor employees should be engaged to improve manufacturing processes. “Factory operators know the best flow across the organization, so their input and engagement in designing the technology are integral for successful deployment.”^{xi}

To help manufacturers benchmark their readiness and their progress in adopting the advancements of Industry 4.0, the World Economic Forum promotes the use of the Smart Industry Readiness Index, or SIRI. The SIRI assessment has already been used by 850 manufacturing firms in 30 countries. Manufacturers can find details on using SIRI [here](#).

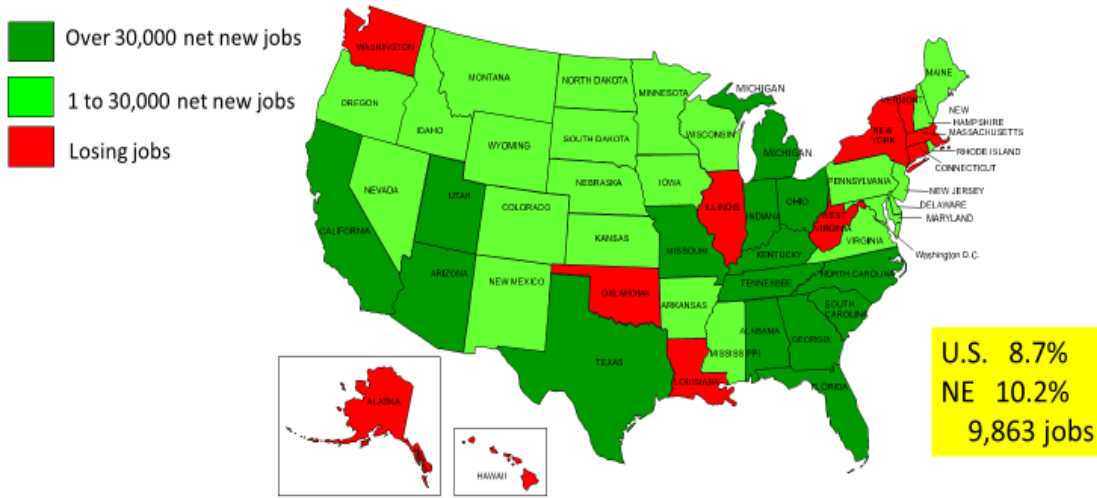
Nebraska Manufacturing by the Numbers

This section examines data to provide a current picture of manufacturing in the United States and in Nebraska. It illustrates historical patterns, describes the recent past and current status, and projects future industry trends as well.

Total manufacturing employment peaked in America in 1979 at nearly 20 million workers. As of fall 2023 that total is about 34 percent lower, with U.S. manufacturing employment hovering at just under 13 million. Despite that long decline in employment, manufacturing GDP continues to rise, and it remains a key sector of the U.S. economy. In Nebraska, manufacturing contributes about \$20 billion annually to state GDP, responsible for 12 percent of state GDP, as well as ten percent of the total non-farm employment.

After the financial crisis and Great Recession from 2008 to 2010, American manufacturing experienced a resurgence in hiring. The last ten years have seen a nearly nine percent increase in manufacturing jobs across the nation, and a gain of more than ten percent in Nebraska.

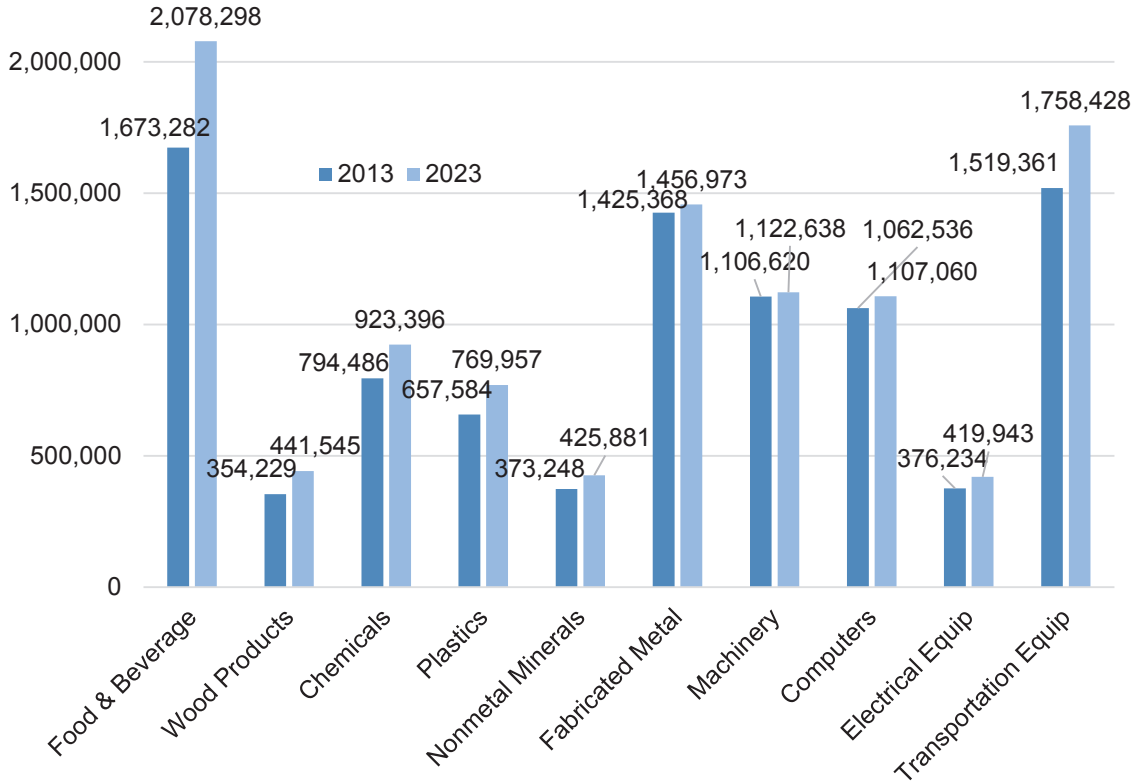
Change Manufacturing Jobs 2013-2023



Lightcast 2023.3

Certain subsectors have been responsible for much of this growth. Food and beverage processing has boomed, adding over 400,000 net jobs nationally. Transportation equipment has also seen significant hiring gains.

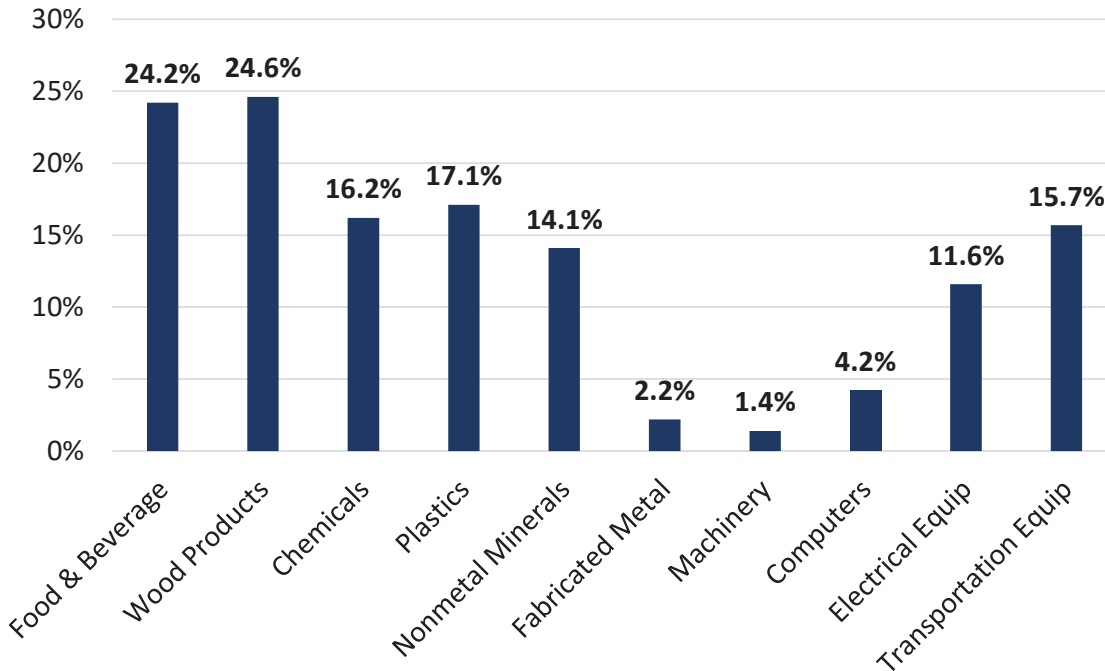
U.S. Manufacturing Jobs 2013 & 2023



Source: Lightcast 2023.3

The following chart shows these 2013-2023 job gains by percentages.

Growth in U.S. Manufacturing Jobs 2013-2023

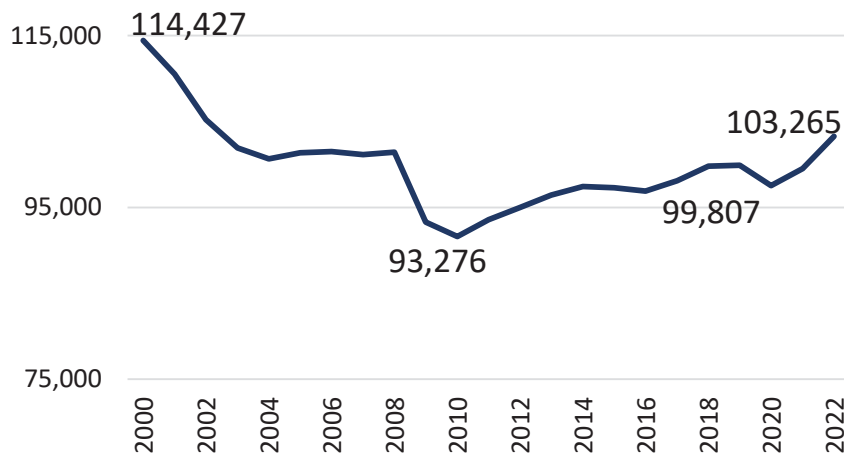


Source: Lightcast 2023.3

Nebraska also saw a significant uptick in manufacturing employment after the Great Recession, adding about 10,000 jobs since 2010.

