



Future Careers in Manufacturing

Building a Stronger Manufacturing Workforce
in Northern California

September 2021



Acknowledgments

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About SFMade

SFMade is a 501(c)(3) non-profit organization that supports local manufacturers who create jobs and career pathways for local residents. Founded in 2010, SFMade has emerged as a full-service hub that connects low-income job seekers to employment and training opportunities; provides local manufacturers with educational resources and customized, one-on-one services; and arms policymakers with strategies and intelligence to create the conditions for home-grown manufacturers and their employees to thrive.

At the heart of SFMade's work is the belief that local manufacturing taps into the unique identity and spirit of the city and the region, and that an economy that prioritizes the workers, entrepreneurs, and artisans who make things has the potential for greater social and environmental impact. From bringing manufacturers into high school classrooms and creating internships to provide early exposure to the field, to creating the region's first and only nonprofit industrial space real estate development company, SFMade is working

constantly to help manufacturers flourish and to ensure that low-income residents have access to jobs with wages that keep up with the cost of living.

About the Institute

Since 1990, the Bay Area Council Economic Institute has been a leading think tank focused on the economic and policy issues facing the San Francisco Bay Area, one of the most dynamic regions in the United States and the world's leading center for technology and innovation. A valued forum for stakeholder engagement and a respected source of information and fact-based analysis, the Institute is a partner and advisor to both business leaders and government leaders. Through its economic and policy research and its many partnerships, the Institute addresses major issues impacting the competitiveness, economic development and quality of life of the region and the state, including housing, transportation, trade and globalization, science and technology, and health.

The Institute is housed at and supported by the Bay Area Council, a public policy organization that includes hundreds of the region's largest employers and is committed to keeping the Bay Area the world's most competitive economy and best place to live. The Institute also supports and manages the Bay Area Science and Innovation Consortium (BASIC), a partnership of Northern California's leading scientific research laboratories and thinkers.

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Executive Summary

With 30,000 manufacturing companies, California is the largest manufacturing state in the nation. Together, those companies support 1.3 million employees; 34% of those workers are people of color, and 31% are women. Most of California's manufacturing companies are small, with 64% having fewer than 25 employees. Manufacturing companies account for 11% of California's total economic output. Their activity contributes to a balanced economic structure in the state and provides middle-skilled jobs that offer good incomes and upward mobility for a segment of the workforce.

From the end of the Great Recession in 2010 through 2019, California's manufacturing job growth (7.8%) lagged the country as a whole (12.8%). Within that number, however, there was significant variation between different regions in the state, with manufacturing employment in the Los Angeles Metropolitan Statistical Area (MSA) falling 9.5%, but growing in the Fresno MSA by 15.3%. This points to the importance of regional variables in explaining the performance of manufacturing across the state. In addition, different types of manufacturing dominate different regions of California, each with their own unique workforce needs.

The Changing Environment for Manufacturing

Reshoring and Global Supply Chains: Changes in the global environment will impact manufacturing's future in California. Some, such as the reshoring of manufacturing activity from overseas, present an opportunity as global supply chains shift in a search for greater security and reliability. Concern with over-reliance on China is a major driver, as was discovered during the pandemic. This presents an opportunity for Northern California if it can offer a competitive cost environment and a trained and technologically ready workforce.

Additive Manufacturing: The accelerated adoption of 3D printing is continuing to democratize manufacturing, particularly for small- and medium-sized companies. It

also enables production to happen in smaller spaces, including urban settings.

Biomedical Manufacturing: The Bay Area and Northern California are benefiting from strong growth in the biopharmaceutical sector. This trend is supported by strong R&D, venture investment, and expanding health priorities. Even more than in other industries, manufacturing in the sector is driven by automation. Unlike many other sectors, many biomanufacturing jobs require at least a bachelor's degree.

County-Level Employment Trends in Northern California

While employment in manufacturing overall has been in decline, data shows that at the county level many sub-industries are growing. This study analyzes the trends in manufacturing in the nine-county San Francisco Bay Area and the San Joaquin Valley. Some highlights:

San Francisco County: Employment in Navigational, Measuring, Electromedical, and Control Instrument Manufacturing (the leading sector for employment in San Francisco) and in Food and Beverage Manufacturing are growing, while Apparel Manufacturing is shrinking.

San Mateo County: Navigational, Measuring, Electromedical and Control Instruments Manufacturing, the leading sector for manufacturing employment in San Mateo, is shrinking, while Bakeries and Tortilla

Manufacturing and Medical Equipment and Supplies Manufacturing are growing modestly.

Santa Clara County: Computer and Peripheral Equipment, which leads manufacturing employment in the county, has seen strong growth, while Semiconductor and Other Electronic Equipment Manufacturing has declined.

Contra Costa County: Employment related to petroleum products, which leads manufacturing employment in Contra Costa, has declined as has manufacturing in Navigational, Measuring, Electromedical and Control Instruments, while Bakeries and Tortilla Manufacturing has grown.

Alameda County: Manufacturing employment is strong across a range of technology sectors, all of which have experienced significant growth with the exception of Semiconductor and Other Electronic Component Manufacturing.

Napa County: Employment in Napa is dominated by Beverage Manufacturing (wine), which is growing.

Sonoma County: Employment in Sonoma County is more diversified, but is also led by growth in Beverage Manufacturing (wine).

Marin County: Marin County's manufacturing base is small, and is led by growth in Beverage Manufacturing as well as dairy products.

Solano County: Solano has experienced strong growth in Pharmaceutical and Medicine Manufacturing, its leading sector for manufacturing employment.

Fresno County: Employment in Fruit and Vegetable Preserving and Specialty Food Manufacturing, the leading sector for manufacturing employment, is declining, while Beverage Manufacturing has grown.

San Joaquin County: Beverage Manufacturing, the leading sector for manufacturing employment, is growing; employment remains strong in Other Food Manufacturing and in Architectural and Structural Metals Manufacturing.

Stanislaus County: Food Manufacturing, the dominant sector for employment, is steady, as is employment in Other Food and Beverage industries.

Accessing Opportunity in Manufacturing

Manufacturing in California is diverse, and multiple factors will influence the demand for workers.

The Need to Attract Younger Workers: According to Deloitte, more than 2.6 million baby boomers are expected to retire from manufacturing jobs in the next decade in the U.S. Pew Research reports that the percentage of baby boomers who are retiring has doubled in the last eight years and will continue to rise until 2030. The Bureau of Labor Statistics (BLS) estimates that the manufacturing sector has the highest tenure in its workforce of all the sectors measured – raising the issue of loss of knowledge as retirements accelerate.

Technological Change and Digital Automation: Technological change will have a growing impact on manufacturing employment as the shift accelerates toward digital automation. Strategies for businesses and partners in education and government must focus on the workplace skills required to accommodate that change as the use of digital tools to improve the proficiency of frontline production grows. For example, the Industrial Internet of Things (IIoT) is accelerating the adoption of robotics, 3D printing, and other advanced processes using sensors, data-driven autonomous systems, and interconnected devices that collect critical metrics and analyze the results in real time.

This transition will require education for new employees entering the workforce, upskilling as new skills are required to perform existing functions, and reskilling as workers take on new or different roles. McKinsey estimates that 39-58% of worldwide work in operationally intensive sectors could be automated using currently available technologies. By sector, the highest level of susceptibility is in manufacturing, where 58% of activity could be automated.

While the overall number of jobs in manufacturing may continue to fall due to technological advances, wages are likely to increase for workers with these more complex skill sets. The need for training beyond two-year college or technical programs will also grow. In 2019, American manufacturers were on track to employ more college graduates than workers with a high school education or less, and more than 40% of manufacturing workers now have a college degree.

Regional Initiatives

There are a number of programs working to support manufacturers in the San Francisco Bay Area and the San Joaquin Valley through workforce and training related initiatives. These include NextFlex, the Bay Area Urban Manufacturing Initiative, AM Bay Area, South Valley Industrial Collaborative, Fresno Business Council's Career Nexus, as well as a wide range of community college and four-year college programs.

Programs by geographic-specific non-profits and economic development corporations include: SFMade/MFG:SJ, the San Joaquin Valley Manufacturing Alliance, Opportunity Stanislaus/VOLT, the Manufacturing Maintenance Mechanic Program of the Fresno Economic Opportunities Commission, and programs of the National Tooling and Machining Association and the Society of Manufacturing Engineers.

Government services are provided by Manufacturing Extension Partnerships and Manex, by Workforce Investment Boards, and by programs of the Prison Industry Board. Subsidized wage and on-the-job training programs include San Francisco's JobsNow! Program, the Bay Area Council's Northern California Apprenticeship Network, Fresno Regional Workforce Development Board's work experience and summer work programs, Fresno's New Employment Opportunities, and Career Nexus programs.

Workforce/Training Ecosystem Gaps

While the San Francisco Bay Area and the San Joaquin Valley support a broad range of workforce programs to develop manufacturing skills, significant gaps remain for workforce developers and service providers. Companies need to both develop talent from within and promote talent development externally. Significant cultural differences also need to be overcome in how businesses, government, and educational service providers interact. Maker spaces offer another area of opportunity, but more needs to be done to meaningfully link them with manufacturing employers.

Recommendations

Interviews and analysis for this report point to a range of strategies that could strengthen manufacturing and attract new workers while providing the skills that manufacturers need. These include: on-site vocational ESL (English as a Second Language) courses; the establishment of a biomanufacturing foundry; a statewide manufacturing supplier network; increased access to maker spaces; updating, expanding and aligning K-12 career educational pathways; and funding high school and college faculty to participate in manufacturing externships.





Introduction

Manufacturing holds an important key to the economy of California, which is the nation's largest manufacturing state. It supports a balanced and diversified economy, is an anchor for research and development (R&D), and provides well-compensated entry level jobs with significant opportunities for advancement. It also fills a critical gap in California's employment structure between lower-paid service jobs and highly-paid employment in technology-related fields, providing opportunities for workers without advanced degrees.

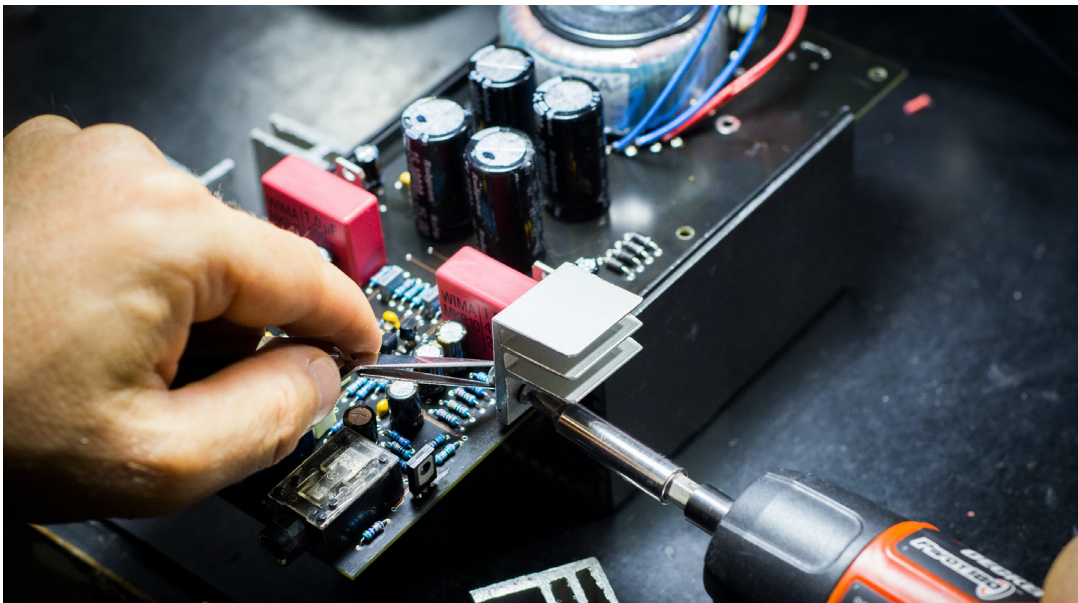
The setting for manufacturing in Northern California is undergoing change as new technologies redefine job functions and the skills required to meet them. It is not a static environment, and targeted support is required to enable manufacturing companies to find the right employees and help workers to develop the skills needed to keep up with technological change. As this happens, the HR function within companies will also need to evolve.

This study assesses drivers of change in Northern California's manufacturing workforce, including the reshoring of manufacturing that is currently overseas,

the realignment of global supply chains, the widespread adoption of digital technology in production processes, 3D printing, and the aging of the industrial workforce. The study also includes a discussion of biomedical manufacturing as a sector with distinct requirements.

Beyond these trends, which impact workforce development in the manufacturing sector across the board, this report analyzes the top sub-sectors for employment in the nine-county San Francisco Bay Area and the San Joaquin Valley, and which of those sub-sectors are growing or shrinking. It also documents existing training programs and provides recommendations for strengthening those programs in the next one to three years.

This report's particular focus is on jobs generated by growing sub-sectors that for the most part require less than a four-year degree. These are jobs that either pay \$20/hour or more and have the ability to grow over time, or start at less than \$20/hour with the opportunity to quickly advance. Research in this report draws on interviews, surveys, an assessment of economic and technological trends, and economic data analysis.





1

The Changing Environment for Manufacturing and Growing Manufacturing Sectors

With change in manufacturing being driven from many directions, context is important to understanding workforce needs. This chapter analyzes the importance of manufacturing in California, its global setting, how manufacturing is being democratized through 3D printing, and the distinct case of biopharmaceutical manufacturing. It also provides data on the largest sectors by employment in the regions being studied, and manufacturing sectors where employment is either growing or shrinking. This employment data is supplemented by a survey of manufacturers.

Manufacturing in California

With 30,000 manufacturing companies, California is the largest manufacturing state in the nation. Together, those companies support 1.3 million employees. Thirty-four percent of those workers are minority, and 31% are women. Nearly 800,000 Californians are employed in production-related occupations, garnering an average annual wage of nearly \$45,000. Most of California's manufacturing companies are small, with 64% having fewer than 25 employees. Manufacturing companies account for 11% of California's total economic output.¹ Their activity contributes to a balanced economic structure in the state and provides middle-skilled jobs that offer good incomes and upward mobility.

From the end of the Great Recession in 2010 through 2019, California's manufacturing job growth (7.8%) lagged the country as a whole (12.8%). Within that number, however, there was significant variation between different regions in the state, with manufacturing employment in the Los Angeles Metropolitan Statistical Area (MSA) falling 9.5% but in the Fresno MSA growing 15.3%.² This divergence points to the importance of regional variables in explaining the performance of manufacturing across the state. This report analyzes trends in the nine-county San Francisco Bay Area and in three adjacent counties in the San Joaquin Valley of Northern California.

The Global Setting: Reshoring and the Shift in Global Supply Chains

Manufacturing in the Bay Area and California can benefit from changes that are currently underway in global supply chains, a shift that is bringing some manufacturing back to the U.S. from overseas. For this to occur, however, California must first address the core issues of cost, regulation, and the availability of a right-sized and technically prepared workforce.

The reshoring of manufacturing has been a topic for over a decade. It was initially believed that rising labor costs in China, technological change, and the desire to return production closer to end markets would lead many companies to bring production home. The reshoring that has occurred has been limited, however, due primarily to continued low costs overseas and the depth and efficiency of the manufacturing supplier base in China. Changes in the global environment in the last few years, however, are leading many to believe that reshoring may now be possible on a larger scale.

Factors that argue for the reshoring of production remain strong. In particular, continued advances in technology that enable more production with fewer workers are reducing the importance of labor in the overall cost in production. That erodes the labor arbitrage advantage of manufacturing overseas and shifts the calculation of where to locate production toward a broader range of factors. Put differently, to make a product at home with large numbers of employees might not be competitive, but producing the same product at home with fewer employees may be feasible when labor-saving technology is applied. From this perspective, labor-saving automation can generate new employment.

Companies that produce domestically can also shorten supply chains and reduce supply chain risk by bringing production closer to its intended markets. The growing perception that low cost but highly concentrated production overseas – and particularly in a single country such as China – creates strategic vulnerability has generated a new focus on supply chain resilience. Other reasons for onshore production include fewer time zones across which to manage and improved communication between companies and contractors.

Sensitivity to supply chain vulnerability grew after the 2011 earthquake and tsunami in Japan shut down the world's largest producer of silicon wafers, closing factories worldwide that produce electronic components for the global automotive sector. More recently, shortages of personal protective equipment (most of it imported) during the COVID-19 crisis have drawn attention to vulnerabilities that may stem from where a range of critical products are produced.