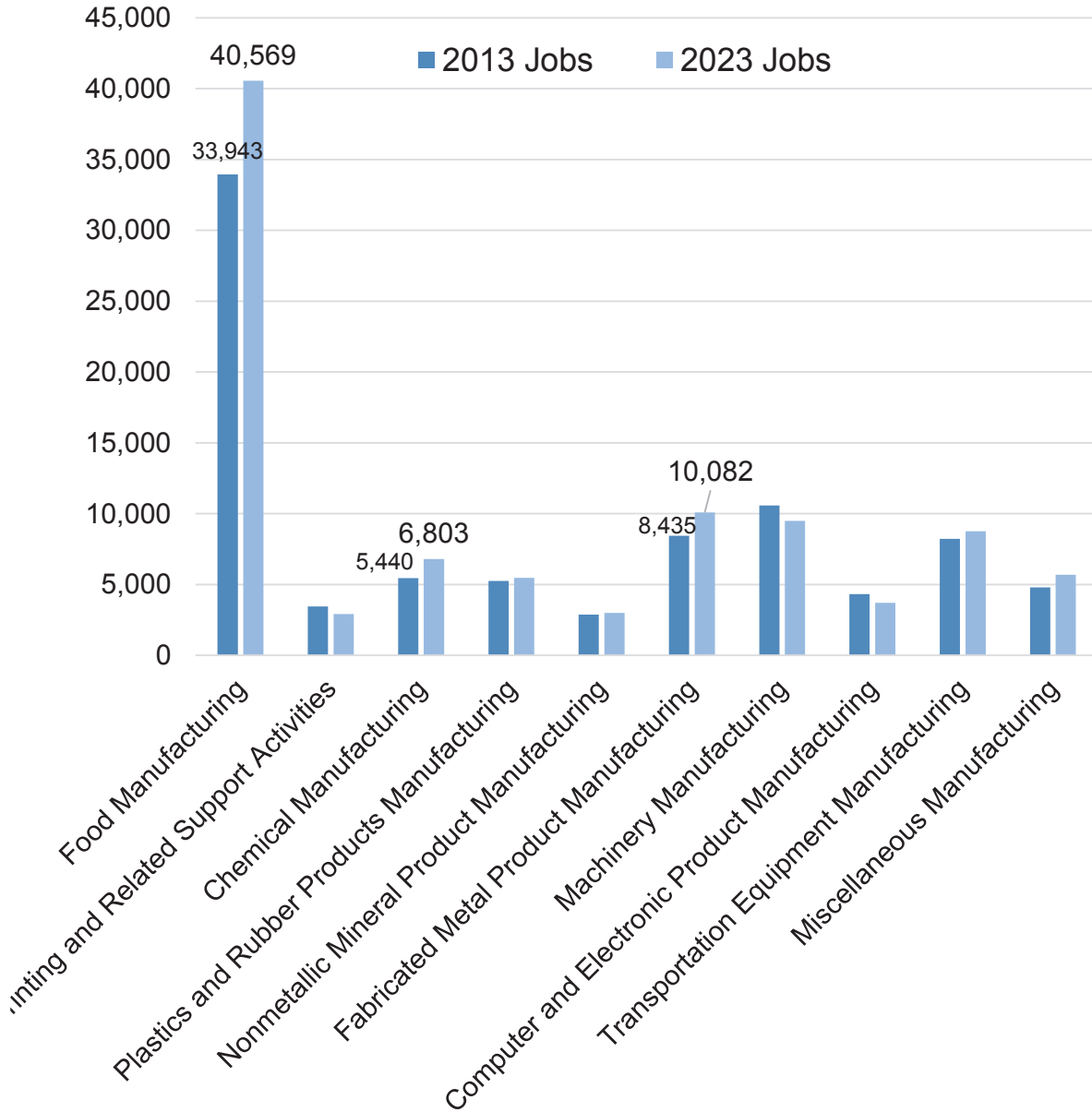
Similar to national trends, the state has experienced robust hiring in the food production segment. However, several other subsectors have seen strong gains, including chemicals and fabricated metal production.

NEBRASKA MANUFACTURING JOBS



Source: US Bureau of Labor Statistics QCEW

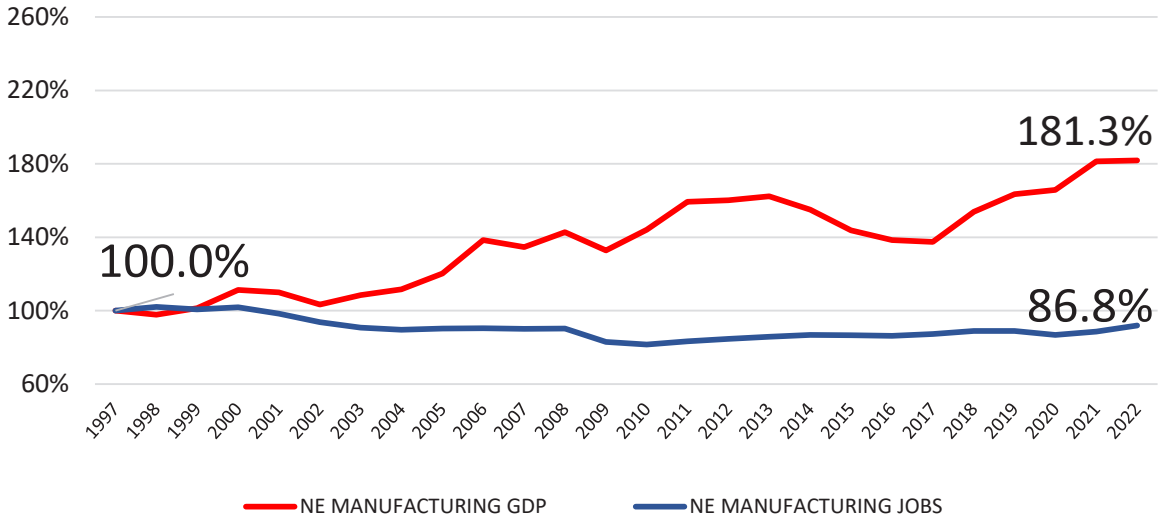
Nebraska Manufacturing Employment 2013-2023



Source: Lightcast 2023.3

Over the long term (since 1997), the increased productivity of U.S. and Nebraska manufacturing is illustrated by the great growth in its contribution to GDP despite lower employment levels. In the last 25 years, Nebraska manufacturing GDP has risen by more than 80 percent, while job levels have decreased by 13 percent.

Nebraska Manufacturing Jobs and Manufacturing GDP Growth
1997 – 2022 (normalized as percent of levels in 1997)



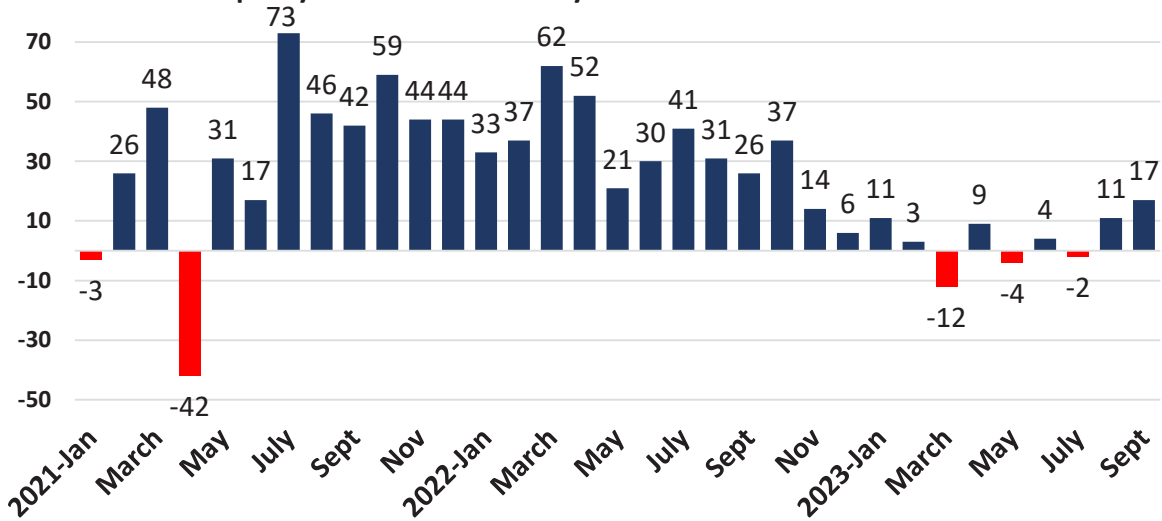
Source: US Bureau of Labor Statistics QCEW and US Bureau of Economic Analysis

The pandemic-related economic shutdowns in 2020 had a stunning impact on American manufacturing. Demand for goods and U.S. manufacturing activity surged for at least two reasons. First, the shutdowns meant that most consumers were unable to spend on services, dining, entertainment, and travel and thus shifted spending to goods; and second, supply chain bottlenecks in China and elsewhere generated renewed interest in locating more manufacturing capacity in the United States.

In the spring of 2021, the ISM Manufacturing Purchasing Managers Index (ISM Manufacturing PMI) hit a recent high of 64.7 percent. This PMI indicated manufacturing sector expansion for 28 consecutive months before starting a downward trend around November 2021. The November 2023 reading of 46.7 percent was the 13th consecutive month showing manufacturing sector contraction (indicated by an index below 50.0 percent). Hiring patterns since 2021 follow a similar trend, demonstrating impressive rates of hiring until late 2022.

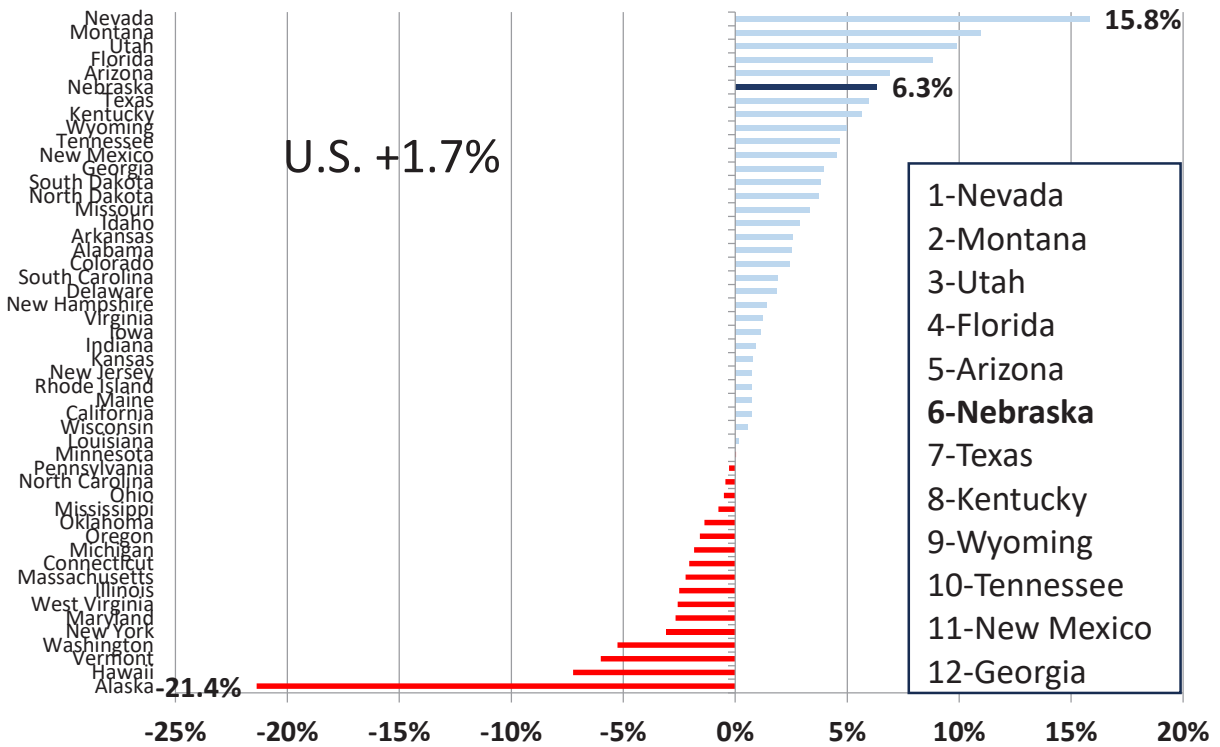
Nebraska has been a leading state for manufacturing job growth over the last three years, with the nation’s sixth highest percentage increase. Strong growth of over six percent in Nebraska is only exceeded in percentage growth by Nevada, Montana, Utah, Florida, and Arizona. The average wage across all jobs in the manufacturing industry is approximately \$78,500 in Nebraska, about 20 percent lower than the national average.