The newest factor in the reshoring calculation is the geopolitical risk associated with a change for the worse in U.S.-China relations. Since 2017, the U.S.-China relationship has become more conflicted, with trade, technology transfer, and strategic competition core issues. With the trade war that ensued, the cost of imported goods and of intermediate parts from China has increased and considerable uncertainty remains regarding the future of U.S.-China trade.

In 2020, even after a phase one trade agreement was reached that paused an escalating war of reciprocal tariffs, U.S. tariffs on imported goods from China averaged 19.3%, a level more than six times higher than before the trade war began.³ In response, some U.S. companies have moved production out of China to reduce their vulnerability to the political crossfire.

The U.S. government is also considering ways to increase supply chain resilience and reduce strategic vulnerability to China by realigning global supply chains for key technologies. The measures that it adopts could shift some production back to the U.S., or to countries considered to be politically aligned or reliable such as Japan, Australia, Canada, Mexico, or the EU.

To a degree this shift is already occurring. Kearny's most recent Reshoring Index shows that in 2019, reversing a five-year trend, U.S. manufacturing production held steady at \$6,217 billion, as imports from low-cost suppliers from Asia fell sharply from \$816 billion to \$757 billion.⁴ Looking forward, a June 2020 Gartner survey of 260 global supply chain leaders found that 33% had moved sourcing and manufacturing activity out of China or planned to do so in the next two to three years. The pandemic was a factor but so were tariffs and a desire to move closer to their customers. Only 21% believed their supplier networks were resilient, but 55% expected to have highly resilient networks over that period.⁵

What is less clear is the scale at which these shifts will occur, as moving supply chains can be slow and costly. U.S. companies that produce in China for the U.S. market (and are subject to U.S. import tariffs) are the most likely to leave, while those that produce for China's domestic market are more likely to stay. China will also continue to exert a gravitational pull due to the depth and sophistication of its supplier base, which is difficult

to replicate. Of companies that do leave, lower cost producers will most likely gravitate to Southeast Asia, India, or Mexico.

McKinsey estimates that across industries, companies can now expect supply chain disruptions lasting a month or longer every 3.7 years with the most severe events taking a major financial toll. In 2018 alone, the five most disruptive supply chain events affected more than 2,000 manufacturing sites worldwide, with factories requiring 22-29 weeks to recover. While domestic production is not immune to supply chain disruptions (affected by issues such as weather or port congestion), the recent growth of geopolitical issues has increased companies' focus on the international dimensions of their supply chains. McKinsey finds that value chains that are heavily traded relative to their output – such as communications equipment, computers, and electronics – are more exposed than those with lower trade intensity. In contrast, value chains with low trade intensity – such as glass and cement, fabricated metals, and food and beverages – have lower exposure to shocks and are more regionally traded.⁶

Even before COVID-19, 70% of companies expected to change their global strategies, with nearly one-fourth planning to move closer to customers and a similar number planning to diversify across countries. Currently, 93% of companies expect to invest in supply chain resilience. As one consequence, trade in goods, which has become increasingly global, is expected to become more regional. In all, 16-26% of annual global trade (valued at \$2.9-4.6 trillion) could shift. While labor intensive jobs will shift primarily to less developed countries, COVID-19 has accelerated the transition toward automation through AI and IoT. This suggests that in advanced economies such as the U.S., any expansion of production derived from reshoring will be highly automated and the jobs created both more skilled and higher paying.⁷

Data suggests that while reshoring is growing it has not yet become a wave. Foreign Direct Investment (FDI) in the United States is actually a larger source of manufacturing jobs than reshoring. That FDI is particularly concentrated in transportation (automobiles), computer and electronic products, and the electrical equipment and component sectors.

This suggests that FDI attraction can be an important source of new manufacturing jobs. Data from 2010 through the first half of 2020 shows that the top foreign investor in the U.S. was Germany (419 companies with 85,829 jobs), followed by China (295 companies with 83,364 jobs) and Japan (386 companies with 75,644 jobs). China was the top country from which companies returned manufacturing (850 companies with 50,641 jobs over the period), followed by Mexico (108 companies with 27,645 jobs), and Canada (65 companies with 12,201 jobs). In the first half of 2020, reshoring and FDI together accounted for 55,037 jobs at 465 companies – 321 companies and 34,309 jobs through reshoring and 144 companies and 20,729 jobs through FDI.

It is noteworthy that when looking at where the jobs created by reshoring and FDI in the period from 2010-2019 are located, California, despite its size, ranks only number 18 among U.S. states as a destination, behind South Carolina, Michigan, Tennessee, Texas, Georgia, Alabama, North Carolina, Ohio, New York, Kentucky, Louisiana, Arizona, Virginia, Nevada, Indiana, Mississippi, and Massachusetts. In 2019, the last year for which full data is available, California failed to break the top 10 states for jobs created by combined FDI and reshoring, with Michigan, Texas, Georgia, Alabama, Tennessee, and North Carolina the top five. The top five for reshoring alone were Texas, Michigan, Ohio, New York and Georgia.⁸ This difference can be partly explained by California's tendency to attract more high-tech investment, which typically brings fewer jobs, while other states attract more investment in large-scale assembly or production facilities. California's failure to attract more manufacturing jobs is also attributable, however, to its high-cost structure, including its high cost of industrial energy and its complex regulatory environment.

One take-away from this emerging pattern is that reshoring, to the extent that it occurs, presents an opportunity to increase manufacturing activity and employment in the Bay Area and Northern California, but how much the region will actually benefit is unclear. The answer will hinge on the cost to manufacture in the region and on its ability to provide a trained and technologically ready workforce in sufficient numbers.

Democratizing Manufacturing through 3D Printing

“We’re at the forefront of making high end design affordable. The biggest thing we bring is our method of manufacturing, which allows us to partner with designers and give our customers high design quality goods at an affordable price. What we’re doing is allowing customers to choose from a variety of designs that best fit their idea of what is in their home, because we can make one product or a hundred. One of the most valuable byproducts is job creation—we just purchased our first 1,000 printers and nobody else in the world is doing what we’re doing at this scale. We need to hire a lot of people to make it happen.”

– Gantri Lighting, San Leandro

Continuing a growing trend, additive manufacturing (3D printing) has the ability to impact local manufacturing in distinct ways. As its sophistication has grown, the additive manufacturing process – which enables the production of three-dimensional objects by layering materials using digital technology – is finding applications in a growing range of products and industries from medical devices to automotive and aircraft parts. According to Kearney, the global market for 3D printing technology is growing at an annual rate of 20% and will reach between \$25 billion and \$50 billion by 2025, with the potential in the longer term “to turn today’s supply chains and manufacturing plants upside down.”⁹

This is particularly significant for small and medium sized companies, as additive manufacturing enables the wider distribution of manufacturing activity and smaller scale production in more localized facilities. Benefits include a higher level of product customization (by avoiding the need for conventional dies) and the location of some production closer to end customers. Production can also be done in smaller facilities in core urban areas. With 3D printing, economies of scale are not a barrier, enabling increased competition from new and smaller companies.

In this respect, additive manufacturing aligns well with the profile of California’s manufacturing companies

– many in the OEM (original equipment manufacturer) supply chain – where two-thirds have fewer than 25 employees.

Biopharmaceutical Manufacturing

The Bay Area and Northern California are currently benefitting from strong growth in the biopharmaceutical sector, which has advanced strongly even during the pandemic. This trend is supported by strong R&D, venture investment, and expanding health priorities. Real estate vacancies in the biotech sector are lower than those for traditional tech,¹⁰ and with a shortage of available biotech space and more tech employees likely to be working remotely, developers and commercial building owners are considering whether to re-purpose under-used tech offices for biotech use. Biotech’s expansion in the region is also being driven by a growing number of startups that are attracting venture funding – and if successful will need to manufacture.

The biomedical industry segments into several sectors: biotechnology, pharmaceuticals, medical devices, medical equipment, digital healthcare, genomics, contract research organizations (CRO), and contract manufacturing organizations (CMO). In 2020, there were 2,198 biomedical industry companies in the Bay Area.

Biomedical Industry Sector	
Type	2020 Companies
Biotechnology	833
Medical Equipment	510
Pharmaceuticals	263
Digital Healthcare	212
Medical Devices	175
Genomics	130
CRO	63
CMO	12
Total	2,198

Source: Biomedical Manufacturing Network 2020

Because biotech intellectual property is closely held, it is very likely that those initial products will be tested and manufactured locally. Another reason for biotech manufacturing to be local is its strong connection to R&D and the benefit of locating production close to the science that generates it. Early production also needs to be close to patients and can take place in small facilities of as little as 10,000 square feet. Small production runs are common as newer versions of a product often follow quickly in succession, making remote manufacturing difficult. Finally, the fact that production processes are closely tracked by the FDA requires companies to maintain close control, another incentive to keep production close.

While global competition is growing, domestically this means that biotech activity is likely to remain concentrated, an advantage for the Bay Area, which is a leading national center for biotechnology. This concentration helps anchor major manufacturing facilities such as Bayer's campus in West Berkeley, which serves as the base for Bayer's global biotech activity and produces a range of products from hemophilia treatments to novel cell and gene therapies. Other cities are making biotech a priority as an economic development strategy.

Even more than in other industries, manufacturing in the sector is being driven by automation. Gregory Theyel, Director at the Biomedical Manufacturing Network, points out that companies are looking to make the most of automation technology and that companies are actively looking to robotics as a way to reduce headcount. The upshot is that while biotech manufacturing is growing, employment numbers are not growing at the same rate and the positions that are available often require advanced skills. Approximately 65% of workers in the industry have at least a master's degree, and the concept of what constitutes manufacturing activity is different than in other manufacturing sectors. For example, someone with a biology background could be making vaccines, or an engineer could be making devices. Neither might describe themselves as being involved in "manufacturing" and might identify themselves more with an "industry," but they are nonetheless making things.

From a workforce perspective, this suggests that while technician programs offered by community colleges remain important, biotech companies are increasingly looking for employees with more advanced skills, often at the bachelor's level in fields such as biotechnology, mechanical engineering, or industrial engineering. Once hired, much of their ongoing education and training is on-site, through learning by doing at production facilities.

Biomedical industry-specific skill needs in the Bay Area have changed since the mid-2000s, reflecting particular growth in biotech, genomics, and digital health care. Appendices B and C show the location of biomedical companies in the Bay Area and the specific workforce skill sets required in these fast-growing segments.

R&D and Manufacturing

The Bay Area is an important locus of manufacturing, in part due to the presence of technology companies that require components and other inputs for production. R&D is another important anchor for manufacturing activity, which might locate elsewhere were it not for the need for proximity to the manufacturing floor as new technologies are developed. This anchors a significant amount of activity, particularly in Santa Clara County, and drives demand for higher skilled employees that operating those facilities requires.

As one recent example, GAF Energy, a manufacturer of integrated solar rooftop systems, recently announced its intention to reshore its manufacturing operations from South Korea to San Jose. The new plant will be a combined R&D and manufacturing facility employing approximately 400 people across manufacturing, engineering, and research. While the shift of manufacturing from Asia to a high-cost location like the Bay Area is unusual, the company believes that housing manufacturing and R&D at the same site will make the investment viable. According to the company's president Martin DeBono, "The co-location of R&D and manufacturing is a huge benefit for the scientists pushing the envelope on what's possible for the product and the engineers responsible for rolling it off the line."¹¹

A listing of the Bay Area’s top manufacturers produced by the Silicon Valley Business Journal suggests the diversity of the region’s production base, with particularly important concentrations in the automotive sector, technology, energy, food, and biotech.¹² This listing does not include important manufacturers – such

as Genentech, which operates major production facilities in Solano County, and Palo Alto Networks, which produces cybersecurity equipment in Santa Clara – for which the Silicon Valley Business Journal was unable to obtain employment data.

Leading Bay Area Manufacturers

Company	Employees	Type of Business
Tesla	10,000	Sustainable Energy, Electric Vehicle
Lam Research	3,200	Semiconductor Equipment
Penumbra	2,000	Medical Devices
Maxar Technologies	2,000	Space
Intel	1,500	Technology Hardware
Chevron	1,500	Energy
Keysight Technologies	1,200	Electronic Product Design & Manufacturing
Western Digital	1,200	Computer Data Storage Technology
Jabil	1,119	Electronic Product Design & Manufacturing
See's Candy	1,070	Food
Bayer	1,055	Life Science/Biotech
Super Micro Computer	800	Computer Data Storage Technology

Source: Silicon Valley Business Journal, August 7, 2020

Other Bay Area Manufacturers

Company	Employees	Type of Business
Sanmina	800	Electronic Product Design & Manufacturing
Marathon Petroleum	690	Energy
Vender-Bend Manufacturing	690	Metals Contract Manufacturing
Amy's Kitchen	631	Food
Cypress Semiconductor	600	Semiconductor Equipment
Jelly Belly	600	Food
USS-POSCO	585	Steel Finisher
Lockheed Martin Space	560	Space & Missile Defense
Boehringer Ingelheim	520	Biologics
BioMarin Pharmaceutical	453	Biopharmaceuticals
C&H Sugar	428	Food
Finelite	350	Lighting

Source: Silicon Valley Business Journal, August 7, 2020

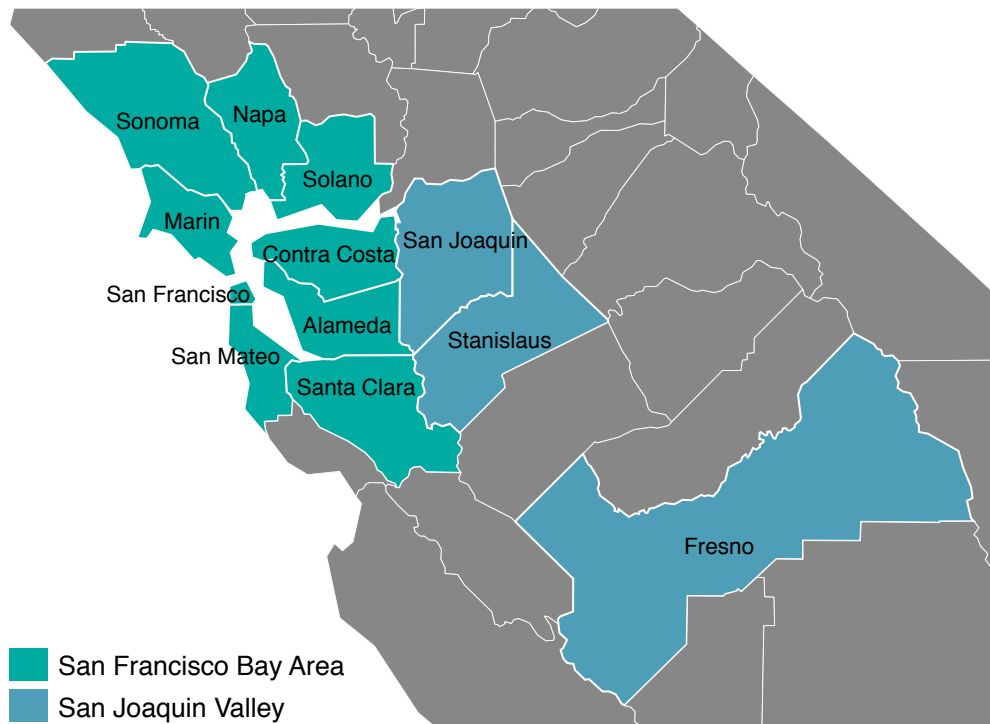
County-Level Employment Trends in the Bay Area and San Joaquin Valley

The analysis in this section is based on data from the California Employment Development Department (EDD) for 2008-2020. Focused on manufacturing sub-industries at the county level in the San Francisco Bay Area and the San Joaquin Valley, it looks at the number of firms, employment, and average annual wages. To protect confidentiality for reporting companies, some of the data has been withheld by EDD where there would be a risk of disclosure of specific company data. Using this data, this section also assesses the size and scale of the manufacturing sector in each county and identifies leading sub-industries and their growth trends. Wages in these geography-based sub-industries are also analyzed in comparison to other economic sectors.

Other data used in this section draws from a survey conducted by SFMade in San Francisco and San Jose and San Joaquin Valley Manufacturing Alliance in Fresno at the end of 2020 and the beginning of 2021 with 185 respondents in San Francisco, 34 respondents in San Jose, and 22 respondents in Fresno. Variation in the number of respondents does not correspond to the number of manufacturers in each region.

Average annual wages drawn from first quarter 2021 EDD data reflect only production-related occupations. They do not include other roles within manufacturing companies. These data points offer a narrow snapshot of compensation in the manufacturing sector since they do not distinguish between educational levels or years of experience. Additional advertised wage information is drawn from Burning Glass, a database that collects online job postings. Since not all manufacturing jobs are advertised online or list wages, this data must also be understood in context.

Regions of Analysis

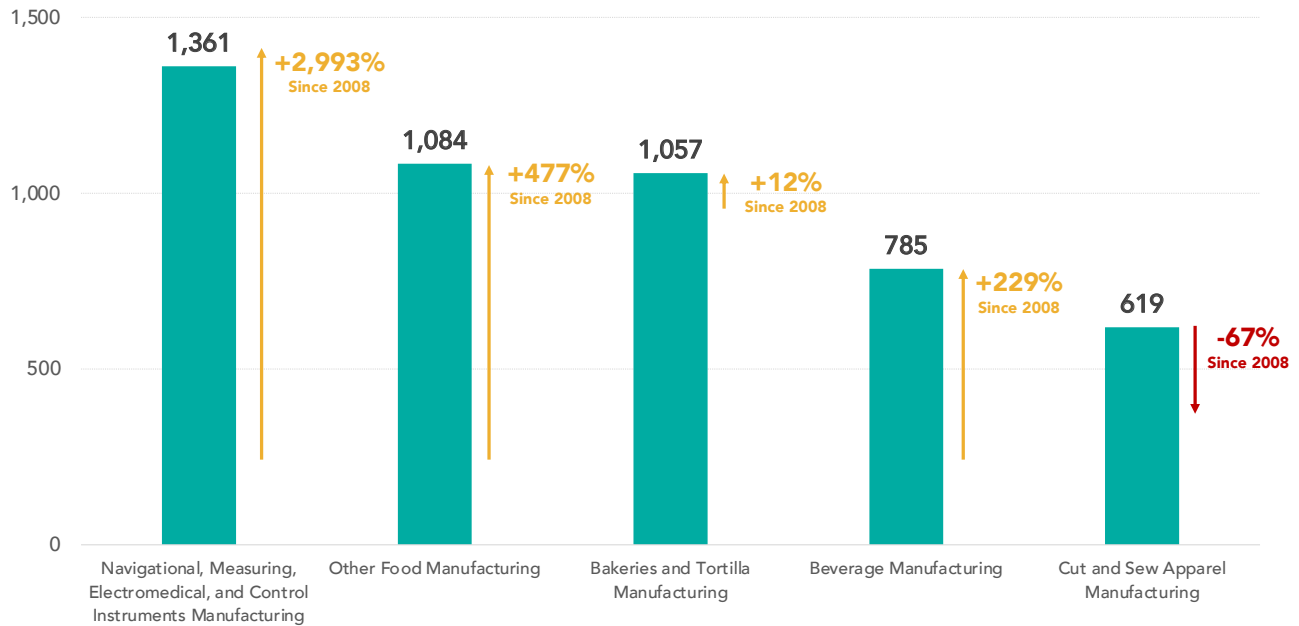


San Francisco County

San Francisco County is home to 9,356 manufacturing employees, with EDD data showing an average of \$50,461 in wages in 2021. Burning Glass data shows an average advertised salary of \$40,000 for people with a high school degree or vocational training, ranging up to \$53,400. For job postings looking for applicants with an Associate’s Degree, the average advertised wage is \$51,400, ranging up to \$70,800. Survey data shows that 85% of jobs at responding businesses pay more than \$18/hour, and 77% of employees live in San Francisco.

Navigational, measuring, electromedical, and control instruments manufacturing is the largest sub-industry by employment, with 1,705 employed in San Francisco County. This is the fastest growing sub-industry in San Francisco, with a nearly 3,000% increase in employment since 2008. Many of these companies are conducting research and development as well as smaller scale manufacturing. San Francisco County has also experienced significant growth in the food & beverage sub-industries. In contrast, employment in cut and sew apparel manufacturing has declined since 2008.

Top 5 Manufacturing Sub-Industries by Employment in San Francisco County (2020)



Source: California Employment Development Department (EDD)

San Francisco County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Printing and Related Support Activities	82
Bakeries and Tortilla Manufacturing	78
Cut and Sew Apparel Manufacturing	59
Other Miscellaneous Manufacturing	51
Beverage Manufacturing	45
Total Firms	766

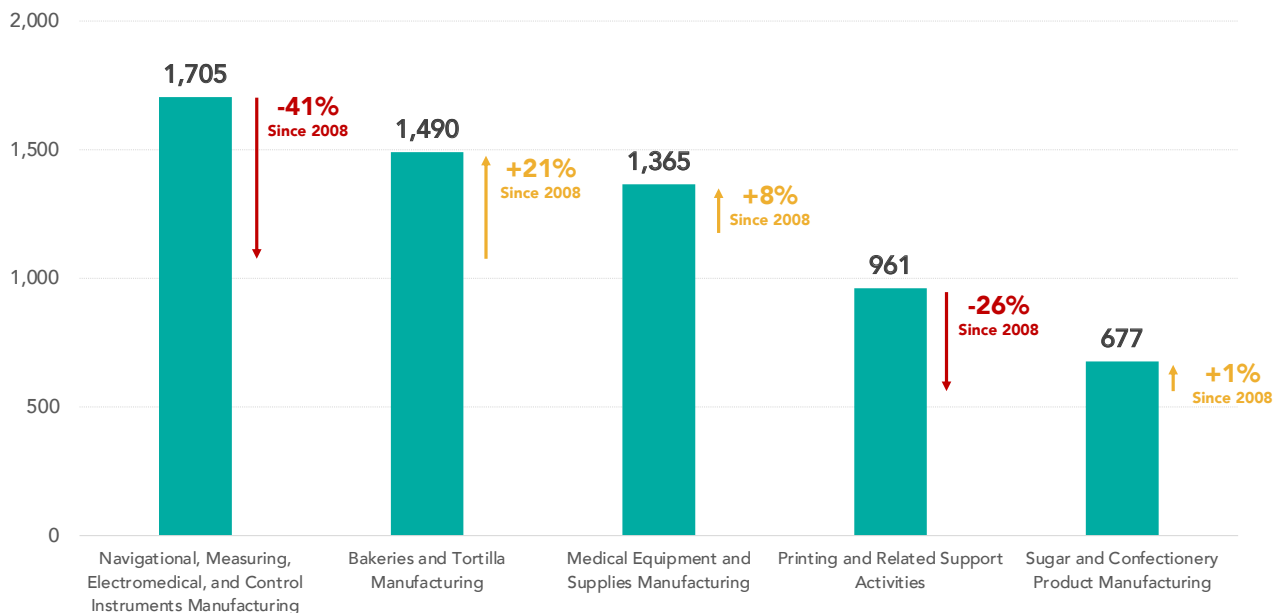
Source: California Employment Development Department (EDD)

San Mateo County

Manufacturing in San Mateo County supports 10,835 employees, with EDD data showing an average of \$50,461 in wages in 2021. Burning Glass data shows an average advertised salary of \$36,300 for people with a high school degree or vocational training, ranging up to \$44,100. For job postings for applicants with an Associate’s Degree, the average advertised wage is \$53,500, ranging up to \$70,100.

The manufacturing base in San Mateo is focused on advanced manufacturing and food and beverage production. Navigational, measuring, electromedical, and control instruments manufacturing is the largest sub-industry by employment with 1,705 employees in 2020. However, the county has experienced a 41% decline in employment in this sub-industry since 2008. Other large sub-industries such as bakeries and tortilla manufacturing and medical equipment and supplies manufacturing have seen an increase in employment over the same time period.

Top 5 Manufacturing Sub-Industries by Employment in San Mateo County (2020)



Source: California Employment Development Department (EDD)

San Mateo County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Medical Equipment and Supplies Manufacturing	65
Bakeries and Tortilla Manufacturing	52
Printing and Related Support Activities	51
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	50
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	45
Total Firms	681

Source: California Employment Development Department (EDD)

Santa Clara County

At the heart of Silicon Valley with 157,626 manufacturing employees in 2,568 firms, Santa Clara County is the largest manufacturing center in the Bay Area. In April 2020, manufacturing accounted for over 15% of all jobs.¹³ EDD data shows an average wage in the county in 2021 of \$48,883. Burning Glass data shows an average advertised salary of \$36,300 for people with a high school degree or vocational training, ranging up to \$44,100. For job postings looking for applicants with an Associate’s Degree, the average advertised wage is \$53,500, ranging up to \$70,100.

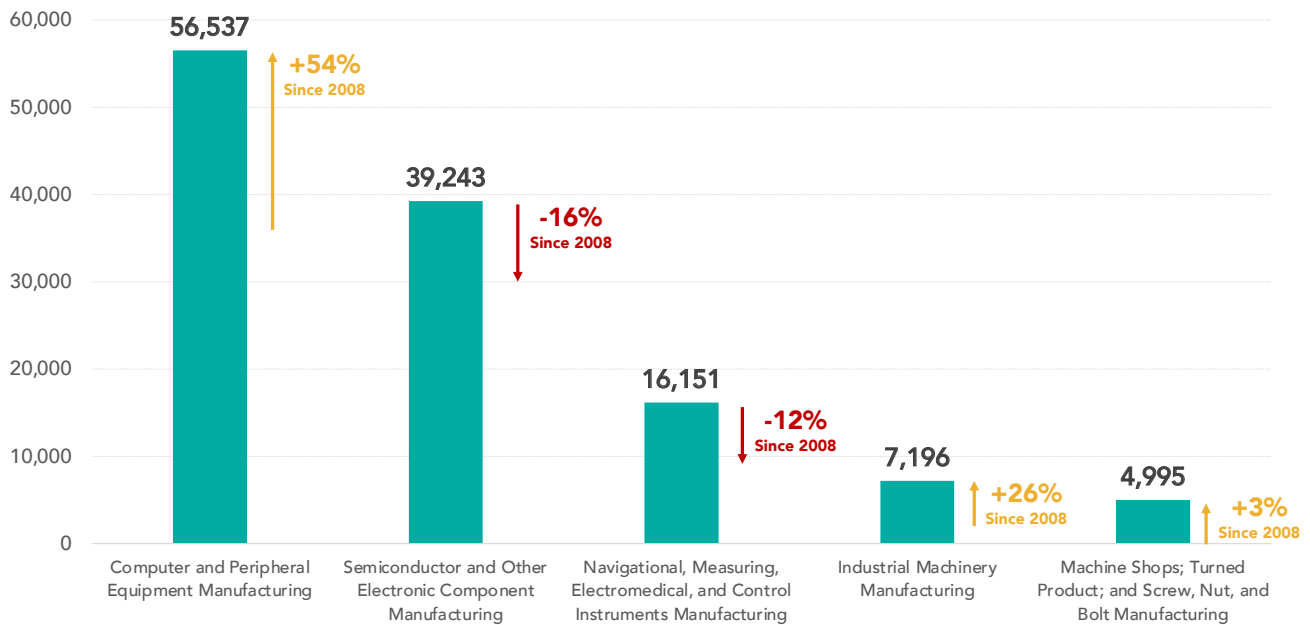
The largest concentration of employment is in the computer and peripheral equipment manufacturing sub-industry with 56,537 employees. This is also one of the fastest growing sub-industries in the county, up from 36,000 employees in 2008, representing a 54% increase.

Firms in this sector manufacture computer printers, monitors, keyboards, webcams, as well as ATMs, self-service kiosks, and point-of-sale terminals. Demand is driven by consumers and government spending, as well as capital spending by businesses.

The semiconductor and other electronic component and the navigational, measuring, electromedical, and control instruments manufacturing sub-industries also account for a large share of employment with 39,243 and 16,151 employees, respectively. These sub-industries, however, have seen a decline in employment since 2008.

Survey data from San Jose shows 79% of employees earning above \$18/hour, with 60% of employees living in San Jose. Of anticipated hires in the next 12 months in manufacturing, 77.4% are anticipated to be in assembly.

Top 5 Manufacturing Sub-Industries by Employment in Santa Clara County (2020)



Source: California Employment Development Department (EDD)

Santa Clara County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Semiconductor and Other Electronic Component Manufacturing	412
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	353
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	250
Printing and Related Support Activities	139
Medical Equipment and Supplies Manufacturing	138
Total Firms	2,568

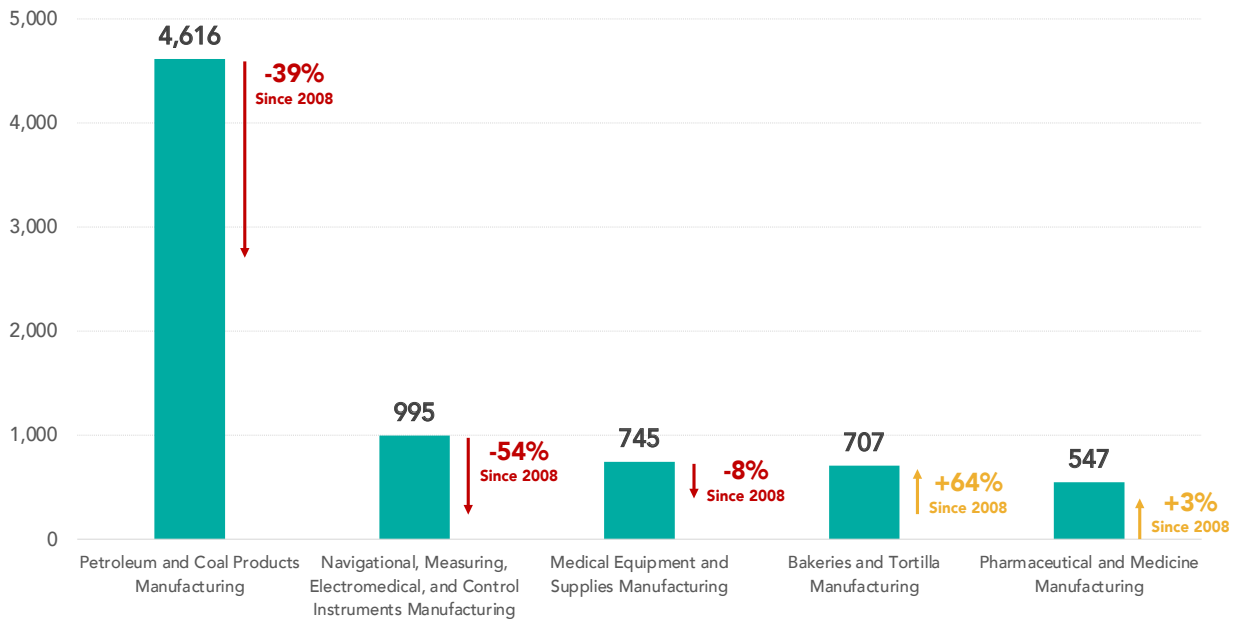
Source: California Employment Development Department (EDD)

Contra Costa County

In 2020, Contra Costa County had 12,948 manufacturing employees, with EDD data showing an average of \$51,926 in wages annually. Burning Glass data shows an average advertised salary of \$35,600 for people with a high school degree or vocational training, ranging up to \$46,100. For job postings looking for applicants with an Associate's Degree, the average advertised wage is \$48,500, ranging up to \$58,700.