U.S. Manufacturing Nonfarm Payroll Employment Monthly Growth in Thousands



Source: US Bureau of Labor Statistics

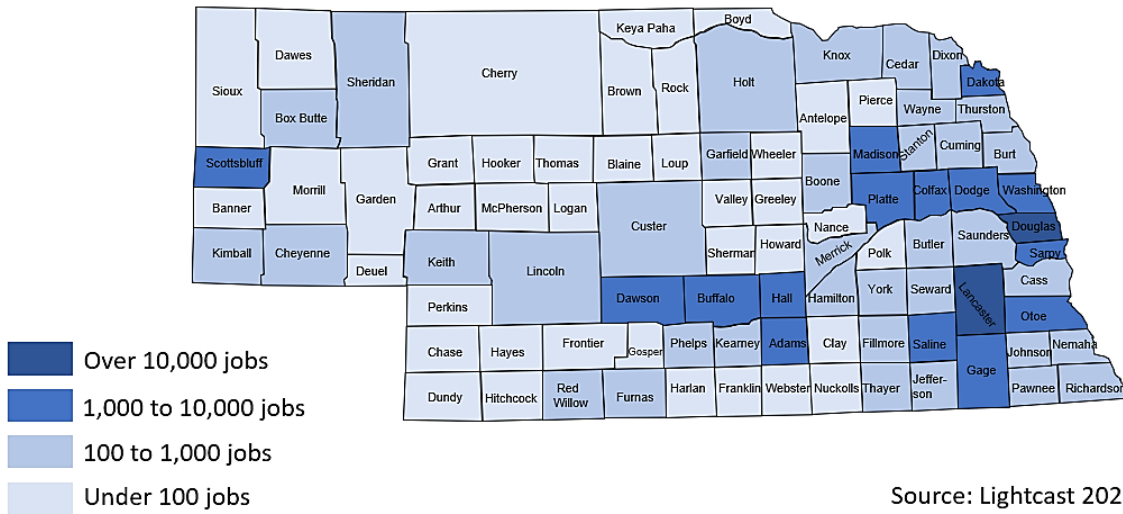
All States Since the Start of Covid Total Manufacturing Employment Percentage Change Feb 2020 - Aug 2023



Source: US Bureau of Labor Statistics

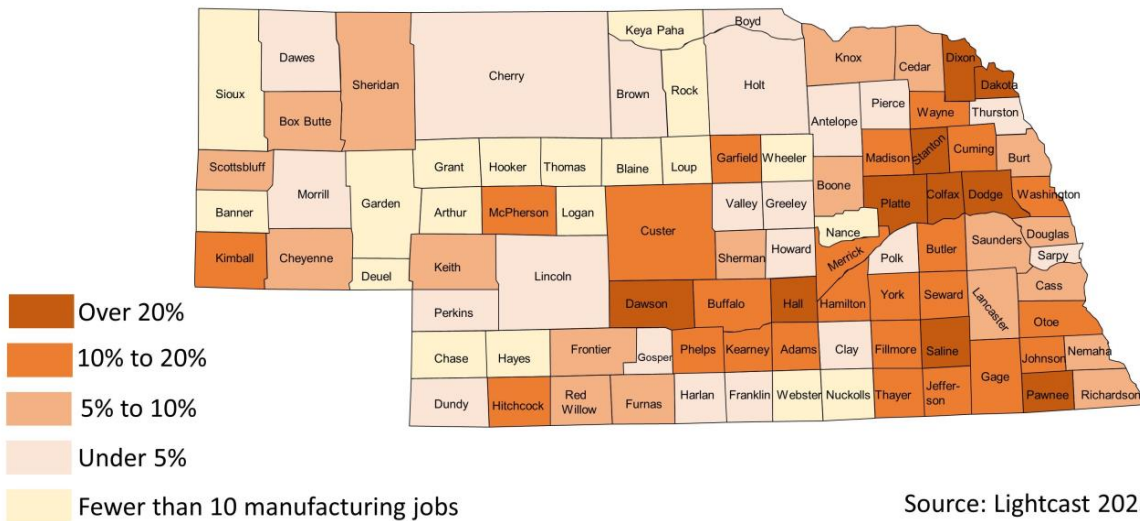
Currently, Nebraska enjoys fairly widespread distribution of manufacturing activity (as shown here by employment) across the state. Seventeen counties have at least 1,000 people employed in manufacturing.

Manufacturing Jobs 2022



Looking at manufacturing employment as a percentage of total county employment shows the importance of this sector across the state. Manufacturing jobs represent greater than 20 percent of all employment in ten Nebraska counties, and at least ten percent of all jobs in 24 additional counties.

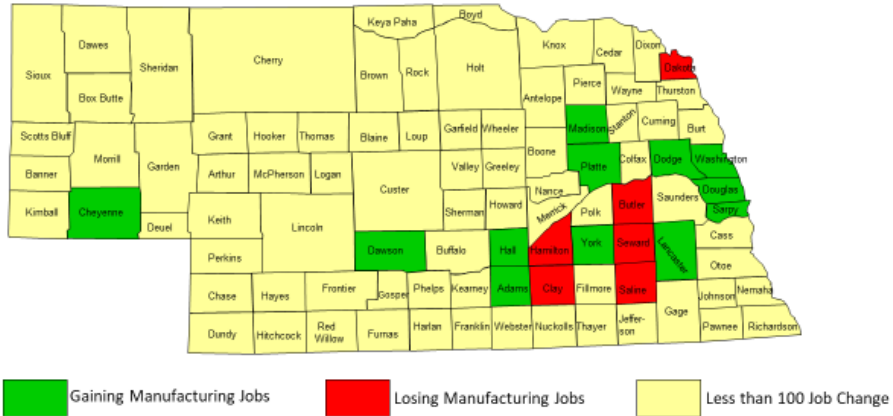
Manufacturing Jobs as Percent of Total Jobs 2022



Nebraska Manufacturing Competitiveness

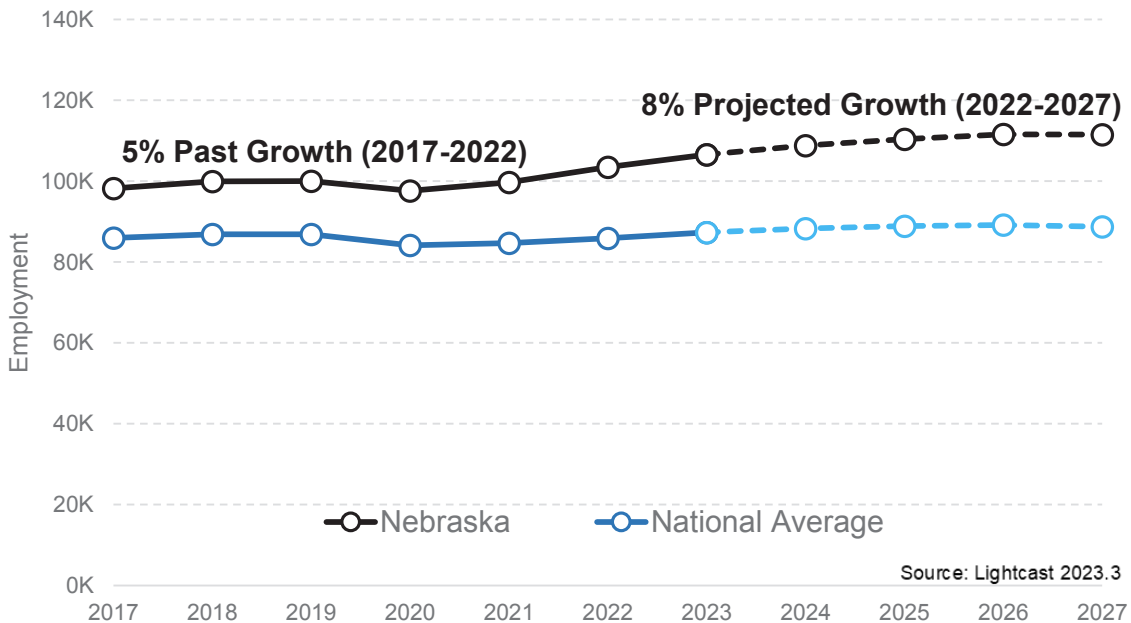
Over the last five years, manufacturing job growth has been somewhat more concentrated, with 12 counties gaining a significant number of jobs.

CHANGE IN MANUFACTURING JOBS 2017 - 2022 Nebraska state average 5.3%



Source: Lightcast 2023.3

The state's recent manufacturing employment growth has been above the national average, and this trend is projected to continue, and grow, in the next five years.

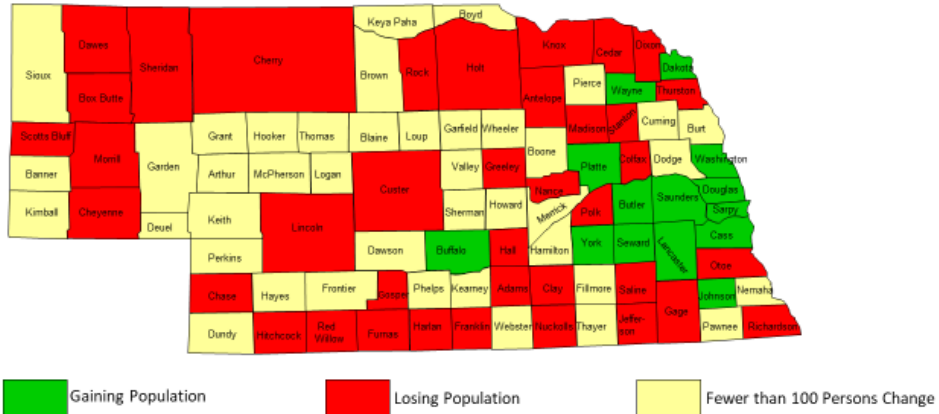


Source: Lightcast 2023.3

Nebraska Manufacturing Competitiveness

Despite a very tight labor market, Nebraska at least has positive growth in its working age population, with a slight increase of 1.5 percent in recent years. However, those gains were highly concentrated with only 14 counties growing working age population, while 38 counties had a loss.