Employment is primarily concentrated in petroleum and coal products manufacturing with over 4,600 jobs based in a small cluster of companies. Firms in this sub-industry refine crude oil and coal into fuel, asphalt products, and other products. While manufacturing employment in the county has experienced an overall decline, petroleum refining and products remains strong

Top 5 Manufacturing Sub-Industries by Employment in Contra Costa County (2020)



Source: California Employment Development Department (EDD)

Contra Costa County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Printing and Related Support Activities	64
Medical Equipment and Supplies Manufacturing	35
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	32
Beverage Manufacturing	30
Bakeries and Tortilla Manufacturing	29
Total Firms	951

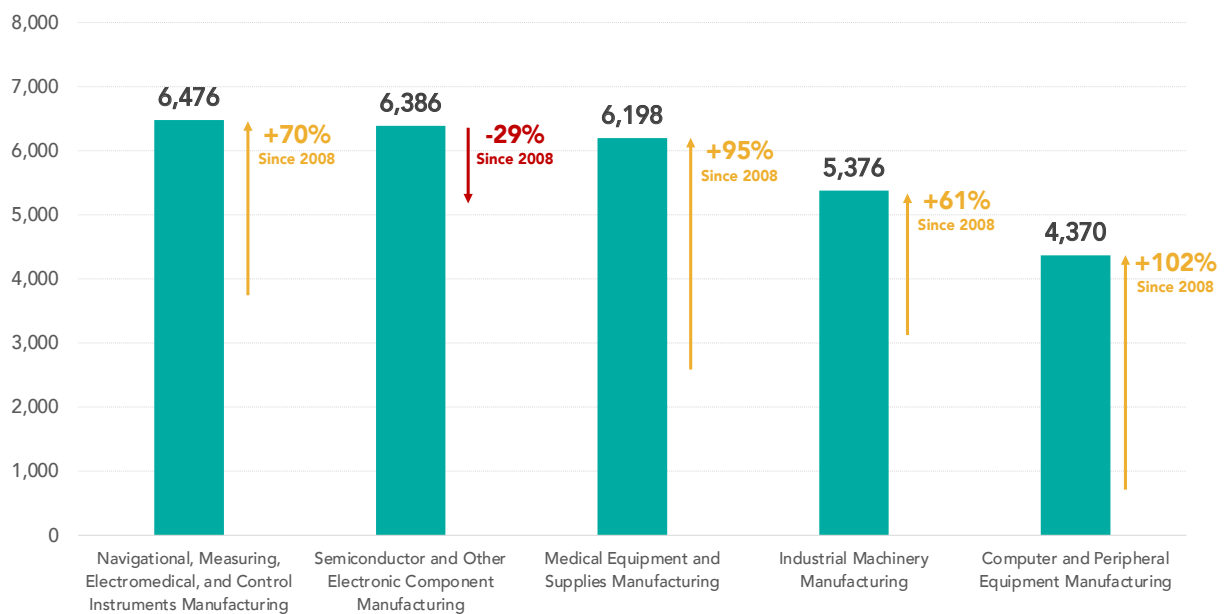
Source: California Employment Development Department (EDD)

Alameda County

Alameda County has seen significant growth in manufacturing post-recession. In 2020, manufacturing in the county accounted for 70,363 jobs, and EDD data showed an average wage of \$51,926 annually. Burning Glass data shows an average advertised salary of \$36,600 for people with a high school degree or vocational training, ranging up to \$46,300. For job postings looking for applicants with an Associate’s Degree, the average advertised wage is \$49,900, ranging up to \$65,500.

Navigational, measuring, electromedical, and control instruments manufacturing is the largest sub-industry by employment with 6,476 employees in 2020, a 70% increase from 2008. Much of this is driven by Tesla. Other large manufacturing sub-industries such as medical equipment and supplies manufacturing, industrial machinery manufacturing, and computer and peripheral equipment manufacturing have also experienced strong growth.

Top 5 Manufacturing Sub-Industries by Employment in Alameda County (2020)



Source: California Employment Development Department (EDD)

Alameda County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Printing and Related Support Activities	153
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	149
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	128
Semiconductor and Other Electronic Component Manufacturing	114
Bakeries and Tortilla Manufacturing	106
Total Firms	2,058

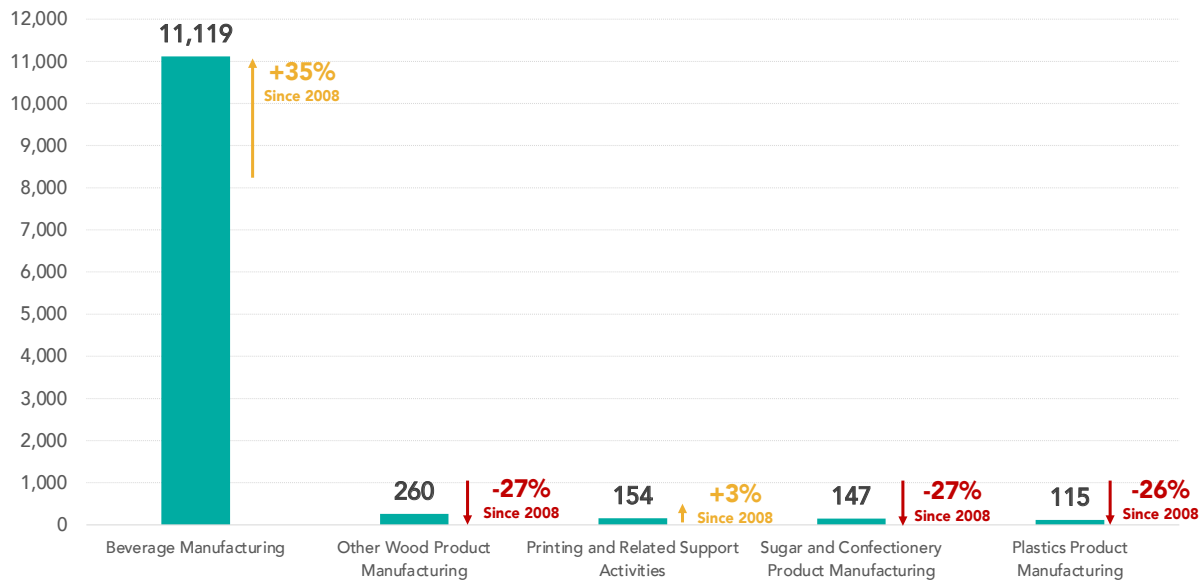
Source: California Employment Development Department (EDD)

Napa County

In 2020, the manufacturing sector in Napa County employed 12,112, with over 11,000 employees concentrated in the beverage manufacturing sub-industry (primarily wine). Other sub-industries in the county have remained relatively small and have declined in employment since 2008. EDD data shows an average

of \$55,682 in wages annually. Burning Glass data shows an average advertised salary of \$33,100 for people with a high school degree or vocational training, ranging up to \$39,100. For job postings looking for applicants with an Associate's Degree, the average advertised wage is \$40,000, ranging up to \$47,400.

Top 5 Manufacturing Sub-Industries by Employment in Napa County (2020)



Source: California Employment Development Department (EDD)

Napa County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Beverage Manufacturing	433
Printing and Related Support Activities	11
Other Wood Product Manufacturing	10
Architectural and Structural Metals Manufacturing	7
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	7
Total Firms	533

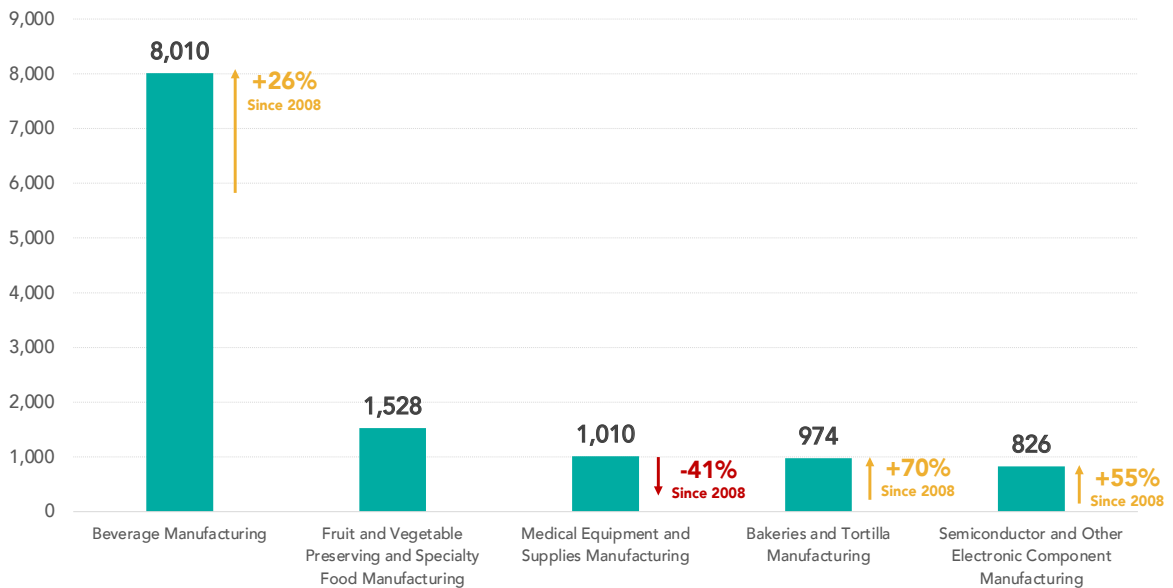
Source: California Employment Development Department (EDD)

Sonoma County

In 2020, over 8,000 employees in the county were engaged in the beverage manufacturing sub-industry (as in Napa, primarily wine). Compared to Napa County, Sonoma County has higher levels of employment in other sub-industries including food processing, medical supplies, and electronic components. In 2020, Sonoma County had 19,175 employees in the manufacturing

sector, with EDD data showing an average wage of \$46,017 annually. Burning Glass data shows an average advertised salary of \$33,800 for people with a high school degree or vocational training, ranging up to \$41,600. For job postings looking for applicants with an Associate's Degree, the average advertised wage is \$42,800, ranging up to \$53,000.

Top 5 Manufacturing Sub-Industries by Employment in Sonoma County (2020)



Source: California Employment Development Department (EDD)

Notes: No data available for Fruit and Vegetable Preserving and Specialty Food Manufacturing in 2008 due to confidentiality

Sonoma County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Beverage Manufacturing	377
Printing and Related Support Activities	50
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	43
Other Wood Product Manufacturing	36
Other Miscellaneous Manufacturing	33
Total Firms	980

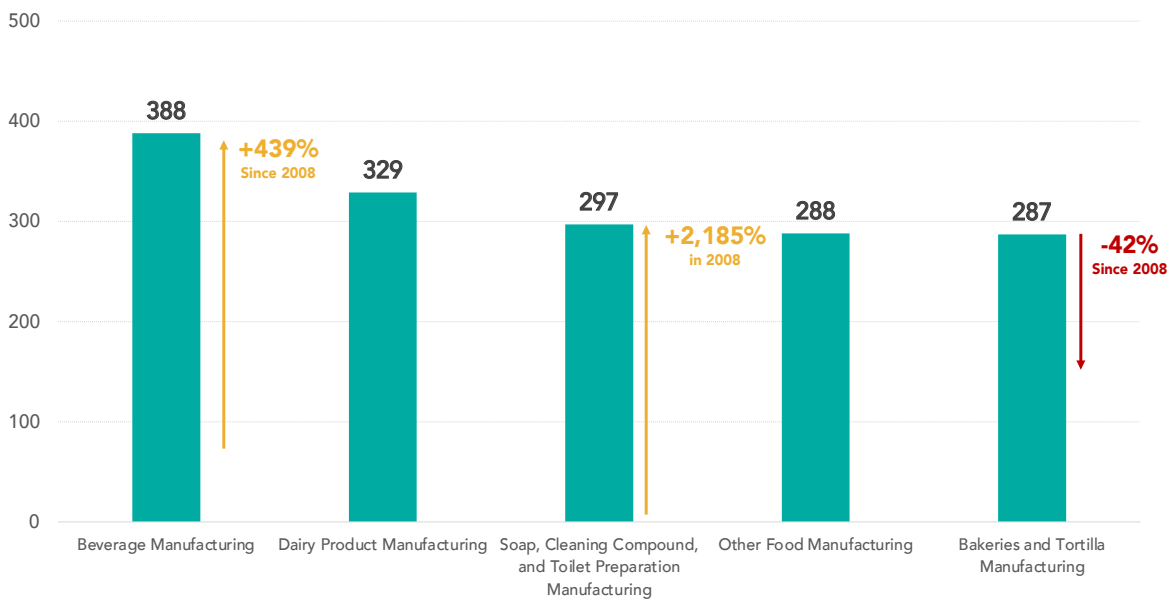
Source: California Employment Development Department (EDD)

Marin County

Marin County has a small manufacturing sector compared to other Bay Area counties, with 2,632 employees, and EDD data showing of an average wage of \$52,815. Burning Glass data shows an average advertised salary of \$35,800 for people with a high school degree or vocational training, ranging up to \$46,100. For job postings looking for applicants with an Associate’s Degree, the average advertised wage is \$40,100, ranging up to \$53,500.

Because of its small dataset of manufacturers and EDD’s commitment to protecting the confidentiality of company information, detailed data for Marin County is unavailable. As in other North Bay counties, beverage manufacturing is the largest employing sub-industry with nearly 400 employees in 2020, a 439% increase since 2008, with dairy and other food products companies also employing significant numbers.

Top 5 Manufacturing Sub-Industries by Employment in Marin County (2020)



Source: California Employment Development Department (EDD)

Notes: No data available for Dairy Product Manufacturing and Other Food Manufacturing in 2008 due to confidentiality

Marin County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Other Fabricated Metal Product Manufacturing	21
Petroleum and Coal Products Manufacturing	21
Other Leather and Allied Product Manufacturing	18
Other Miscellaneous Manufacturing	15
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	13
Total Firms	234

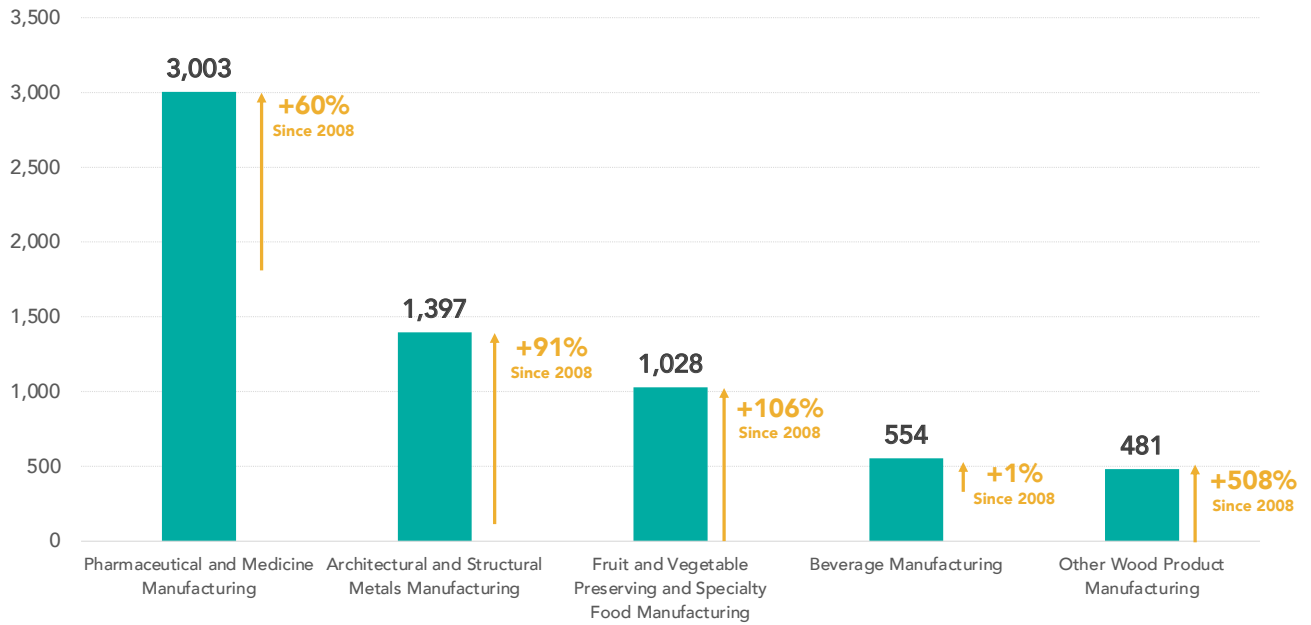
Source: California Employment Development Department (EDD)

Solano County

Since 2008, Solano County has seen its manufacturing base grow across a diversified base of sub-industries. Unlike other counties in the North Bay, employment is not primarily concentrated in beverage manufacturing. Led by the pharmaceutical and medicine manufacturing sub-industry, the county has a strong base in construction materials, biotech, as well as food and beverages.

In 2020, Solano County had 9,375 manufacturing employees, with EDD data showing an average wage of \$50,937 annually. Burning Glass data shows an average advertised salary of \$29,700 for people with a high school degree or vocational training, ranging up to \$37,000. For job postings looking for applicants with an Associate's Degree, the average advertised wage is \$42,700, ranging up to \$51,700. Each of the top sub-industries in terms of employment has experienced growth since 2008. In 2015, manufacturing contributed approximately one-fifth of Solano County's gross regional product, or over \$4 billion annually.¹⁴

Top 5 Manufacturing Sub-Industries by Employment in Solano County (2020)



Source: California Employment Development Department (EDD)

Solano County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Beverage Manufacturing	19
Bakeries and Tortilla Manufacturing	17
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	15
Architectural and Structural Metals Manufacturing	14
Medical Equipment and Supplies Manufacturing	12
Total Firms	271

Source: California Employment Development Department (EDD)

San Joaquin Valley

“Basically, Agriculture is manufacturing. If you don’t have automation, you’re toast. We grow what we sell, it needs to be processed, packaged, and transported to customers.”