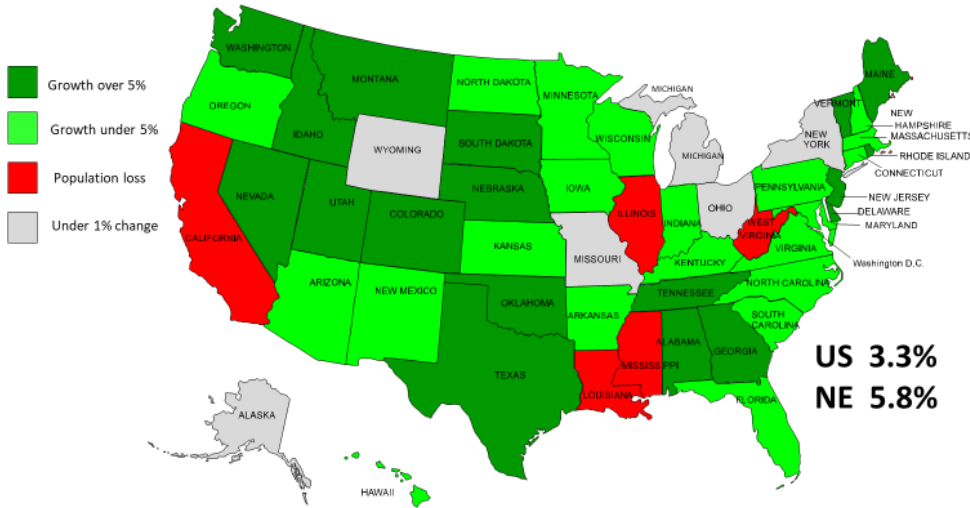
CHANGE IN WORKING AGE POPULATION AGES 25-64 2017 - 2022 Nebraska state average 1.5%



Source: Lightcast 2023.3

Projections for the next ten years are for Nebraska to grow the working age population by more than the national average, though less than several competitor states.

Projected Population Change 2022–2032 Ages 25-64

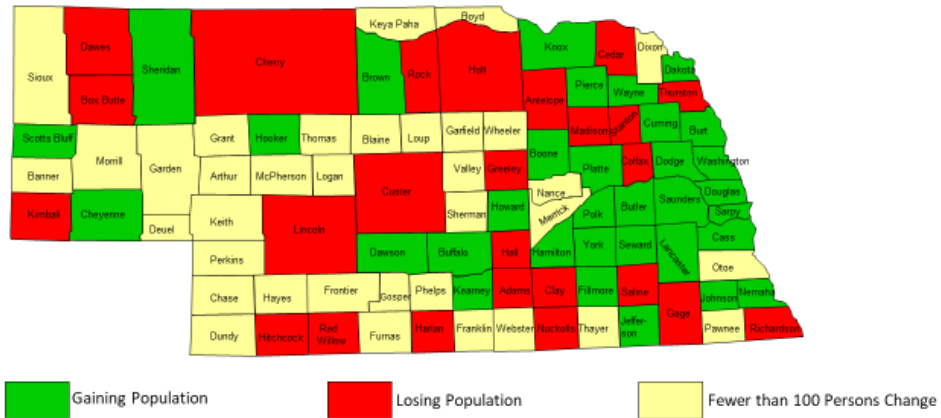


Sources: Lightcast 2023.3

Nebraska Manufacturing Competitiveness

However, conditions are again expected to vary widely across the state. Data provider Lightcast forecasts 32 counties in Nebraska to add working age population while 25 counties see declines. The remaining counties will have stable working age populations.

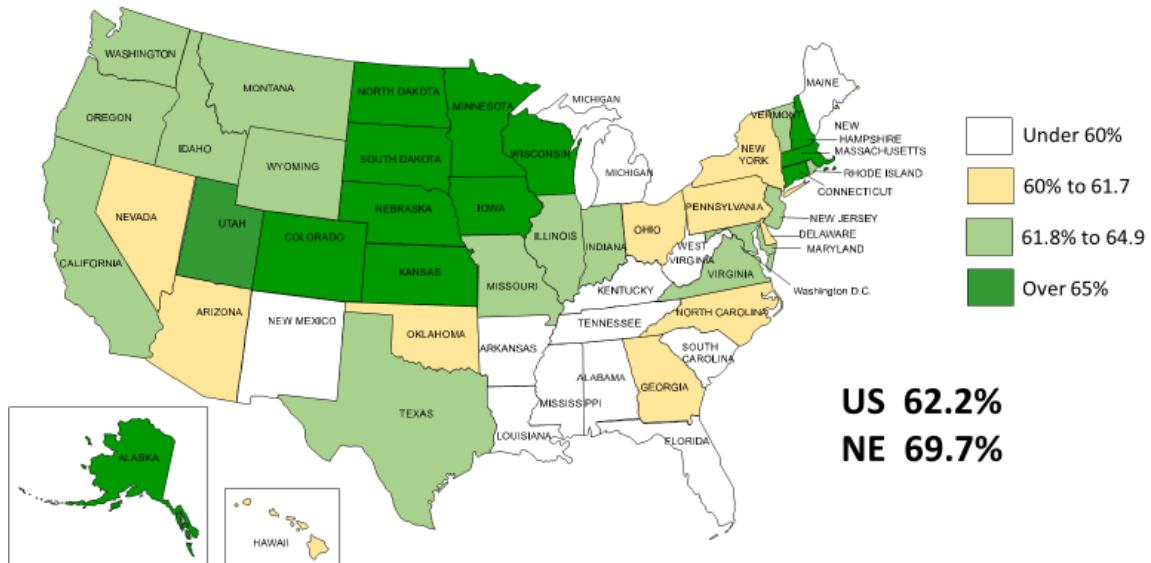
PROJECTED CHANGE IN WORKING AGE POPULATION AGES 25-64 2022 - 2032 Nebraska state average 5.8%



Source: Lightcast 2023.3

Another workforce positive for Nebraska is the labor force participation rate, which at nearly 70 percent is one of the highest in the country.

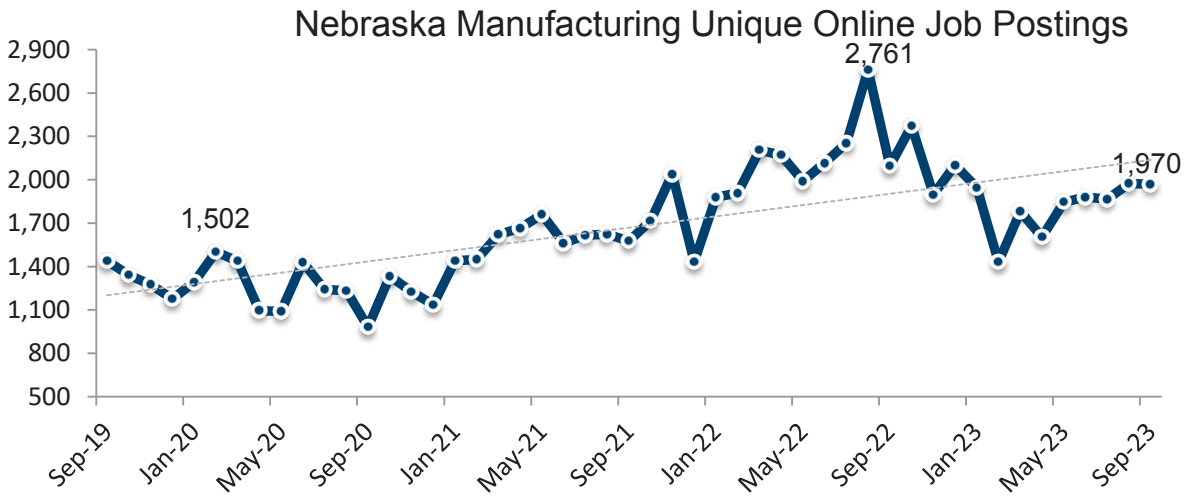
Labor Force Participation Rate 2022



Source: US Bureau of Labor Statistics

Many states have programs to encourage adults that are not in the labor force to seek employment. Nebraska’s high participation rate means that there are relatively few disengaged, untapped adults to attract into the workforce and into manufacturing.

Combined with slow and uneven population growth, this has created chronically tight labor conditions for Nebraska’s manufacturers. In the past 12 months, the average number of online job postings for manufacturing positions in the state was 23 percent higher than the national average. While the number of postings came down in 2023, they are still above the pre-pandemic level. Unemployment levels for manufacturing workers also remain at historic lows.



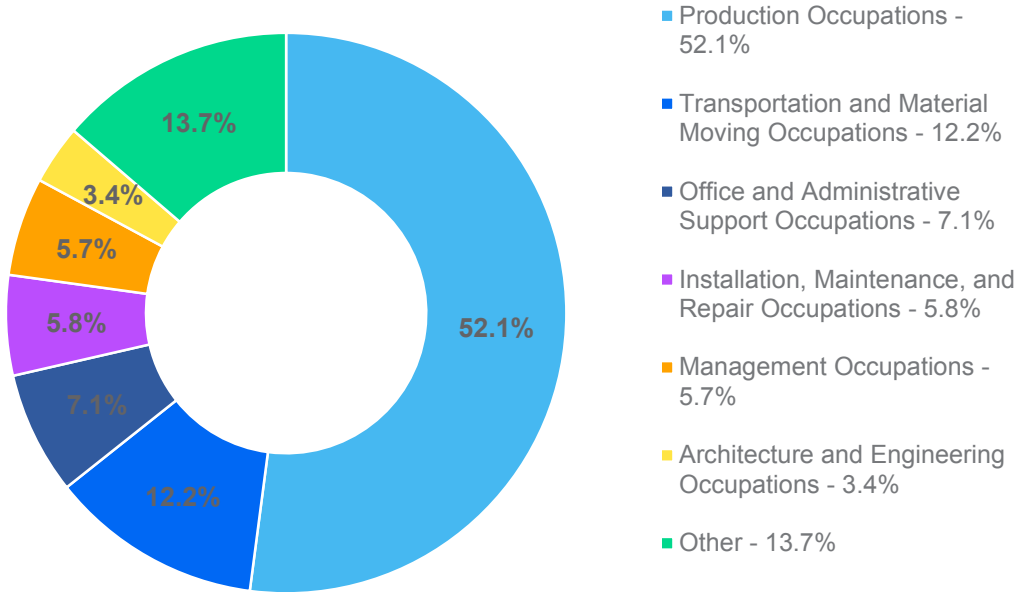
Source: Lightcast 2023.3



Source: Lightcast 2023.3

What is the composition of the manufacturing workforce, and are there opportunities to reach groups that have been under-represented? First, we look at the workforce by occupation. More than half of all manufacturing workers are in production (52%), followed by those in transportation and material moving (12%) and office support (7%). Critical jobs in maintenance and repair make up about six percent of all occupations.