-Betts Company, Fresno

The San Joaquin Valley is comprised of Fresno, San Joaquin, Merced, Madera, Kern, Kings, Tulare, and Stanislaus counties. Together, they account for over 105,000 manufacturing jobs. This section analyzes manufacturing employment in three counties: Fresno, San Joaquin, and Stanislaus.

Fresno County

Home of the fifth largest city in California (Fresno), Fresno County’s economic base has historically been and continues to be in agriculture. The county leads the state in the value of its agricultural production.¹⁵ Manufacturing in the county is also heavily focused on food processing.

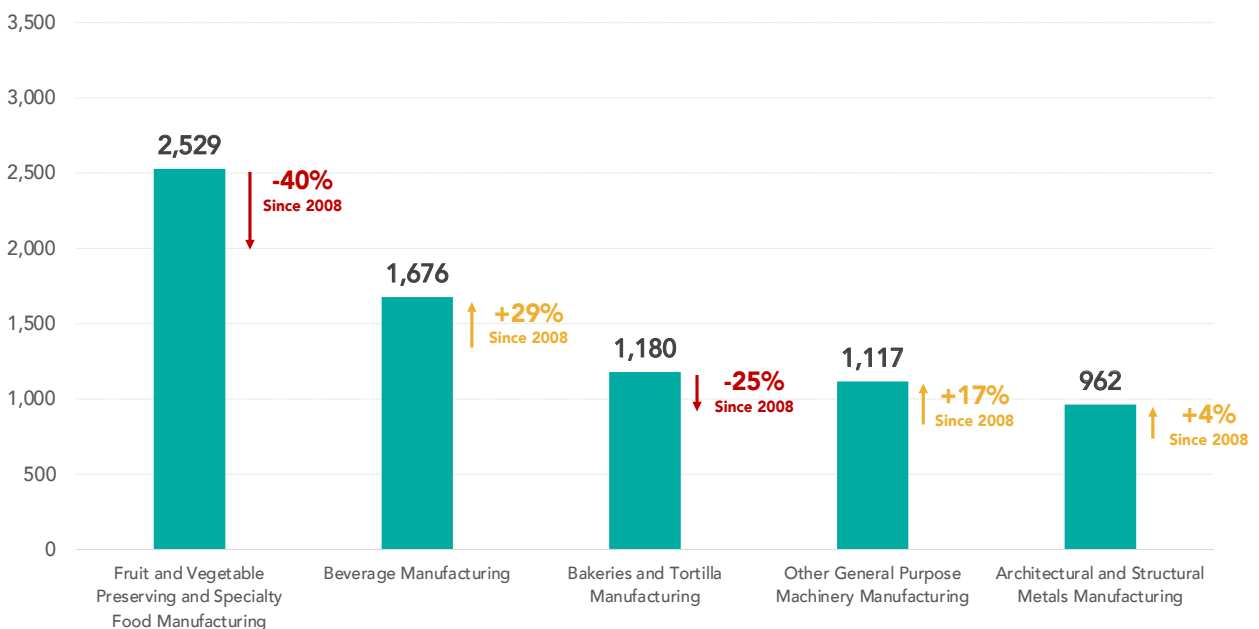
In 2020, Fresno County had 17,049 employees in the manufacturing sector, with EDD data showing an

average wage of \$40,706. Burning Glass data shows an average advertised salary of \$30,000 for people with a high school degree or vocational training, ranging up to \$38,900. For job postings looking for applicants with an Associate’s Degree, the average advertised wage is \$50,900, ranging up to \$66,600.

Led by the fruit and vegetable preserving and specialty food manufacturing sub-industry with over 2,500 employees, food and beverage manufacturing accounts for the largest number of manufacturing employees in the county. Since 2008, there has been a shift toward beverage manufacturing, with a 29% increase in employment. Food processing, however, has seen an overall decline with fruit and vegetable preserving and bakeries and tortilla manufacturing sub-sector employment falling 40% and 25%, respectively. General manufacturing has seen an increase in employment as the county has focused on growth opportunities in non-agricultural manufacturing to help diversify its economy.

Survey data showed 56% of employees earn above \$18/hour, and 66% of employees live in Fresno. A lower cost of living in Fresno compared to San Francisco and San Jose may partially explain the lower wages.

Top 5 Manufacturing Sub-Industries by Employment in Fresno County (2020)



Source: California Employment Development Department (EDD)

Fresno County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Printing and Related Support Activities	51
Bakeries and Tortilla Manufacturing	37
Beverage Manufacturing	36
Architectural and Structural Metals Manufacturing	34
Other Miscellaneous Manufacturing	28
Total Firms	609

Source: California Employment Development Department (EDD)

San Joaquin County

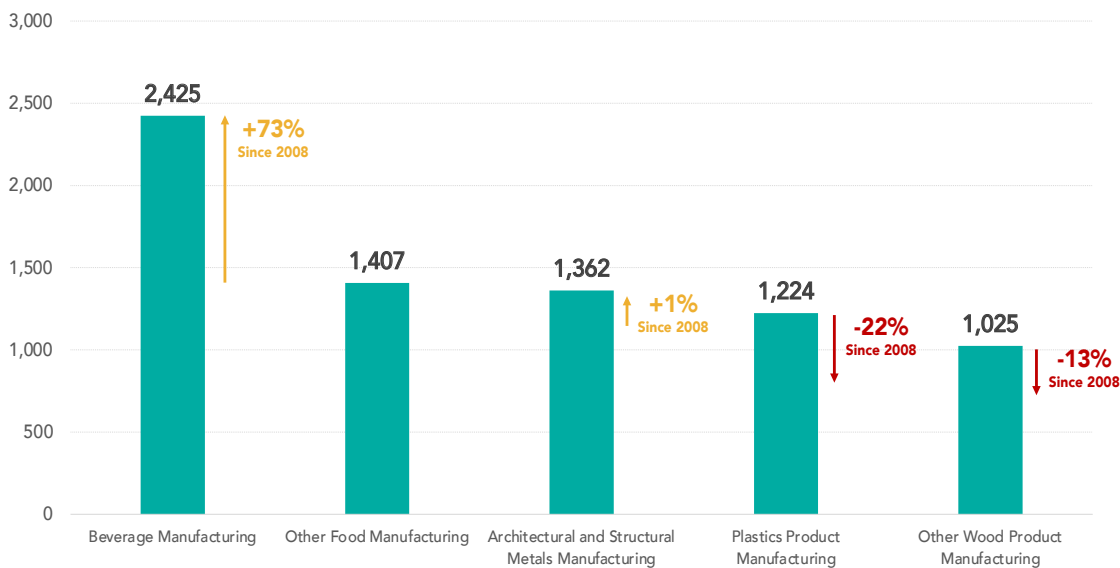
San Joaquin County has a mix of food and beverage processing, agriculture, and advanced manufacturing. Companies have located in cities such as Stockton and Manteca for their lower costs and infrastructure such as the Port of Stockton, Union Pacific Railroad, and interstate freeways.

In 2020, there were 17,543 employees in manufacturing in San Joaquin County, with EDD data showing an average salary of \$43,398 annually. Burning Glass data shows an average advertised salary of \$30,900 for

people with a high school degree or vocational training, ranging up to \$38,100. For job postings looking for applicants with an Associate’s Degree, the average advertised wage is \$44,500, ranging up to \$55,000.

Since 2008, there has been a substantial increase in food and beverage production, specifically in beverage manufacturing, which has seen a 73% increase in employment to over 2,400 jobs in 2020. The plastic product manufacturing and other wood product manufacturing sub-sectors have experienced a decline in employment, but still remain strong within the region.

Top 5 Manufacturing Sub-Industries by Employment in San Joaquin County (2020)



Source: California Employment Development Department (EDD)
 Notes: No data available for Other Food Manufacturing in 2008 due to confidentiality

San Joaquin County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Beverage Manufacturing	82
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	38
Architectural and Structural Metals Manufacturing	29
Other Wood Product Manufacturing	28
Printing and Related Support Activities	26
Total Firms	568

Source: California Employment Development Department (EDD)

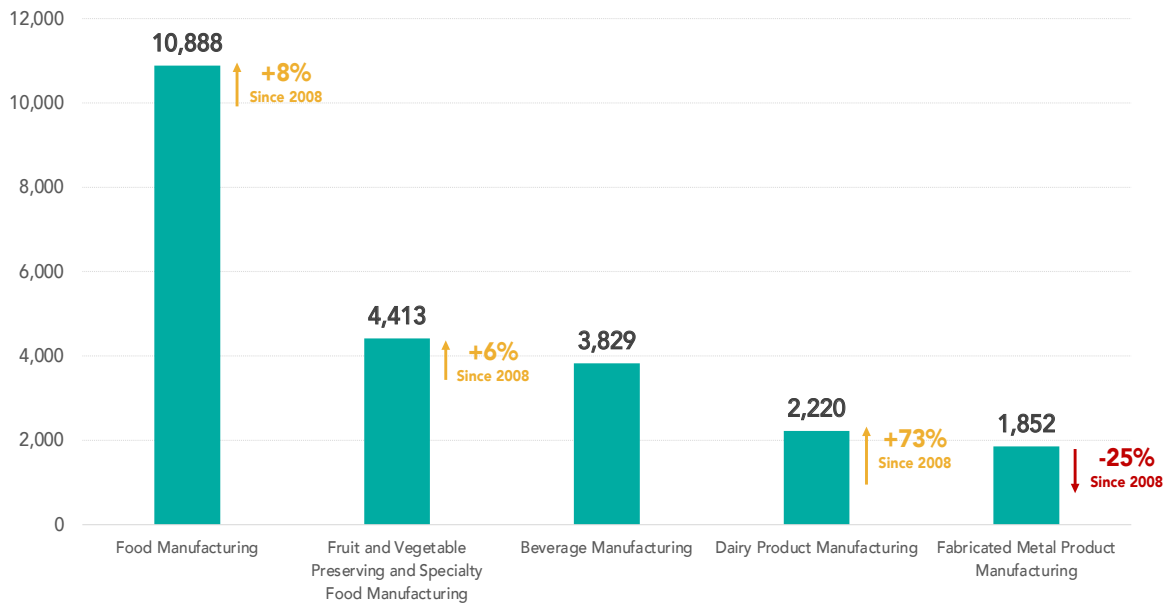
Stanislaus County

In 2020, there were 27,749 employees in the manufacturing sector in Stanislaus County, with EDD data showing average wages of \$43,274 annually. Burning Glass data shows an average advertised salary of \$35,900 for people with a high school degree or vocational training, ranging up to \$56,600. For job postings looking for applicants with an Associate’s

Degree, the average advertised wage is \$46,400, ranging up to \$60,100.

Manufacturing is concentrated in food and beverage processing. Since 2008, there has been a substantial increase in food manufacturing, particularly in dairy product manufacturing, which has experienced a 73% increase in employment and supports over 2,200 jobs in 2020.

Top 5 Manufacturing Sub-Industries by Employment in Stanislaus County (2020)



Source: California Employment Development Department (EDD)
 Notes: No data available for Beverage Manufacturing in 2008 due to confidentiality

Stanislaus County - Top 5 Sub-Industries by Number of Firms

Sub-Industry	Firms
Food Manufacturing	131
Fabricated Metal Product Manufacturing	93
Machinery Manufacturing	39
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	33
Architectural and Structural Metals	30
Total Firms	473

Source: California Employment Development Department (EDD)

Central California's Strategic Location for Modular Building Manufacturing

Some types of manufacturing that may not currently account for a large share of employment in their sector should be noted for their growth potential. Modular construction – pre-fabricated structures that are manufactured at a factory and assembled on-site – are one example. This technique is applicable to homes, multi-unit residential, and commercial structures. As a general rule, working conditions are safer, construction can be done up to 50% faster, and costs are in many cases lower due to the indoor

storage of materials, the ability to work regardless of weather, and the ability to simultaneously do component manufacturing and site preparation. Recent projects built by Factory OS in Vallejo, for example, include a 110-unit residential building in West Oakland and a 95-unit residential structure in Truckee. The East Bay and Central Valley are strategic locations for this type of manufacturing due to the lower cost of real estate and the proximity to major construction markets.



2

Accessing Opportunities in Manufacturing

Having established which sub-sectors of manufacturing are growing and merit particular attention by workforce developers, in this section we describe several factors that will influence the demand for workers in the sector and the kinds of skills they will need.

Attracting Younger Workers

Job statistics often track job growth or loss, but not workforce attrition. In manufacturing, there are at least two factors at play. One is that when layoffs occur, they tend to be concentrated mostly in younger, less experienced employees. That shifts the balance in the workforce toward older employees, while younger employees who were laid off are more likely than older ones to find new occupations and are therefore less likely to return to manufacturing when growth returns.

Cycles of this kind exacerbate the underlying challenge of retirements. Before the recession brought on by the dot-com bust, for example, Hewlett-Packard (HP) had approximately 6,000 employees in Sonoma County, of which more 2,000 were in manufacturing. That figure fell to approximately 600, with most of the remaining employees having been at the company for 15-20 years. Since then, hiring younger people with the right skills has been difficult. Patrick Harper, who managed HP's manufacturing operations in Sonoma County until 2018, notes that 10 years ago approximately 65% of machinists at the company were approaching retirement age and that by 2018 five manufacturing employees

were leaving the company for every one that joined. This pattern highlights the importance of manufacturing skills pipelines and feeder programs at community colleges and elsewhere that can continuously fill the gaps created by retirements. "If we don't develop these programs," Harper notes, "we'll be pushing more manufacturing to other countries."¹⁶

According to Deloitte, despite a trend toward delayed retirement – the average age of retirement is 66 – more than 2.6 million baby boomers are expected to retire from manufacturing jobs in the next decade. By 2028, more than half of open jobs (2.4 million) are at risk of remaining unfilled due to retirements and the exacerbating factors of shifting skill sets and popular misconceptions regarding manufacturing jobs.¹⁷ According to Pew Research, the percentage of baby boomers who are retiring has doubled in the last eight years and will continue to rise until 2030. The Bureau of Labor Statistics (BLS) estimates that the manufacturing sector has the highest tenure in its workforce of all the sectors measured. This raises the further issue of loss of knowledge as retirements accelerate.¹⁸

Technological Change and Digital Automation

Technological change will have a growing impact on manufacturing employment as the shift accelerates toward digital automation, with underlying advances

led by data analytics, artificial intelligence, and low-cost cloud computing. Strategies for businesses and their partners in education and government must focus on the workplace skills required to accommodate that change as the use of digital tools to improve the proficiency of frontline production grows.

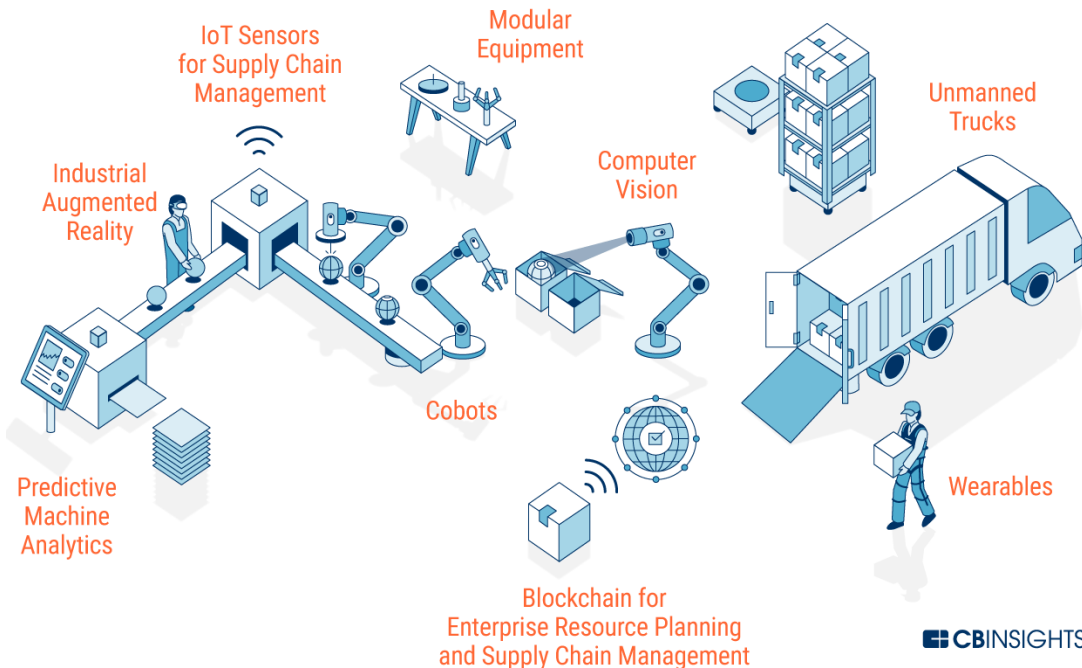
A fall 2020 survey of manufacturers by the World Economic Forum found a dominant concern: “Empowering the factory workforce with knowledge and digital tools will be essential to surviving the current pandemic and ensuring that operations can adapt to change anytime, anywhere – crisis or not.” The need for cross-training, upskilling and professional development was another concern: “Software that provides just-in-time digital content and learning – like digitized, interactive work procedures that ensure every step is accurately followed and information is readily available via a mobile device – are becoming a factory floor norm. Companies that provide opportunities for employees to build multiple competencies, from technical skills (automation, IT, engineering, data science) to “soft skills” (communication, adaptability, ownership,

collaboration, problem-solving) will be more resilient in the long term.”¹⁹

For example, the Industrial Internet of Things (IIoT) is accelerating the adoption of robotics, 3D printing, and other advanced manufacturing processes using sensors, data-driven autonomous systems, and web-connected interconnected devices that can collect critical metrics and visual data in real time and analyze the results to optimize manufacturing processes. In Industry 4.0, or the Fourth Industrial Revolution, that data is converted to insights at the operator level to support rapid and efficient decision making.