Nebraska Manufacturing Industry Occupations, 2022



Source: Lightcast 2023.3

Over the last 12 months, the manufacturing job titles in the state with the most unique online job postings have been these:

- Maintenance Technicians
- Equipment Mechanics
- Machine Operators
- Service Technicians
- Material Handlers

The skills most often sought in online postings in 2022 and 2023 include the following:

- | | | |
|------------------|----------------------|----------------------------|
| • Forklift Truck | • Project Management | • Hand Tools |
| • Marketing | • Warehousing | • Food Safety & Sanitation |
| • Auditing | | |

Below are the leading specific (five-digit) occupations in Nebraska manufacturing as of 2022. The chart shows job changes over the past five years, with big gains for material movers, slaughterers and meat packers, maintenance and repair, and shipping and receiving. Median hourly wages ranged between \$17 and \$29 per hour.

Top Occupations in the Nebraska Manufacturing Industry

Occupation Name	Employed in Industry (2022)	Job Change (2017 - 2022)	Median Hourly Earnings	% of Total Jobs in Industry (2022)
Meat, Poultry, & Fish Trimmers	5,095	-3,770	\$20	4.9%
Material Movers by Hand	4,950	+2,070	\$17	4.8%
Assemblers and Fabricators	4,590	-45	\$18	4.4%
First-Line Production Supervisors	4,330	+290	\$29	4.2%
Slaughterers and Meat Packers	3,500	+1,730	\$19	3.4%
Packaging Machine Operators	3,370	+280	\$18	3.3%
Welders	2,840	+90	\$22	2.7%
Inspectors, Testers, & Weighers	2,660	-370	\$22	2.6%
Maintenance and Repair, General	2,470	+950	\$21	2.4%
Sales Reps	2,020	-20	\$29	2.0%
Shipping & Receiving Clerks	1,980	+810	\$18	1.9%
Heavy Truck Drivers	1,830	+250	\$28	1.8%

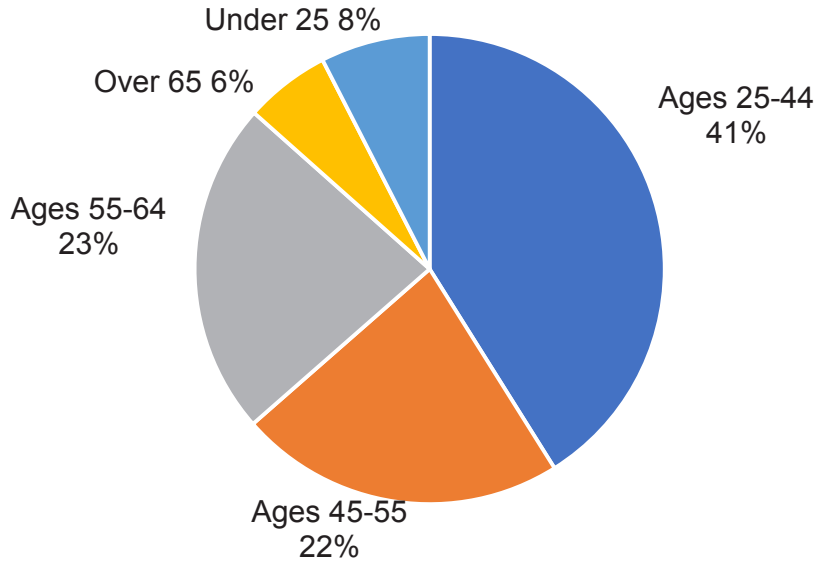
Source: Lightcast 2023.3

When evaluating the workforce by age, there is the concern that 29 percent of workers are 55 and older. However, an impressive 49 percent are age 44 or younger. The worker retirement risk in Nebraska is about nine percent lower than the national average.

By gender, 69 percent of the state's manufacturing workforce are men and 31 percent are women.

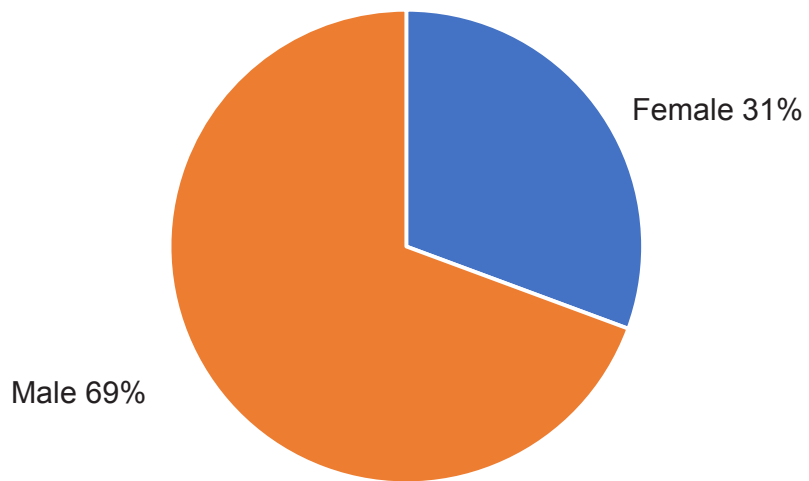
In recent decades the total number of women in manufacturing peaked in 2001, though it is approaching that level again now. In recent national surveys, women indicate that the two biggest issues limiting their participation in manufacturing are the need for schedule flexibility and childcare concerns.

Nebraska Manufacturing Jobs by Age, 2022



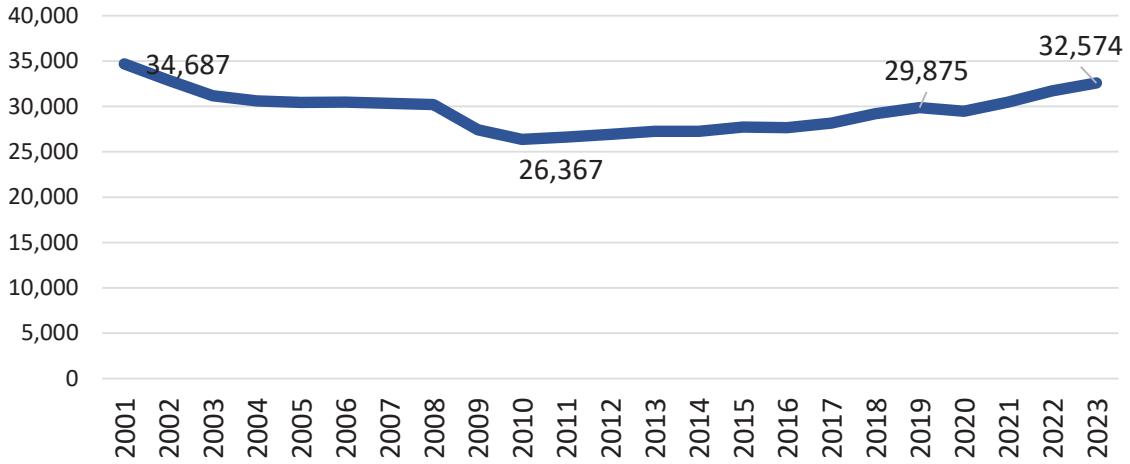
Source: Lightcast 2023.3

Nebraska Manufacturing Jobs by Gender, 2022



Source: Lightcast 2023.3

Nebraska Manufacturing Female Employment



Source: Lightcast 2023.3

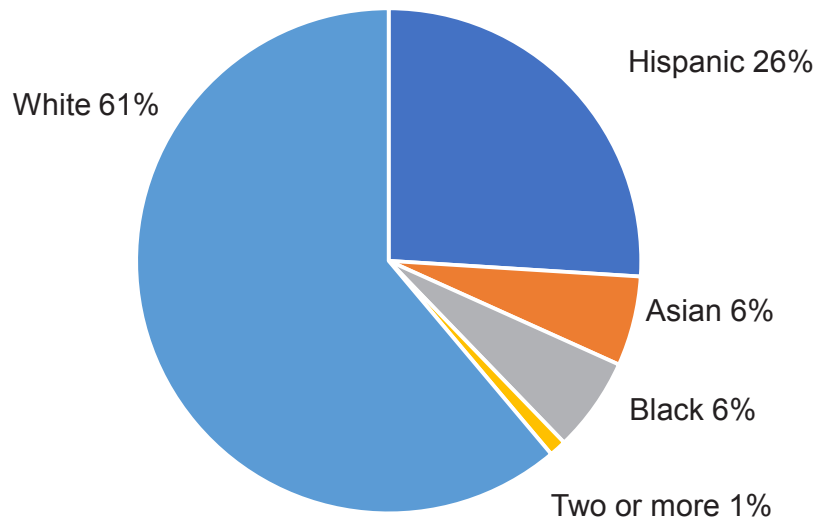
By race and ethnicity, the Nebraska manufacturing workforce is more diverse than the state population overall, with high participation levels from Hispanic workers.

This review of the makeup of the state's manufacturing workforce points to women as the largest group of adults that are under-represented in the current workforce.

Expanding the number and geographic range of career awareness events across Nebraska by organizations such as Women in

Manufacturing (WiM) could improve participation by this critical part of the labor force. Nebraska has one of WiM's 33 national chapters. Greater shift flexibility and assistance with childcare will likely reap benefits as well.

Nebraska Manufacturing Jobs by Race & Ethnicity, 2022



Source: Lightcast 2023.3

How Nebraska Stacks Up: The 2023 Manufacturing Competitiveness Index

A proprietary index developed by Economic Leadership measures the competitiveness of each state’s manufacturing environment based on factors in five different areas:

- Business Climate
- Workforce
- Infrastructure
- Innovation
- Economic Strength

For 2023, Nebraska ranked number 11 in the United States for overall manufacturing competitiveness. It got solid ratings across the board, ranking highest in workforce (fifth) and no lower than 33rd (innovation) in any category. Utah placed first in this latest version of the index, followed in the top five by North Carolina, Idaho, Tennessee, and Texas.



Source: Economic Leadership LLC Manufacturing Competitiveness Index

Data for this index was gathered from public sources including the Bureau of Economic Analysis, National Science Foundation, Bureau of Labor Statistics, Energy Information Administration, and the U.S. Census Bureau, as well as from global data provider Lightcast. Indicators were standardized to account for differences in states’ population or economy size. The most recent available data was used, primarily from the years 2021 to 2023. To evaluate trends over time, a five-year percentage change was used.

For business climate, Nebraska ranked 17th overall. Within this category, it fared the best in legal climate and air quality and the worst in greenhouse gas emissions and corporate tax rate.

For workforce, Nebraska came in fifth. It earned top ten scores for right to work status; labor force participation; change in output per employee; share of disengaged young adults; math scores; veterans' unemployment rate; and manufacturing credential attainment. It scored lowest in the share of students completing tech and STEM programs.

Nebraska ranked 24th in infrastructure, scoring highest (11th) for its natural gas prices. It received its lowest rating (34th) in the percentage of the state with access to terrestrial broadband service. In innovation, where the state placed 33rd overall, it got a top ten ranking for technology licensing from universities. However, it ranked among the bottom 15 in America for patents issued, R&D as a percentage of state GDP, and R&D spending as a percentage of private industry output.

Lastly, Nebraska ranked 18th in manufacturing economic strength. It scored within the top five states for three categories based on manufacturing's share of state GDP. It received its lowest scores (35th) for total manufacturing employment and for the level of capital expenditures by manufacturing firms in the state.

Nebraska's rankings have been consistent in recent years, with the business climate showing improvement and infrastructure declining.

Nebraska Manufacturing Multifactor Competitive Index

Results	2021	2022	2023
Business Climate	24	19	17
Workforce	5	3	5
Infrastructure	8	12	24
Innovation	38	38	33
Econ Strength	20	16	18
Overall Rank	10	10	11

(A more complete description of the competitiveness model can be found in Appendix 1 of this report)

Nebraska Manufacturing Competitiveness

2023 OVERALL STATE RANKINGS							
		BUSINESS CLIMATE	WORKFORCE	INFRA-STRUCTURE	INNOVATION	ECONOMIC STRENGTH	TOTAL RANKINGS
33	Alabama	26	39	27T	36T	9	137
48T	Alaska	42	49	25T	46	50	212
9	Arizona	12	27	27T	13	11	90
43	Arkansas	23	41	30T	45	23	162
26	California	50	25	42T	2	6	125
14T	Colorado	27	1	50	3	28	109
30T	Connecticut	33	10	37	23	30T	133
40	Delaware	28	29	32	30	37	156
6	Florida	9	15	14	12	26	76
10	Georgia	24T	13	13	15T	30T	95
48T	Hawaii	30	42	42T	49	49	212
3T	Idaho	5	21	12	15T	21	74
37	Illinois	48	22	45	24	3T	142
13	Indiana	14	7	41	35	5	102
22	Iowa	43	14	19	43	3T	122
20	Kansas	35	30	8	32	13T	118
8	Kentucky	15T	24	9	40	1	89
50	Louisiana	44T	48	46	48	33	219
44	Maine	36T	44	38	22	24T	164
27	Maryland	38	17	10	15T	46	126
34	Massachusetts	40	9	48	5	36	138
16T	Michigan	15T	34	40	20	2	111
39	Minnesota	47	32	16	26	27	148
29	Mississippi	13	45	17	42	11	128
28	Missouri	10	40	39	14	24T	127
38	Montana	22	33	4	36T	48	143
11	Nebraska	17	5	24	33	18	97
45	Nevada	24T	36	47	31	38	176
12	New Hampshire	29	3T	33	21	13T	99
21	New Jersey	49	11T	23	8	29	120
30T	New Mexico	21	47	2	18	45	133
42	New York	44T	37T	30T	9	41	161
2	North Carolina	1	3T	18	6	19	47
18	North Dakota	8	19	1	47	39	114
23T	Ohio	18	28	36	25	17	124
41	Oklahoma	11	43	20	41	43	158
23T	Oregon	36T	46	25T	4	13T	124
36	Pennsylvania	46	31	21	10	32	140
47	Rhode Island	41	35	44	38	47	205
35	South Carolina	19	37T	34T	29	20	139
14T	South Dakota	2	18	5	44	40	109
3T	Tennessee	6T	20	22	19	7	74
5	Texas	20	26	6	7	16	75
1	Utah	3	2	3	11	8	27
32	Vermont	39	16	11	27T	42	135
7	Virginia	6T	6	7	34	35	88
16T	Washington	31T	8	49	1	22	111
46	West Virginia	31T	50	15	50	44	190
19	Wisconsin	34	11T	34T	27T	10	116
23T	Wyoming	4	23	27T	36T	34	124
			top 15			bottom 15	

A Manufacturing-Focused Plan: Blueprint Nebraska

Among existing economic development plans for the state, the 2019 Blueprint Nebraska strategy focused particularly on the potential of advanced manufacturing to drive the state's future economy.

It laid out these goals for the year 2030:

- Make Nebraska a top three state to live in according to national rankings.
- Create 25,000 additional jobs.
- Grow median annual income by \$15,000.
- Add 43,000 Nebraska residents in the 18-to-34 age group.
- Boost R&D investment by \$200 million annually.



Blueprint Nebraska proposed to implement this through the following advanced manufacturing strategies:

- A. Investing in automation.
- B. Building broadband connectivity.
- C. Focusing on venture capital and productivity incentives for next generation manufacturing.
- D. Improving the workforce by scaling apprenticeships and internships, boosting STEM skills, and enhancing customized workforce and other training programs.
- E. Creating a manufacturing Center of Excellence.
- F. Developing an inland port.

Other related initiatives promoted in Blueprint Nebraska included a “Choose Nebraska” campaign to attract more 18- to 34-year-olds. To address housing shortages, it called for building 30,000 to 50,000 attainable housing units.

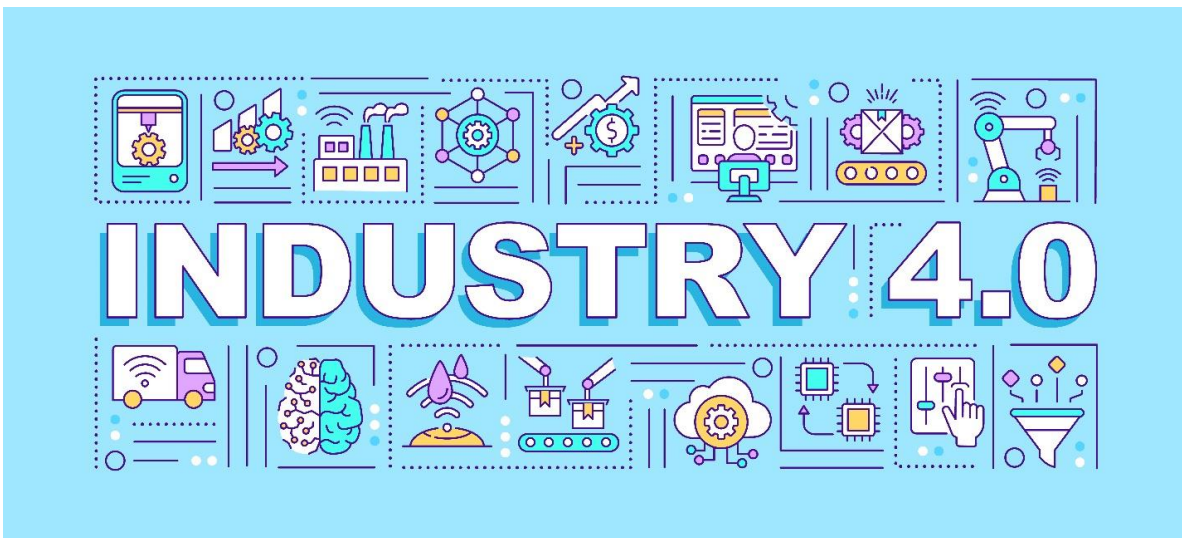
Some progress has been made, but much more work is needed. The COVID pandemic interrupted the economy and reset global manufacturing. This report incorporates these changes and builds on the goals of Blueprint Nebraska. In the five years since Blueprint Nebraska was released, technological advances have accelerated, globalization has changed course with reshoring now an impactful reality, and the federal government has adopted a new industrial policy that supports industries critical to the U.S. economy and national security. For Nebraska, challenges have grown, but so have opportunities.

National Manufacturing Sector Trends and Best Practices

Just before the COVID-related shutdown, the ISM Manufacturing PMI read 50.9 percent in January 2020. Three months later, the figure indicated contraction at 41.5 percent. But less than one year after that, the index hit a recent high of 64.7 percent, with a Yahoo Finance columnist noting that “businesses simply cannot keep up with this recovery.” The index indicated manufacturing expansion for 28 consecutive months, then started a downward trend around November 2021. The reading in November 2023 was the 13th consecutive month showing manufacturing sector contraction (indicated by an index below 50.0 percent).

The National Association of Manufacturers (NAM) Manufacturers’ Outlook Survey for the third quarter of 2023 reveals mixed opinions about current and expected future conditions. A solid majority of manufacturers – 65.1 percent – are somewhat or very positive about their firm’s outlook, but this represents the fourth consecutive quarter with sentiment below the long-term average of 74.9 percent. Some concerns have eased significantly, including worries about the likelihood of a recession, inflation fears, banking instability, and supply chain problems.

The biggest concern across America – not surprisingly – is workforce. Seventy-two percent of manufacturers cite this as their top challenge. Workforce is followed by domestic economic conditions, healthcare costs, and an unfavorable business climate as the most daunting business concerns. The percentage indicating worry about an unfavorable business climate is the highest in six years.^{xii}



An industry review by Oracle in July 2023 noted five major trends driving innovation in manufacturing. This drive to modernize – often called Industry 4.0 – is creating a “generational shift” to smart factories that incorporate robotics, the Internet of Things (IoT), data analysis, augmented reality, and other technologies.^{xiii} This push to innovate

is driven by both technological advances and federal government initiatives such as the CHIPS and Science Act and the Infrastructure Investment and Jobs Act.

These are the five key trends underway:

A. Technology Investments

According to a 2023 survey by Deloitte, the three most common investments in manufacturing technology are in 1) robotics and automation; 2) data analytics; and 3) the Internet of Things (IoT). Robotics and automation is critical for addressing labor shortages, reducing costs, and speeding up production. Data analytics are used in market forecasting and to spot supply shortages sooner. IoT uses sensors throughout the factory and in equipment to improve supply chain tracking, manufacturing efficiency, and product maintenance.

Manufacturers are also prioritizing digital transformation to increase competitiveness. They rank the top positive impacts of digital and data-driven processes as:

- Increased efficiency;
- Better and faster product development;
- More responsiveness to the market; and
- Deepened customer relationships.

One example of what digital transformation can bring is the microfactory, a “small, modular, highly automated, and technologically advanced” structure that can be set up near customer hubs to reduce shipping and storage costs and make it easier to build customized products.

(A Return-On-Investment Model for investments in manufacturing automation can be found in Appendix 2.)

B. Reevaluating Supply Chains

Manufacturers are investing in digital technology for their supply chains as well, to analyze the role each participant plays along the chain. American firms are increasingly reshoring some



materials sourcing and diversifying their supplier base across the globe to increase reliability and flexibility. However, companies need good data as they weigh the benefits of supplier diversification against the added time and cost of monitoring more suppliers.

C. The Factory of the Future

To the extent that factories can reduce human error and inaccuracies, they will become more efficient and productive. Factories already incorporate software for supply chain management and enterprise resource planning, but these often operate under disconnected legacy systems. As manufacturers update these systems and incorporate data analytics software, they will be much more able to use real-time data to improve efficiency. Meanwhile, the adoption of robots, drones, and other automation will increase productivity while reducing labor costs and safety concerns. The global industrial robot market is expected to grow from \$475 million in 2020 to \$8 billion in 2030.