These processes offer added benefits to manufacturing companies by extending the lifespan of equipment, reducing equipment breakdowns, and increasing throughput. According to one study, the growing familiarity of companies with cloud technologies and connected devices has 78% of manufacturing organizations planning to increase their investment in IoT.²⁰

FACTORY OF THE FUTURE

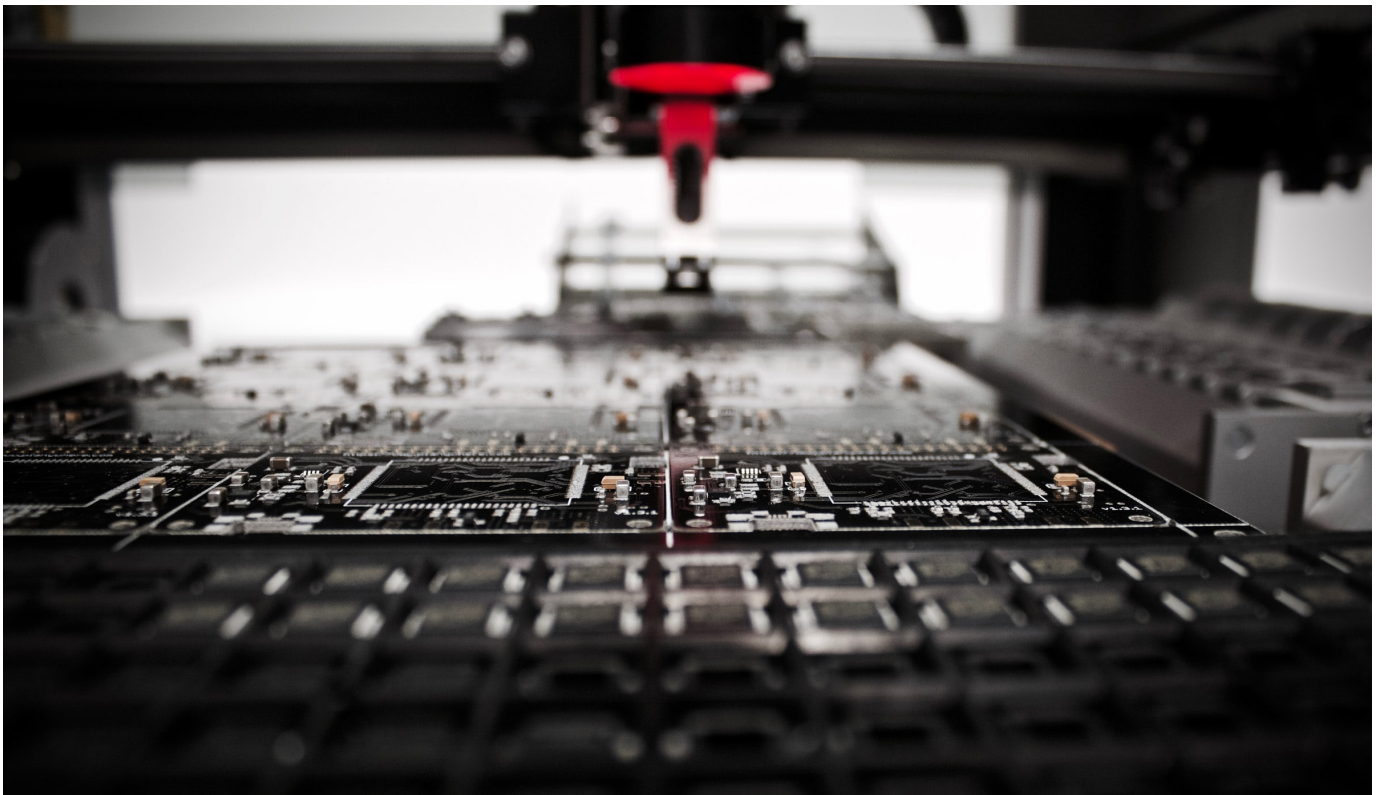


This transition will require education for new employees entering the workforce, upskilling as new skills are required to perform existing functions, and reskilling as workers take on new or different roles. McKinsey estimates that 39-58% of worldwide work in operationally intensive sectors could be automated using currently available technologies. By sector, the highest level of susceptibility is in manufacturing, where 58% of activity could be automated.

Automation and digitization affect both operations and maintenance. As one Fresno manufacturer, Anlin Windows, points out, "Machine operating has become simpler, and programming, fixing, and maintaining them has become more complex. We're a technology company that makes windows and doors. All the equipment we're buying has computers attached. Saws and welding are computerized, so running them is easier. Maintaining and programming the equipment and installing software is more complex."

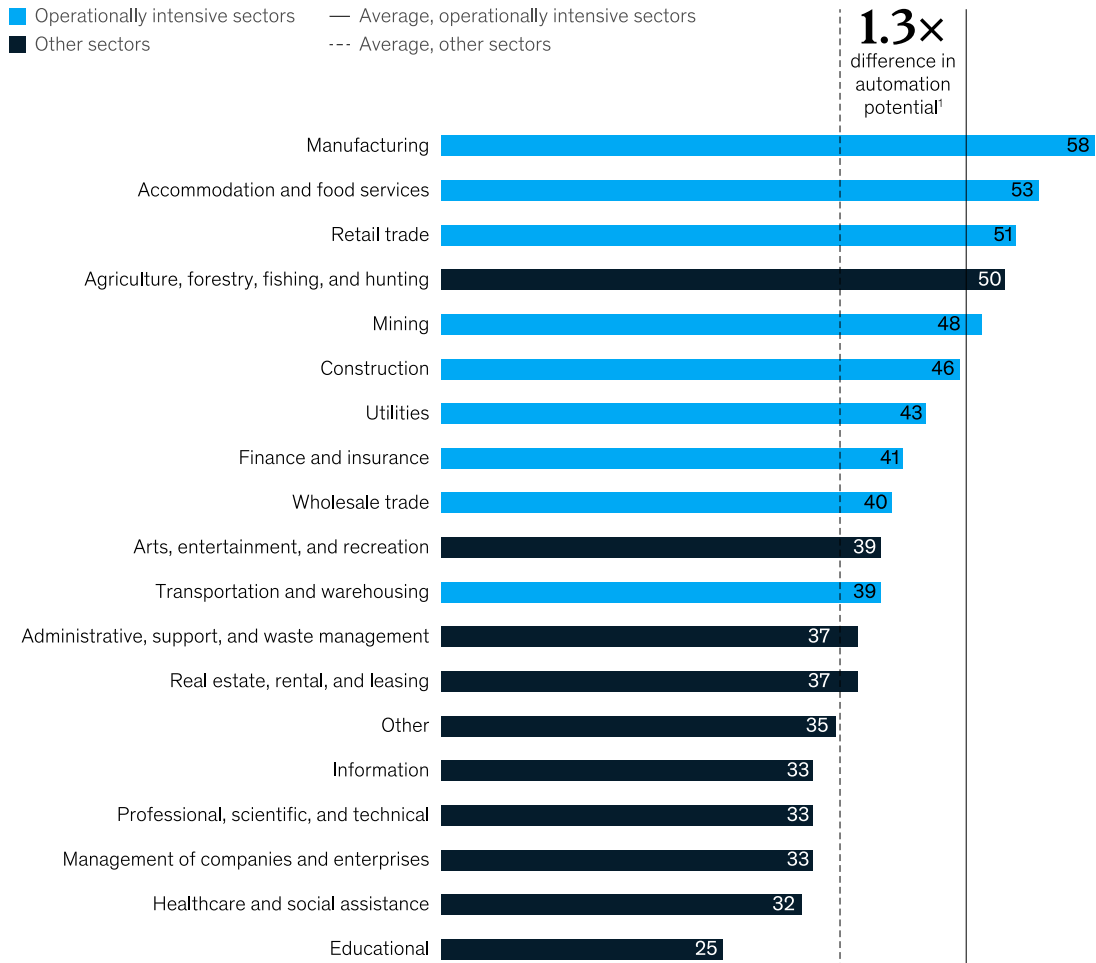
"With more automation, more maintenance mechanics are electrical, mechanical, and Programmable Logic Controller engineers, not just a guy who's good at fixing things. For example, a hydraulics shear, which is a piece of equipment that takes one piece of steel and cuts it into two, used to have 3 buttons – one to turn on, one to go up, and one to go down. If something went wrong you could chase the wires back to the button, or the board, or the hydraulic valve that is taking a signal. Now, a more complex machine that performs this operation has an in-feed and an out-feed conveyor, a jaw that operates along three axes, a Programmable Logic Controller, a hydraulic unit, a welding unit, and a vacuum unit – all different systems. When you're diagnosing and maintaining a piece of equipment, now you need to have someone who can think spatially."

-CBC Steel Buildings, San Joaquin County



Operations-intensive sectors have 1.3 times the automation potential of other sectors.

Technologically automatable activities by sector, % of total activities



¹We define automation potential by the work activities that can be automated by adapting currently demonstrated technology. Source: McKinsey Global Institute analysis

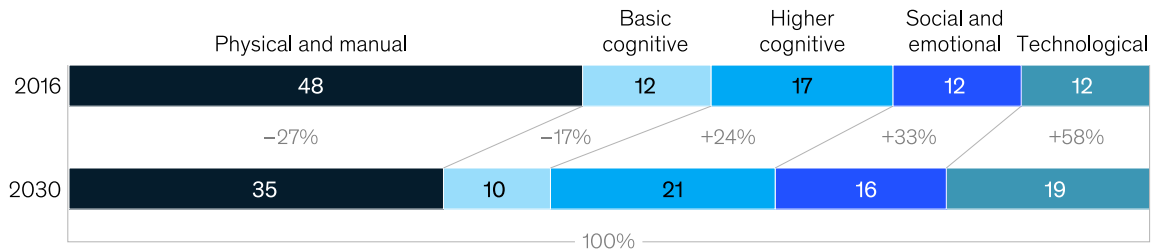


Trends toward digitalization were strong across all sectors, and have been accelerated now by the impacts of COVID-19. The skills demanded by manufacturers will continue to shift toward those needed to manage, maintain, and operate automated equipment that increasingly is digital. McKinsey estimates that the demand for physical and manual skills in repeatable and manual tasks will decline by 30% over the next decade,

while demand for technological skills requiring coding or interaction with technology will grow by 50%, and the need for complex cognitive skills will grow by one-third.²³ A recent survey of manufacturing executives finds that the top skill sets where demand is expected to increase are: technology/computer skills, digital skills, programming skills for robots/automation, working with tools and technology, and critical thinking skills.²⁴

Automation will have a significant impact on skill requirements.

Skill shift in US and Western Europe by category, % of time spent



Note: Figures may not sum to 100%, because of rounding.
 Source: McKinsey Global Institute analysis



While the overall number of jobs in manufacturing may continue to fall due to technological advances, wages are likely to increase for workers with these more complex skill sets. The Aspen Institute found that jobs in manufacturing increasingly will be higher-skill, professional, managerial, and technical. This will expand the need for training beyond two-year college or technical programs. In 2019, American manufacturers were on track to employ more college graduates than workers with a high-school education or less. More than 40% of manufacturing workers now have a college degree, up from 22% in 1991.²⁶ Key skill sets focus on engineering fields such as robotics, coding, and programming.

The push toward greater efficiency and fewer on-site workers has been accelerated by COVID-19, and many of these changes are here to stay. Heath Ceramics, for example, reports that its workforce is now 15% smaller than before the pandemic but has since seen a significant improvement in productivity levels. One consequence is that with leaner, more efficient teams some companies will find a need for more cross-training. Heath reports that it has “created many

hybrid positions.” San Francisco brewing company Fort Point notes, “With a smaller team, people rotate a lot more,” which has led to “a smaller, higher skilled, more multifaceted workforce.”

This technological transition can be a challenge not only for workers but for manufacturing companies themselves, who often don’t have a clear understanding of how automation, digitization, and other trends will affect the skills they will need in the future, don’t know how to quantify the business case for addressing potential digital skills gaps, or don’t know how to evaluate different solutions. In other words, employers may not always have a real-time roadmap of their future skills needs.

This places a premium on the evolution of training programs as specific needs develop. Successful training programs for employees (such as apprenticeships) are likely to involve a combination of classroom and on-the-job experience that may also involve a reorientation of the employee toward new ways of working and the opening of expanded opportunities for professional growth.



3

Today's Workforce: Training Ecosystems and their Gaps

The San Francisco Bay Area and the San Joaquin Valley support a broad range of workforce training programs that support manufacturing skills development. This section analyzes environmental factors in the manufacturing ecosystem that influence what kind of training is provided and identifies a range of initiatives and programs that are offered across the two regions studied. It also identifies gaps in the system that workforce service providers need to address.

From the perspective of education, a good economic sector would look like the healthcare industry, which has well-defined career paths and training programs from which large employers are willing to hire from directly. The manufacturing sector is more complex. From the perspective of employers, an ideal ecosystem for hiring would look more like a geographic region with a large number of manufacturers in a similar sub-industry, so that (1) the local workforce is highly aware of career opportunities in the sector and (2) employers can hire employees with previous experience.

For example, Neal Beardmore, who came from Stoke-on-Trent in England to lead production at Heath Ceramics in San Francisco, says, "The pool of labor, particularly for a ceramics business, just doesn't exist in the Bay Area. In the world that I came from, with literally thousands of people working in the ceramics industry in potteries, whenever you went out to recruit you were almost embarrassed by the volume and the quality of

"We've never developed a go-to pipeline for employees via a relationship with a community college or institution. That takes time and consistency, it's like needing milk and thinking you can only get it at Costco, when there are so many other places to go and get it immediately. That's what happens when we're hiring. We're not hiring for a huge number of people at one time, so we say 'we need a few more people, let's see where we can find them.' We're going to get our milk from the corner store – talk to people, get employee referrals, see what happens."

-Mountz, San Jose

applicants. If you're looking for a plant manager or a plate forming specialist here, you can't find them."

In these circumstances, companies need to both develop talent from within and promote the development of talent externally. The most successful workforce training ecosystems center around concentrations of similar businesses and identifiable occupations. From this perspective, the more that regions can do to increase awareness of career opportunities in manufacturing, the higher the volume of applicants is likely to be. There is a particular opportunity to attract workers from the agricultural, retail, and service sectors who may have less predictable schedules, may not have full benefits, or have fewer opportunities for advancement.²⁷

The Bay Area and the San Joaquin Valley both have strong workforce development and training ecosystems, with some existing connections to their respective manufacturing sectors. The San Joaquin Valley has strong community college technical training programs that act as pipelines to many businesses and some manufacturing related Career and Technical Education high school programs. The Bay Area has fewer manufacturing-specific training programs, with weaker connections between industry and training.

Regional Initiatives

There are several programs working to support manufacturers in the San Francisco Bay Area and the San Joaquin Valley, some with workforce and training related initiatives.