D. Talent Attraction and Retention

According to Oracle, labor shortages for U.S. manufacturers “are only expected to worsen in the coming years.” In addition to experienced workers retiring faster than they can be replaced, there is a particular shortage of individuals with needed skill sets –

interacting with robots, sensors, and Industry 4.0 software, as well as the machinists, welders, and maintenance experts that are always needed. McKinsey & Company estimates that employer demand for hands-on, physical labor will decline by 30



percent in the next decade, while demand for technical skills will rise by 50 percent.^{xiv} Overall, the talent issue has resulted in 45 percent of industry leaders saying they had recently turned down business due to workforce shortages.

Here are some of the tactics that manufacturers are using to improve talent attraction and retention:

1. Diversifying their recruitment efforts by targeting under-represented groups, including women, Black, Asian, and Latinx candidates;
2. Offering wage increases;
3. Implementing comprehensive recognition programs for team members;
4. Reskilling and upskilling of existing workers;

5. Improving the work environment, including the use of robots and drones to perform more dangerous or repetitive tasks;
6. Promoting a continuous learning environment to attract and keep younger workers.

E. Sustainability Investments

In a recent McKinsey survey, 22 percent of manufacturers said they have generated value (such as cost savings) from sustainability initiatives in the last five years, and 40 percent expect to reap value from initiatives in the next five years. Common measures incorporate “smart building” technologies such as sensor-controlled heating, cooling, and lighting. Other measures include sourcing renewable energy for their facilities and greater use of electric vehicles.

More manufacturers are emphasizing corporate social responsibility. This can take the form of a carbon neutral pledge; thorough evaluation of supply chains for their environmental impact; and making social progress through hiring and promotion practices as well as inclusive corporate governance. Other trends to watch in manufacturing:

- Fast-Growing Subsectors – according to a forecast by IBISWorld, the top-growing U.S. industrial manufacturing subsectors (by revenue) through 2028 will be: Solar Power Equipment; 3D Printers; Drones; and Electric and Hybrid Vehicles.^{xv}
- Product as a Service – creating more reliable income streams by not only selling products, but also offering them as a service, often by subscription. Examples include cloud computing and car makers providing vehicles on a service basis. Other potential services are product installation, monitoring, and maintenance.

Another growing impact on U.S. manufacturing is a rise in the reshoring of manufacturing activity. Recent growth in geopolitical tensions and unprecedented federal government investments in a new national industrial policy have contributed to a surge in reshoring. Data provided by the Reshoring Initiative show the growth in reshoring and strong increases in foreign direct investment. Taken together, these trends create opportunities for Nebraska to grow and attract significant manufacturing investment in the next decade.



Best Practices in Manufacturing

★ Creators Wanted is a national campaign to build the manufacturing workforce of tomorrow, led by the National Association of Manufacturers and the Manufacturing Institute.

Creators Wanted and the many resources on its website aim to address two key industry issues: misperceptions of modern

manufacturing and worker skill gaps. Campaign goals for 2025 include attracting 600,000 new workers; increasing parents' positive perception of the industry from 27 percent to 50 percent; and increasing the number of students in Career and Technical Education (CTE) and reskilling programs by 25 percent.^{xvi}

★ More colleges are helping students and manufacturing employers by offering Industry 4.0 education and training. Northeast Wisconsin Technical College (NWTC), based in Green Bay, is one example. NWTC's Industry 4.0 curriculum can be used to upskill workers at a manufacturers' site, or to train new workers at one of the college's locations. Topics covered include:

- Introduction to Industry 4.0
- IoT Data Analysis and Visualization
- Virtual Reality and Augmented Reality Training and Remote Troubleshooting
- Supervisory Controls and Data Acquisition.

Manufacturing students can obtain a certificate in Additive Manufacturing or an associate degree in one of seven manufacturing subareas. There are also a number of related I.T. and business diploma and degree tracks.

★ The successful Be Pro Be Proud career awareness program began in Arkansas in 2016, a joint initiative of Associated Industries of Arkansas and the Arkansas State Chamber of Commerce. The Be Pro Be Proud model has now been adopted in five additional states. Be Pro Be Proud touts the attractiveness of careers in skilled professions such as automation and robotics, CNC operations, commercial truck driving, medical technicians, and welding. It features mobile workshops that bring hands-on exposure to skilled trade careers to school students across a state. Be Pro Be Proud has exposed over 312,000 young people to skilled professions so far.



Manufacturing Stakeholder Input

An online focus group with manufacturing stakeholders across Nebraska in September 2023 generated thorough discussion and input on the status of this sector. One complaint was that several participants feel these issues have been talked about and understood for years, but little has happened to make a real impact. The discussion provided the following conclusions and comments:



FOCUS GROUP

Workforce is the number one barrier to growth in the state's manufacturing sector.

Much of the problem is quantity, "not enough people". Very low unemployment is partly a result of low population growth. But quality is at times an issue as well. It is difficult to find people with mechanical and electrical skills. Those with technical expertise don't want to move to central Nebraska where our facility is located.

We'll look anywhere and everywhere to find more workers.

We try to grow our own, identifying kids in high school who may be interested in a manufacturing career. We try to tap into the underemployed; the Lincoln Manufacturing Council has an introduction to manufacturing class targeted to the underemployed. But are we getting enough people into upskilling and reskilling programs? There's been some success reaching the Latinx community; our firm is converting all our materials into Spanish. But there are some issues with work status and getting through E-Verify. We are seeing more healthcare and nursing home staff shift into manufacturing since the pandemic. Finally, more employers are working with the recently incarcerated.

The state's Native American population is an overlooked, relatively untapped workforce source for manufacturers.

Among other barriers to growth, housing and childcare are the most important.

There is a lack of workforce-related infrastructure, like housing and childcare, needed to recruit and retain talent. One company is working with a builder to construct apartments near their facility, but small manufacturers don't have the capacity to take on projects like that. For childcare, the cost can be a major factor – are employers willing to subsidize this cost?

Additionally, the need to find capital and invest in automation is a problem for some firms, especially smaller and mid-sized ones. Small manufacturers also often lack the staff to help them identify their strategic direction and how to get there. The business climate is a lower priority issue for these manufacturers.

According to the focus group, these are the top state-level actions that would support growth in the manufacturing sector:

- **Help craft a solution to increase legal immigration and reduce immigrants' cost barriers.** Immigrants need assistance with learning English, gaining access to affordable housing, and other needs. The entire immigration process is expensive for participants.
- **Promote careers in manufacturing,** as an alternative to a four-year degree. Manufacturing is not “sexy,” and we need to work together with K-12 schools more to get speakers in the schools regularly, bring groups into manufacturing facilities, and promote Manufacturing Days. This needs to be a concerted effort to interact more closely with the schools – doing it one manufacturer and one school district at a time won't change anything.

The public schools should be responsive to the state's workforce needs. Accountability measures should ensure that career awareness and work experiences are offered to all students. Funding for colleges should reflect student employment outcomes.

- **Revamp state incentives for manufacturing.** Many current state incentive programs are tied to the creation of new jobs, but we can't find the people needed to add jobs, making state incentives inaccessible to many manufacturers. Incentives should be aligned with gains in productivity and GDP. Programs should also be simpler – current ones are convoluted and difficult to track. Site and building availability, while still a challenge, are less of a priority for Nebraska's manufacturers.

Input from One-on-One Stakeholder Interviews

In our interviews with business stakeholders, we also asked about the greatest barriers to manufacturing sector growth in Nebraska. **Workforce** again rises to the top, with concerns including both quantity and skill levels. As one interviewee says, “We turn away a lot of business” due to a lack of workers. The shortage of workers possessing the skill sets needed to automate is a particular concern.



Related to this is the challenge to increase productivity by adopting automation and other new technologies. Capital needs for automation initiatives can be a barrier. Other concerns mentioned multiple times include the availability and cost of housing, and the state's business climate – especially the overall tax burden.

When asked what state-level action would best support manufacturing growth, business leaders offered the following ideas:

- Work on two fronts to a) increase workforce quantity and b) support manufacturing innovation and automation.
- Promote careers in manufacturing, through efforts such as the “Coolest Thing Made in Nebraska” events sponsored by the NE Chamber and the Nebraska Manufacturing Alliance.
- Help to forge a solution to increase legal immigration.
- Revamp manufacturing incentives – focus on capital investment, automation, and innovation.
- Continue to reduce the state's aggregate tax burden.

The data and stakeholder input agree: Nebraska is a competitive state for manufacturing, but it faces two clear throttles on future growth and industry success.

First, there is a need for more manufacturing workers and for workers with specific high-demand skills. Young Nebraskans need increased exposure to the industry and the state needs to aggressively recruit new residents and welcome immigrants.

Second, manufacturing is undergoing a technological transformation that will reward firms that innovate and automate. Nebraska needs to ensure that its state regulations and incentives are responsive and supportive of innovation and investments in productivity.



Recommendations to Support Nebraska Manufacturing

The following actions are critical for boosting the future prospects of Nebraska's manufacturing sector:

Manufacturing Career Awareness

Manufacturers and manufacturing organizations should partner with chambers of commerce, K-12 schools and community colleges to provide career awareness events and content to students (and their parents) more frequently and across a wider geography of the state.



This can include use of existing tools such as the National Association of Manufacturers' and the Manufacturing Institute's **Creators Wanted** campaign; **Manufacturing Days**; the Nebraska chapter of **Women in Manufacturing (WiM)**; the **Coollest Thing Made in Nebraska** events sponsored by the NE Chamber and the Nebraska Manufacturing Alliance; and the **Be Pro Be Proud** skilled professions website and mobile workshops developed by Associated Industries of Arkansas and the Arkansas State Chamber of Commerce.

Specific goals should include bringing events on a regular basis to each of the 17 counties across the state with at least 1,000 manufacturing employees.

Also, a goal should be established to increase women's share of the manufacturing workforce from 31 percent to 40 percent.

Immigration

Nebraska manufacturers should lead the state in forming a coalition of like-minded states (such as those with large manufacturing and agriculture sectors) to push the federal government for a solution that facilitates an increased volume of legal immigration into the United States. "Closing the back door" while "opening the front door" is essential for many leading segments of the state and national economy to thrive in an increasingly competitive global environment. More information can be found in Economic Leadership's report, *Immigration and America's Workforce Shortage: A Nebraska Challenge in Need of a National Solution*.

Innovation

State economic development incentive programs relevant to manufacturing should be updated to focus less on major job creation numbers and more on capital investment and modernization that leads to greater innovation and GDP growth. As an example, **Texas' new JETI Act** allows for tax incentives for as little as ten new jobs and \$20 million in capital investment. Job and investment thresholds are also tiered based on county population to make them more attainable in small counties.

Smaller manufacturing firms and those located outside the two major metro areas need more assistance with strategic direction, adoption of automation and other advanced manufacturing technologies, and accessing capital for growth. Existing small business innovation and capital resources in the state should be gathered by a lead entity – perhaps the Nebraska Manufacturing Extension Partnership – and packaged in a concise resource guide created for manufacturers. This guide should be presented to groups of manufacturers across the state, in particular reaching all 17 counties that have at least 1,000 manufacturing employees.

Housing

Manufacturers should partner with a wide range of business groups to push for additional state-level programs to promote new housing development of all types and price ranges. In addition to state-operated programs, more states are adopting incentives for the private sector and non-profit organizations to increase housing construction.