NextFlex

NextFlex in San Jose is one of nine Manufacturing Innovation Institutes created by the Department of Defense Manufacturing Technology Program to accelerate manufacturing capability and technology innovation and commercialization through pre-competitive partnerships. It particularly seeks to advance the manufacturing of flexible, conformal,

and lightweight electronic systems and devices for commercial and defense applications. In addition to advancing the technical art, its mission includes fostering the growth of the future U.S. workforce by preparing workers for new jobs in the advanced manufacturing sector and developing a sustainable U.S. manufacturing ecosystem for flexible hybrid electronics (FHE). The organization runs technical working groups, sponsors two regional nodes in Massachusetts and New York, and distributes federal grants for business development. It also runs workforce development programs including:

- **FlexFactor®** – an outreach program designed to engage K-12 students through technology, entrepreneurship, and the development of education and career pathways that lead to careers in advanced manufacturing. Layered over an existing class, it challenges small teams of students to identify a real-world problem, conceptualize an advanced hardware product, and build a business model around it. Core program elements include an industry tour, a college tour, and mentored workshops. At the end of the program, teams pitch their product ideas to a panel of mentors. The program can be delivered virtually, in-person, or in a hybrid format.

A Note on Maker Spaces:

Over the past 10 years, the rising popularity of Maker Spaces, the Maker Fair, and interest in learning fabrication technology has tracked side by side with the manufacturing field. Many well-resourced colleges and high schools have installed maker spaces, and the field of Maker Education has its own organizations, such as the nonprofit Maker Ed, which connects making to STEAM education. Maker spaces tend to have light manufacturing technology and teach people how to use it on their own, mostly for personal projects or small businesses. Common technology includes laser cutters, low-cost 3D printers, wood and metal shops, sewing machines, and soldering. The culture of tinkering, building, and curiosity about how things are made and work aligns with manufacturing. In essence, manufacturing is simply making at scale.

Some manufacturers will naturally recognize the value of experience in a maker space environment, especially if they're looking for someone to use multiple types of machines or excel at learning new fabrication techniques. However, much work remains to link maker spaces to manufacturing employers in a meaningful way. At their worst, maker spaces can be elite spaces where diverse, lower-income populations don't feel welcome. At their best, they can be equity focused places that provide an introduction to technical skills for underserved populations. Organizations that serve manufacturing businesses can help job seekers translate these experiences and skills so that manufacturers can understand their benefits. Maker spaces and the organizations that run them also need to engage employers and help their users understand their career options in manufacturing.

- **Flex2Future** – a work-based learning program designed to allow colleges to integrate on-the-job training into advanced manufacturing learning pathways. Through the program, colleges and companies collaborate to place students in advanced manufacturing internships, apprenticeships, and co-ops. Students gain both foundational STEM education and applications-based learning essential to graduating prepared for the workforce. The objective of the program is to produce a cohort of students with the professional, communication, knowledge, and hands-on skills to be competitive hires in the advanced manufacturing sector.
- **FlexPro** – an education program designed for professionals in the advanced manufacturing sector. Through exercises and theory-based lectures, participants discover how flexible hybrid electronics can be integrated into product designs to reduce their size, weight, power requirements, and cost and increase manufacturing efficiencies.

Bay Area Urban Manufacturing Initiative

Launched in 2016 at the Bay Area Urban Manufacturing Summit, the Bay Area Urban Manufacturing Initiative (BAUM) is a project to facilitate the creation of a well-defined and interconnected regional manufacturing ecosystem. Its 32 regional partners include Alameda, Antioch, Berkeley, Brentwood, Concord, Contra Costa County, Dublin, Emeryville, Fairfield, Fremont, Hayward, Livermore, Milpitas, Morgan Hill, Napa, Newark, Oakland, Oakley, Petaluma, Pittsburg, Pleasanton, Richmond, San Francisco, San Jose, San Leandro, San Rafael, Santa Rosa, Sonoma County, South San Francisco, Union City, Vacaville, and Vallejo. BAUM supports manufacturing throughout the region by providing education to city leaders and by helping communities create a strong MFG Week presence.

AM Bay Area

AM Bay Area is a trade group dedicated to ensuring that manufacturing thrives in the Bay Area, supporting and promoting Bay Area manufacturing through member education, workforce development, purchasing power, and grassroots advocacy and collaboration. It is led by a board of directors that includes executives

from a variety of manufacturing industries, sub-regions, and support organizations. Activities include a yearly summit, webinars, and an ambassador program that connects manufacturers to local schools.

South Valley Industrial Collaborative

The South Valley Industrial Collaborative (SVIC) is a partnership for community excellence whose purpose is to support industry-driven and community-supported partnerships, which strengthen economies in the South San Joaquin Valley. It provides a sub-regional platform for San Joaquin Valley industry and businesses to collaborate and connect with regional, state, and national partner organizations to support the region's efforts to become a globally competitive location for manufacturing and industrial jobs. Priorities include talent acquisition, development, and retention. A feasibility study conducted for an industry training center in the South San Joaquin Valley has been completed with favorable results.

Career Nexus

Career Nexus is a community initiative of the Fresno Business Council and one of 19 initiatives of Fresno DRIVE – an effort supported by the Central Valley Community Foundation to develop an inclusive, vibrant, and sustainable economy for the Fresno region. Initial three-year funding for Career Nexus has been provided by the James Irvine Foundation, along with additional ongoing funding from the Fresno Regional Workforce Development Board, to underwrite paid internships. Currently in the development phase, Career Nexus is piloting the program with a range of businesses and a diverse class of interns. Interns are 18-28 year-old young adults who are referred by partner organizations after completing an introductory career readiness program. During the 100-200 hour internship they work on the payroll of a third party and complete an online work readiness certificate. Internship pilots began in late 2020, initially focusing on small to mid-sized manufacturers, healthcare organizations, and public institutions. The program is set to launch on a larger scale across more industry segments in January 2022, with anticipated funding for 1,000-2,000 internships per year over three years. Approximately 30% of those internships are expected to be in manufacturing.

High School Career Technical Education

The Bay Area and the San Joaquin Valley have few manufacturing-specific high school and Career Technical Education programs. Career Technical Education (CTE) is the modern equivalent of vocational education, which once featured auto shops, metal shops, and wood shops in most large high schools. Vocational education fell out of favor, however, as the focus of educators shifted toward four-year degree programs.

Current CTE programs supplement the traditional high school curriculum. Statewide, there are 15 industry sector curriculum standards, one of which is Manufacturing and Product Development.²⁸ Under that are pathway standards for: Graphic Production Technologies, Machining and Forming Technologies, Welding and Materials Joining, and Product Innovation and Design. These statewide standards serve as guidelines to sub-state agencies for developing their local programs. Broadly, CTE programs tend to be more oriented to building and construction trades and to engineering and architecture than to manufacturing, although there is some overlap in content.

A list of CTE programs in the Bay Area and San Joaquin County can be found in Appendix IV. It includes schools with manufacturing-specific programs, but not those that focus only on welding, which are more targeted on the trades than manufacturing. It also doesn't include schools that only have engineering programs, since those programs often guide students toward four-year engineering programs and not necessarily the manufacturing applications of engineering.

Regional Occupational Programs (ROPs) which operate throughout California under the Department of Education, were formed in the 1960s to provide career technical education to students who weren't being served by a single school or district. The primary function of ROPs as part of a comprehensive CTE system is to provide higher-level (capstone) courses for students in grades 11 and 12 that may lead to industry certification, dual enrollment with a local community college, and attainment of the skills and knowledge that can benefit them in post-secondary

placements. There are three ROPs in the San Joaquin Valley that provide manufacturing courses to multiple schools: Valley ROP offers courses in Manufacturing and Product Development, Central ROP offers Engineering and Product Development (covering manufacturing techniques), and Fresno ROP offers Manufacturing and Product Development Industry courses.

The Fresno County Superintendent of School's Career Technical Education Charter High School (CTEC) has received a Strong Workforce grant from California's community colleges, an initiative that encourages K-12 schools to partner with community colleges. A private donor contributed a further \$2 million to get the school up and running. Through what is now the SJV Manufacturing Alliance, local manufacturing businesses were an integral part in the development of CTEC and have been highly involved in the development of the manufacturing curriculum. CTEC enables high school students to dually enroll and receive college credit for courses taken while in high school, with the opportunity to graduate with both a high school diploma and an associate's degree in Industrial Technology from Fresno City College. Students have the opportunity to develop skills and earn certifications within chosen technical pathways so that they can immediately pursue a career or continue their education and skill development at the post-secondary level. The program offers just two tracks: advanced manufacturing and commercial construction.

NextFlex's Flex Factor Program: What started as a pilot program in San Jose with eight students in the fall of 2016 has expanded throughout Silicon Valley and has now engaged over 3,000 students. In 2018, Lorain County Community College in Lorain, Ohio became the first national adopter of the FlexFactor program. Since then, the program has expanded to seven ecosystems across the country in partnership with Boeing, and an additional 13 ecosystems with the support of the Department of Defense. The program runs for four weeks during which students take a Career Readiness Workshop, attend an Industry Day and a College Day, work in groups on a business problem, and pitch their solutions to a panel of industry mentors. The program seeks to motivate students to join the technology sector, and since it can layer on top of a range of high school or middle school subject areas isn't limited to students who have self-selected into STEM pathways.

Community College Programs

Community colleges are one of the strongest partners for manufacturing training in both regions. Borga Steel in Fresno says, "Most of my entry level employees come from the junior colleges. I give the kids tours, and afterward they knock on the door and put in an application."

The California community colleges have designated workforce training contacts by industry sector. The advanced manufacturing sector has a statewide director for workforce development, a director for workforce development of the San Francisco/San Mateo/East Bay/Silicon Valley/North Bay/Santa Cruz/Monterey region, and a director for workforce development of the Central Valley/Mother Lode region.

Regional Directors of workforce development are tasked with working with colleges in the system to strengthen connections between career education and industry, engage community college leadership, collaborate and coordinate with ROPs and high schools, and strategize on funding priorities based on the needs of business and industry. A list of community college manufacturing programs in the Bay Area and the San Joaquin Valley can be found in Appendix IV.

Evergreen Valley College's Advanced Manufacturing Associate's of Science Program

This program is a partnership between Evergreen Valley College, NextFlex, the National Science Foundation, and local advanced manufacturing companies. The Advanced Manufacturing Technology (AMT) program is a two-year technician program with curriculum co-developed and co-delivered by industry partners, including Cobham, DuPont, Flex Interconnect Technologies, and Jabil. The curriculum itself is comprised of stackable certificates, which, when taken with additional general education classes, can roll up into an Associate of Science degree. Courses center on applied and experiential learning techniques and culminate with a formal work-based, for-credit learning experience to seamlessly transition students to employment. To recruit students into the AMT program, Evergreen Valley College is leveraging NextFlex's FlexFactor program, a project-based recruitment program that is anchored in immersive industry experiences.

Four-Year Colleges and Universities

Most four-year colleges and universities in the two regions offer engineering courses. A few examples are highlighted below. Appendix IV contains a list of four-year college programs that support manufacturing. Most four-year colleges and universities offer engineering Programs, which can sometimes relate to manufacturing, but aren't listed here unless they relate directly to manufacturing.

Fresno State VIP Program: The Valley Industrial Partnership at Lyles College of Engineering at Fresno State facilitates paid internship opportunities for qualified students, including those studying industrial technology. The program has been operating for 20 years and has strong ties to local manufacturers.

Cal Poly Cooperative Consortium in Packaging Technology: Cal Poly offers a B.S. in Industrial Technologies and Packaging, a B.S. in Business Administration with a Consumer Packaging Concentration, and an MS in Packaging Value Chain. Its Cooperative Research Consortium in Packaging Science and Technology serves the packaging industry through fundamental and applied research in the technologies of the industry and as an active program of knowledge and technology transfer. Consortium research programs are supported by funds from member companies. The results of the research are proprietary to Cal Poly State University and are made available to consortium member companies on a first-access basis.

Geographic-Specific Non-profits and Economic Development Corporations

SFMade/MFG: SJ:

SFMade is a 501©(3) non-profit organization that supports local manufacturers who create jobs and career pathways for local residents who have overcome barriers to employment. Founded in 2010, SFMade has emerged as a full-service hub that connects low-income job seekers to employment and training opportunities;

provides local manufacturers with educational resources and customized, one-on-one services; and equips policymakers with strategies and intelligence to enable home-grown manufacturers and their employees to succeed. Manufacture: San Jose (MFG: SJ) is a public-private initiative, with the goal to drive resources, knowledge, and visibility to the city's more than 1,200 manufacturers and the more than 65,000 men and women they employ. Launched in 2018, MFG: SJ is a partnership of the City of San Jose and the non-profits CMTC California's Manufacturing Network and SFMade.

Humanmade

Humanmade is a non-profit makerspace based in San Francisco. This extensive state-of-the-art facility is equipped with complete wood and metalworking labs, laser and 3D printing, industrial sewing, and electronic stations. Humanmade provides advanced manufacturing training programs in computer numerical control (CNC) machining and 3D printing, aimed at providing individuals from all backgrounds with high value skills.

The Crucible

The Crucible is a non-profit organization and art school dedicated to making the fine and industrial arts accessible for all ages, backgrounds, and abilities. Their work is centered in Oakland and the East Bay, where they provide high-quality classes and workshops to thousands of people each year. They offer turning and milling, a machine shop lab, welding, woodworking, and mold making.

San Joaquin Valley Manufacturing Alliance

The San Joaquin Valley Manufacturing Alliance (SJVMA) is an organization of the Valley's manufacturing leaders that works to advance their industry and create a world-class workforce at the local level. Launched by the Fresno Business Council, SJVMA particularly aims to strengthen regional manufacturing. The Alliance designs training programs, provides jobs to interns for hands-on experience, educates the public on the benefits of manufacturing careers, addresses legislative issues, and brings local businesses and industry innovators together for an annual manufacturing conference.

Opportunity Stanislaus/Valley Occupational Learning and Technology Institute (VOLT)

The VOLT Institute is a partnership of the Stanislaus County Office of Education, Modesto Junior College, and Opportunity Stanislaus. VOLT programs focus on filling a range of positions such as industrial maintenance mechanic training, a Supervisor Development Academy, as well as a Career Accelerator Program that focuses on communication and ethical standards for employment. The most recent additions to the curriculum are a programmable logic controller (PLC) training program, a Senior Leadership Series, and Supervisor Development Academy.

Fresno Economic Opportunities Commission's Valley Apprenticeship Connections: Manufacturing Maintenance Mechanic Program

The Manufacturing Maintenance Mechanic Program is a no-cost multi-week program that focuses on requirements for success in the Maintenance Mechanic Program at the Fresno City College Career & Technology Center. Its manufacturing courses include: Introduction to Manufacturing, Trade Mathematics, Programmable Controllers, Job Preparation and Soft Skills, Technical Report Writing, Fluid Power Fundamentals, Pneumatic Fundamentals, Hydraulic Fundamentals, Power Transmission, Welding Fundamentals, and Electrical Fundamentals.

National Tooling and Machining Association (NTMA), San Francisco Chapter

NTMA-U is a fully online educational program that includes instruction for a machinist apprenticeship and incumbent-specific training. In addition to offering members free courses through NTMA-U, the San Francisco Bay Area Chapter of NTMA hosts free bi-monthly in-person training sessions for members with De Anza Community College manufacturing instructors and local industry experts. NTMA-U is a fully online educational program that includes the related instruction for a machinist apprenticeship and specific incumbent worker training.

Society of Manufacturing Engineers, Silicon Valley Chapter

The Society of Manufacturing Engineers Silicon Valley Chapter connects people who are engaged in manufacturing, design, and engineering. Its activities promote education for manufacturing and product development, provide a link between industry and education, enable members to stay up to date on the latest trends, innovations, and solutions, and connect members to business and to educational opportunities.

Government Agencies, Workforce Investment Boards, and Other Groups

Manufacturing Extension Partnerships and Manex

The Hollings Manufacturing Extension Partnership (MEP) is based at the National Institute of Standards and Technology (NIST), a division of the U.S. Department of Commerce. Its national network comprises the National Institute of Standards and Technology's Manufacturing Extension Partnership (NIST MEP), 51 MEP Centers in all 50 states and Puerto Rico, and over 1,400 advisors and experts at more than 385 MEP service locations. MEP is a public-private partnership – federal appropriations pay one-half, with the balance for each center funded by state and local governments and/or private entities, as well as client fees.

California's MEP is called California Manufacturing Technology Consulting (CMTC). Through the California Manufacturing Network, CMTC subcontracts with more than 25 partners focused on serving small- and medium-sized manufacturers, including SFMade. The program offers a full range of consulting services organized around the topics of innovation and growth, information technology, lean manufacturing, quality standards, recruitment, energy sustainability, workforce training and management development, supply chain optimization, and export management. Another subcontractor of CMTC is Manex, which used to be the direct MEP provider for Northern California and today provides similar services to larger manufacturers.