South Dakota passed a **\$200 million workforce housing bill** in 2022 to reduce the cost of housing by creating grants and a revolving loan fund for infrastructure (streets, water and sewer lines) that supports housing development. **West Virginia's new BUILD WV** program provides a ten-year property tax credit, a tax exemption for purchasing construction materials, and a potential business and occupation tax exemption for housing projects as small as six units in approved districts around the state. As of fall 2023 there are nine approved BUILD WV districts.

Other efforts can encourage young people and young families to invest in the state. The Ohio Housing Finance Agency has operated **Ohio's Grants for Grads** initiative since 2009. Grants for Grads offers down payment assistance for those who graduated with at least an associate degree in the past 48 months. Recipients must take free homebuyer education classes. The down payment assistance is forgiven if the homeowner remains in Ohio for five years. Nearly 200 home buyers took advantage of Grants for Grads in 2022.

In addition to programs like these, regulatory changes can stimulate new housing development. State and local governments are increasingly backing **zoning code changes** to allow greater density, smaller lot sizes, a wider range of housing types, and accessory dwelling units.

Childcare

Similarly to housing, the manufacturing sector should partner broadly with chambers of commerce and community organizations to promote innovative ways to improve the availability and affordability of childcare. Nebraska has done a good job of funneling more resources into support for working parents and childcare providers. To increase momentum on this topic the state should also incentivize greater involvement by employers. **Georgia** provides a 100 percent tax credit to businesses that purchase property to build a childcare facility, as well as a credit up to 75 percent of costs for employers who provide or subsidize childcare for their workforce. In 2022, **West Virginia** Senate Bill 656 established a tax credit for employers creating a childcare facility, equal to the first-year startup and operating costs of a new facility and to be taken over five years. **Iowa** adopted a similar Child Care Business Incentive Grant program the same year.

Appendix 1 - Manufacturing Competitiveness Index

Economic Leadership's annual Manufacturing Competitiveness report is based on a Manufacturing Competitiveness Index which was originally included as part of *A New Blueprint – Making the American South's Manufacturing Sector More Competitive by 2030*, a report for the Economic Development Administration. The multifactor analysis includes five indexes that were originally created with input from a group of manufacturing CEOs.

Business Climate Index

Manufacturing, like almost all businesses, is concerned with ease and costs of doing business. Cost, legal, and regulatory factors are often cited as critical reasons when manufacturing companies consider expansion or relocation. The Business Climate Index focuses on wages, taxes, and legal barriers. These metrics are often determined by state government policy choices and are opportunities for states to make changes that will improve manufacturing competitiveness. The Business Climate Index consisted of the following nine metrics:

Business Climate Index Metrics

- Manufacturing Industry Tax Climate Scorecard 2020
- Top Marginal Corporate Tax Rate 2023
- Legal Climate Rankings 2019 (this was updated every two years, but has not been updated)
- Air Quality – Average Exposure to PM2.5 2022
- Workers Comp Insurance Premium per \$100/Payroll 2020
- Best States for Manufacturing – Overall Ranking 2023
- Best States for Manufacturing – Operating Costs Ranking 2023
- Value of \$100 2023
- Greenhouse Gas Emissions Per Capita (Metric Tons of CO2) 2021

Workforce Index

The availability of a skilled labor force is consistently ranked among the top factors impacting site selection by *Area Development* magazine. Today, the challenge of finding enough appropriately skilled labor is the top public policy conundrum. In 2023, two of the top five factors in the annual survey of site selection consultants and CEOs were related to labor. Over the past decade, manufacturing business leaders have often expressed concern about difficulties finding enough skilled employees, including specialty skills such as CNC machinists and other middle-skilled credentialed workers.

The Workforce Index measures education, health of the population, creative class population, and manufacturing productivity. Two changes were made to the metrics with the addition of the percent of women working in manufacturing and the percent of women in production occupations. Both of these new data points are sourced from

Lightcast. Of the other metrics used for this index, nine were able to be updated and seven remained the same. The Workforce Index consisted of the following eighteen metrics.

Workforce Index Metrics

- Right-to-Work State 2022
- Percentage of Population with Adult Obesity 2021
- Persons Aged 18 to 24 Not Attending School, Not Working, and No Degree Beyond High School 2021
- High School Graduation Rate for All Students 2019-20
- Labor Force Participation Rate 2022
- Manufacturing Output Per Manufacturing Employee 2022
- Change in Manufacturing Output Per Manufacturing Employee 2017-2022
- Age 25-44 Population Growth 2017-2022
- Completed Tech & STEM Education Programs Per 1,000 Enrolled Students 2021
- Percent Change in Tech & STEM Education Program Completions 2016-2021
- Average 8th Grade Reading Score 2022
- Average 8th Grade Math Score 2022
- Veteran Unemployment Rate 2022
- Veteran % Share of Total Population 2022
- Total Number of Sub-baccalaureate Occupational Credentials in Manufacturing 2021
- Sub-baccalaureate Occupational Credentials in Manufacturing as Percent of Total Credentials 2021
- Percent of Women Working in Manufacturing Industry Sector 2022
- Percent of Women in Production Occupations 2022

Infrastructure Index

Highway accessibility was ranked by the two *Area Development* surveys in 2023, as 7th by Site Selection Consultants and by CEOs as 11th. Over 93 percent of managers considered highway accessibility as very important or important when deciding on a new facility, expansion, or relocation. Infrastructure is still significant for manufacturing firms because of the need to move raw materials in and products out to major markets.

Ignited by the critical role broadband played in our pandemic lives, and amplified by the current widespread supply chain challenges, infrastructure has been a priority of politicians and policy experts over the past three years. Pre-pandemic, The American Society of Civil Engineers currently gave the nation a grade of D+ when it came to infrastructure, estimating a needed investment of \$3.6 trillion to address needs. In 2021 the infrastructure bill appropriated over a trillion dollars to begin the work.

The Infrastructure Index consisted of the following nine metrics.

Infrastructure Index Metrics

- Total State Spending on Transportation Per Capita FY2022
- Average Retail Electricity Price for Industrial Customers, Cents Per Kwh August 2023
- Percent of Bridges in Poor Condition 2022
- Percentage Growth in Freight Shipments Tons (thousands) 2017-2021
- Percentage Growth in Freight Shipments \$\$ (millions) 2017-2021
- Miles of Interstate Highways per 10,000 Population 2022
- Average Retail Natural Gas Price for Industrial Customers, \$ per Thousand Cubic Feet July 2023
- State Transportation Expenditures as Percent of Total Expenditures FY2022
- Percentage of State Geography with Access to Terrestrial Broadband 2022

Innovation Index

The Innovation Index measures the state's performance in university technology transfer, patent development, R&D funding, and venture capital funding. Innovation and research help generate new manufacturing companies and products. Innovation is a tool that grows manufacturing from within a region, as businesses are more likely to start and remain close to their original research connection. An area known for innovation and a talented technological workforce is more likely to attract businesses looking to relocate. It is also more likely to draw top talent in the creative class. Four of the metrics were available and have been updated. The Innovation Index consisted of the following seven metrics.

Innovation Index Metrics

- Technology Licenses and Options Executed from Universities 2022
- Patents Issued 2016-2020
- Total Technology Industry Employment Growth 2017-2021
- Total R&D percent of GDP 2019
- Business Performed R&D - Percent of Private Industry Output 2020
- Average Venture Capital Funding Per \$1 Million of GDP 2017-2022
- Percent of Adults becoming Entrepreneurs – monthly average - 2021

Manufacturing Economic Strength

The final index, Economic Strength, evaluates the existing presence of the manufacturing sector within each state and evaluates indicators of overall economic performance. Existing industry in a state can create a clustering effect and attract further manufacturing to the area. Clusters have been known to attract other prospective businesses because of the benefit of higher concentrations of skilled employees and regional suppliers. A strongly performing overall economy beyond manufacturing is important for prospective companies as growth inspires innovation, talent movement, and investment. The Economic Strength Index consisted of the following fourteen metrics.

Manufacturing Economic Strength Index Metrics

- Manufacturing's Share of Gross State Product 2022
- Change in Manufacturing's Share of Gross State Product 2017 -2022
- Manufacturing's Share of PRIVATE Gross State Product 2022
- Change in Manufacturing's Share of PRIVATE Gross State Product 2017 -2022
- Growth in Manufacturing GDP 2017 - 2022
- Total Manufacturing Employment 2022
- Manufacturing Employment as Percent of Total Employment 2022
- Change in Real GDP per Capita 2017-2022
- Change in Real Personal Income per Capita 2017-2022
- Change in Real GDP Chained 2012 Dollars 2017-2022
- Exports of Manufactured Goods Percent Change 2021 - 2022
- Total Exports of Goods Per Capita 2022
- Manufacturing Establishments Total Capital Expenditures (\$millions) 2021
- Manufacturing Establishments Total Capital Expenditures per Manufacturing Employee 2021

Appendix 2 – Return on Investment Calculation Model

Return on Investment for Manufacturing Automation

The anticipated return on investment (ROI) from purchasing new robotics or other automated machinery for the manufacturing process is a key consideration in any modernization process and purchase decision. However, calculating a realistic ROI is not an easy process as conditions relating to the investment will vary in every case. The basic formula for calculating a percentage ROI is straightforward:

$$\text{ROI} = \frac{\text{Gained Revenues} - \text{Investment}}{\text{Investment}^{\text{xvii}}} \times 100$$

The true costs of automated equipment and machinery can include many expenses, such as:

- Installation costs
- Training costs – to get team members up to speed on new machinery.
- Operational costs – power consumption (new equipment will often use less energy than older machinery), labor costs for programming and operating.
- Maintenance costs – which also may be lower but need to include scheduled down time.
- Financing costs – if the automation equipment is not paid for up front, the monthly payments to pay off the purchase.

The benefits that lead to additional revenues will vary as well, depending on:

- Productivity rate – the ability to work more quickly, efficiently, and with less down time than manual manufacturing processes. Greater output often equals increased revenues. An engineering firm suggests that productivity gains are often in the range of 25 percent to 50 percent, and one ROI calculator estimates productivity increasing by 27 percent.^{xviii}
- Labor savings – the potential for considerable savings due to fewer employees and less turnover in positions that involve tedious, repetitive, dangerous, or error-prone tasks.^{xix}

Other benefits of automation can include greater accuracy in production, less waste, higher quality, and fewer product recalls. The increased capacity from higher productivity can lead to fewer instances of having to turn down work due to staff limitations. Labor savings can build over the long term thanks to decreased expenses of hiring and onboarding. Increased safety and potentially lower expenses for safety equipment, safety training, and workplace injury issues can be additional benefits.

There is no standard percentage return on investment for manufacturing automation, but industrial advisors do provide a typical timeframe for when investment returns turn positive. One source suggests that most investments start to be profitable 12 to 36 months after implementing an automation project,^{xx} while an industry non-profit organization says that 24 months is the average time.^{xxi}

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