Workforce Investment Boards

Federal funding for workforce development flows to local regions through the Workforce Innovation and Opportunity Act (WIOA). WIOA funds support local Workforce Investment Boards (WIBs) and workforce development agencies, which serve job seekers and distribute training funds. The WIB structure requires participation from local businesses, but not all industries are represented. In the Bay Area and San Joaquin Valley, a few Workforce Investment Boards have staff who specialize in engaging the manufacturing sector, for example Work2Future in San Jose. These boards sometimes offer industry orientation and specific job listings. For example, the Fresno Regional Workforce Development Board has a manufacturing orientation and jobs flyer.

Jails and Prisons

Incarcerated people often have the opportunity to work while behind bars through programs such as the Prison Industry Board, which runs manufacturing businesses staffed by incarcerated people and offers an industry employment program. Traditionally, many of these jobs are in manufacturing. San Quentin has a CNC Academy that is part of the state's CTE program. Central California Women's Facility and Valley State Prison offer manufacturing adjacent training programs including mechanics, electronics, masonry, and welding.²⁹

Subsidized Wage and On-the-Job Training

Subsidized wage and on-the-job training programs are different from education-based training programs but are also important to skills development. While some positions in manufacturing require technical training that can be delivered by educational institutions, most employers prefer to do the majority of their own training on the job and promote from within in order to home grow talent. For this reason, subsidized work and on-the-job training programs are a significant tool for building the manufacturing workforce. This section describes different models for how these services are provided and offers several noteworthy examples.

It is important to distinguish subsidized wage and on-the-job training from incumbent worker training, tax credits, and apprenticeships. The State of California has a robust incumbent worker training program called the Employment Training Panel program, which reimburses businesses for training their existing workers or already planned new hires, and for increasing their wages. There are also state and federal tax credits, including the New Employment Credit and the Work Opportunity Tax Credit, which offer tax breaks for hiring targeted populations. Traditional apprenticeships consist of 2,000 hours of training for a hired employee, often facilitated by unions in unionized companies. Since there is no



official definition of apprenticeship, many companies have customized apprenticeship programs to fit their needs without unionization.

What makes subsidized wage and on-the-job training programs distinctive is that they financially encourage employers to hire from targeted populations and are intended to motivate businesses to take a chance on hiring someone they might not otherwise have been able to engage due to the costs associated with training. The power of these programs is that they can map on to specific hard-to-fill roles, without requiring a company-wide strategy.

The most ubiquitous type of subsidized wage/on-the-job training funding in California comes from the federal Workforce Innovation and Opportunity Act that flows resources to local Workforce Investment Boards and is distributed differently in each region. This means that every city in California has some form of on-the-job training funding available to businesses. The program provides reimbursements to businesses of up to 50-75% of the wage of the new hire for a set amount of time, usually between three and six months. To access this subsidy, businesses need to contract with the local workforce agencies or their sub-grantees (often local workforce non-profits) and either hire a person referred by the workforce system or have the person they want to hire screened for qualification based on their income or other factors. Many manufacturing companies don't take advantage of their local on-the-job training funding because of the administrative burden of applying and contracting with the agency or organization distributing the funds, or because they're not aware of them.

A second type of publicly funded wage subsidy program in California comes through local social service agencies that distribute cash public assistance, as a form of "welfare to work." These programs are structured similarly in that they reimburse for a percentage of wages for the first year of employment, based on hiring from a specific pool of underserved job seekers. These

programs are unique in that in some regions they have been deployed more robustly and have reached more businesses – sometimes through mass hiring events – and because their requirements for job-seeker participants may be looser.

San Francisco's JobsNOW! Program

Run by the San Francisco Human Services Agency for the past 10 years, JobsNOW! pays the full salaries of qualified employees for the first three months and partial wage reimbursement for the second three months of employment. Eligibility for this program has recently expanded, and both non-profits and for-profit businesses have taken advantage of the program.

Bay Area Council's Northern California Apprenticeship Network

The Northern California Apprenticeship Network (NCAN) is a newly created initiative with the goal to create, coordinate, and expand apprenticeship programs in new industries across the Northern California region. Currently, most of these programs are in the professional services or tech industries, but there is the potential that they could grow in the future to include manufacturing.

Fresno's New Employment Opportunities Program

Run by the Fresno County Economic Development Corporation in partnership with the Department of Social Services (DSS), the New Employment Opportunities Program (NEO) is a wage reimbursement incentive program available to qualified employers hiring underserved Fresno County residents. It reimburses eligible employers for 100% of wages for the first 13 weeks of full-time employment (up to a specific hourly wage) and 75% for weeks 14-26.

Gaps

While there is an impressive infrastructure of manufacturing related organizations and programs in the Bay Area and the San Joaquin Valley, gaps remain that limit the sector's potential to more fully support higher wage opportunities, particularly to underserved populations.

Limited Manufacturing Focused CTE Programs

Many high schools and colleges struggle to find CTE instructors. Those instructors must be professionals in their field but are often also required to have a teaching credential. It can be difficult to find professionals from the manufacturing sector to fill this type of role. More broadly, schools are responsive to parents and manufacturing in general still carries a stigma of not being a high wage, safe, and viable career path.

Lack of Short-term, Flexible Training for Working Adults

While many strong community college programs exist, navigating the certification process and fitting it into a full-time work schedule – often on top of family responsibilities – limits the potential pool of trainees who can benefit. Community college programs, for

example, don't always offer flexible course offerings in the evenings and require attendance on a campus rather than at the work site. Apprenticeship programs are strong and successful for those who can tolerate their duration but may also take several years to complete.

Due to the pandemic, the Evergreen Valley College Advanced Manufacturing program ran a short-term version of its program, a six-week Electronic Skills Program with Cobham, with classes held in the evenings. SFMade's Next Generation Manufacturing Program offers a 12-week 3D printing class that is also held in the evenings. These programs are the exception, however, rather than the rule.

Institutional Gaps and Orientation toward Four-year Degrees

While connections with industry for some community colleges are strong, cultural and structural differences can inhibit the ability of industry and community colleges to work together to identify and fill skills and employment gaps. Many academics, counselors, and parents also still believe that a four-year college degree is the path to success, which focuses K-12 education almost exclusively on preparing students for college. While today an emphasis is placed on social skills, an orientation to practical life skills is also important.





4

Recommendations

Many prescriptions have been offered for how to support manufacturing careers in California and build a skilled workforce required for a stronger manufacturing

sector in the state. What follows is a selection of several ideas that could move manufacturing forward in Northern California.

Challenges in Bringing Together Stakeholders

For manufacturers, participating in regional initiatives that bring together multiple stakeholders such as businesses, educational institutions, and government agencies is essential. Success, however, requires a commitment to civic stewardship.

If not well organized, working with community and other service providers can be a trial for companies. For one business interviewed for this report, participation in a regional sector strategy initiative “turned out to be a situation of herding cats” and they finally gave up. That experience is a cautionary tale. As described by the executive, “I spent a lot

of my personal time going to these meetings, in rooms with a hundred people, all these different job placement organizations and everything else, and the reality was you didn’t have a person in charge with the hammer and the checkbook.” Another manufacturer who was participating concluded, “This is a waste of time. Are we going to have more meetings or are we going to get something done? As manufacturers we have to perform daily and don’t have time to pontificate about what’s going to happen in nine months. When I started getting frustrated, I knew it was time to do something different with my time and energy.”

Interviews and analysis for this report point to a number of strategies that could strengthen manufacturing and attract new workers while providing the skills that manufacturers need:

On-site Vocational ESL Courses

One barrier to internal advancement within manufacturing businesses is the language barrier for monolingual front line workers. Local government agencies and educational institutions should come together to offer Vocational English as a Second Language (VESL) courses on manufacturers' sites. SFMade has implemented on-site courses at two of the larger manufacturers in San Francisco in partnership with San Francisco City College, and Fresno City College has partnered with the Fresno Regional Workforce Development Board in an effort to offer VESL courses.

These efforts should be implemented and replicated at scale. Manufacturing companies are likely to support online or on-site classes because "they don't want their workforce to have to work all day, then travel to campus to take a course. It's not feasible and it's very difficult logistically," says Genelle Taylor Kumpe, CEO of the San Joaquin Valley Manufacturing Alliance (SJVMA). SJVMA attempted to partner with Reedley College on a VESL course for the fall of 2021, but the idea was dropped when it was determined that the college's requirement that courses be delivered on campus would not provide flexibility or the access afforded by delivery at work sites.

Statewide Manufacturing Supplier Network

To support reshoring efforts, California should develop a state-wide online manufacturing supplier network. Manufacturers need easy access to suppliers for the goods and materials they need. Currently, there are a few isolated efforts to connect manufacturing suppliers, but most have to do the research themselves. A coordinated database of manufactured products and raw materials would significantly streamline this process.

Biomanufacturing Foundry

While Northern California is a leader in biotechnology R&D, it currently lacks a commercial or a pre-commercial

contract biomanufacturing facility. The development of such a facility, proposed by Lawrence Berkeley National Laboratory, could help to anchor both biotech manufacturing and R&D in the state, particularly serving smaller companies that have promising technologies but that lack the resources to develop their own production facilities. The location of such a facility in the San Joaquin Valley, which is close to the Bay Area but has lower costs, could also be a catalyst for high quality job creation in a region where high-skilled, well-paid jobs are often lacking.

Increase Access to Maker Spaces

One long-standing issue that has discouraged new entrants to the workforce is the perception that manufacturing jobs are dirty, not well paid, or dead end. With the application of technology that narrative is outdated, but attracting younger workers remains a challenge. Career orientation can be developed in high school, junior high school, or earlier. One strategy to address this challenge is to create more maker spaces that are accessible to hobbyists but also to community colleges and other industry-oriented training organizations. Some maker spaces can be mobile, moving between schools to provide students in wider geographies with the hands-on experience of making.

Update, Expand and Align K-12 Career Educational Pathways

In 2019, the state's Community College Directors for Advanced Manufacturing produced a set of Advanced Manufacturing Sector Goals that broadly define the scope of both the need and the opportunity in manufacturing training, including the goal of aligning K-12 curriculum with industry needs. This includes creating solutions to increase the pool of qualified faculty members, developing cross-sector pathways to support student success, and increasing articulation agreements and curricular portability across institutions. Schools should also consider how to create alternative school day structures to allow for students to participate in internships while earning course credit.

Fund High School and College Faculty to Participate in Manufacturing Externships

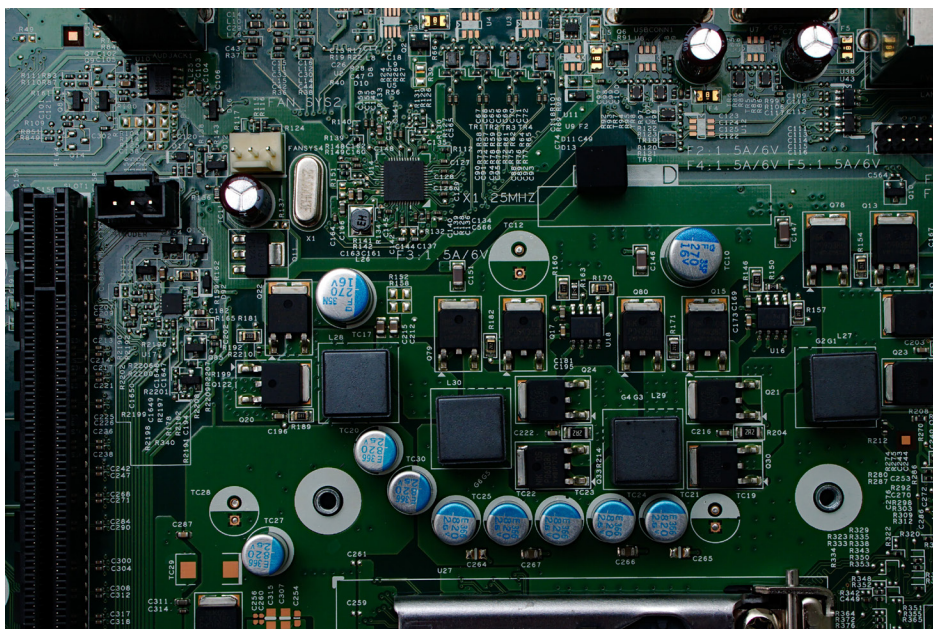
Too often, instructors are at a disadvantage of not knowing what their region offers and requires of job seekers. It is the role of educators to inform and teach their students so that they are equipped with the skill sets necessary to obtain gainful employment. Campuses, whether secondary or post-secondary, rarely compensate their educators for externships – which

are the only way to really understand the landscape of manufacturing. Spending several days at a work site will contribute to the knowledge base needed to develop relevant curricula and programs.

Recommendations to support manufacturing have also been produced by California Forward and the California Economic Summit and can be accessed at: <https://cafwd.org/action-areas/>.

Conclusion

California's manufacturing sector, the largest in the United States, fills a critical role in the state's economy. Whether, where, and how it grows will depend to a large degree on the quality and skills of the workforce it has to offer. External forces such as the reshoring of production from overseas and the realignment of global supply chains as companies seek greater resilience and security offer an opportunity to increase the manufacturing base – if California can provide the right conditions. Rapid changes in the nature of manufacturing processes, particularly through digitization, will require new skills that in turn must be supported by workforce development and training programs that equip workers for changing roles. Northern California's array of manufacturing training programs provide an essential base of support for companies and for workers who are looking to build careers in the sector. To continue to provide value, these programs must demonstrate flexibility, a collaborative relationship with industry, and a readiness to adapt quickly to the changing needs of the sector.



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Appendix I: Top 25 Manufacturing Subindustries by Employment

Appendix IA

Alameda County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	6,476
Semiconductor and Other Electronic Component Manufacturing	6,386
Medical Equipment and Supplies Manufacturing	6,198
Industrial Machinery Manufacturing	5,376
Computer and Peripheral Equipment Manufacturing	4,370
Bakeries and Tortilla Manufacturing	3,860
Beverage Manufacturing	3,078
Pharmaceutical and Medicine Manufacturing	2,847
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	2,380
Plastics Product Manufacturing	2,032
Other Food Manufacturing	1,965
Architectural and Structural Metals Manufacturing	1,863
Printing and Related Support Activities	1,740
Sugar and Confectionery Product Manufacturing	1,670
Other General Purpose Machinery Manufacturing	1,473
Converted Paper Product Manufacturing	1,128
Other Miscellaneous Manufacturing	1,120
Coating, Engraving, Heat Treating, and Allied Activities	1,065
Other Electrical Equipment and Component Manufacturing	955
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	928
Office Furniture (including Fixtures) Manufacturing	889
Other Wood Product Manufacturing	881
Communications Equipment Manufacturing	821
Animal Slaughtering and Processing	805
Electric Lighting Equipment Manufacturing	796
Total Employees	70,363

Source: California Employment Development Department (EDD)

Appendix IB

Contra Costa County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Petroleum and Coal Products Manufacturing	4,616
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	995
Medical Equipment and Supplies Manufacturing	745
Bakeries and Tortilla Manufacturing	707
Pharmaceutical and Medicine Manufacturing	547
Basic Chemical Manufacturing	501
Printing and Related Support Activities	499
Other Food Manufacturing	369
Communications Equipment Manufacturing	327
Commercial and Service Industry Machinery Manufacturing	319
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	316
Architectural and Structural Metals Manufacturing	315
Beverage Manufacturing	281
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	266
Other Furniture Related Product Manufacturing	243
Other Electrical Equipment and Component Manufacturing	205
Other Miscellaneous Manufacturing	187
Cement and Concrete Product Manufacturing	159
Other Chemical Product and Preparation Manufacturing	123
Semiconductor and Other Electronic Component Manufacturing	122
Other General Purpose Machinery Manufacturing	111
Industrial Machinery Manufacturing	108
Cut and Sew Apparel Manufacturing	102
Foundries	99
Office Furniture (including Fixtures) Manufacturing	91
Total Employees	12,948

Source: California Employment Development Department (EDD)

Appendix IC

Fresno County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Fruit and Vegetable Preserving and Specialty Food Manufacturing	2,529
Beverage Manufacturing	1,676
Bakeries and Tortilla Manufacturing	1,180
Other General Purpose Machinery Manufacturing	1,117
Architectural and Structural Metals Manufacturing	962
Converted Paper Product Manufacturing	958
Other Wood Product Manufacturing	958
Motor Vehicle Body and Trailer Manufacturing	743
Other Food Manufacturing	656
Agriculture, Construction, and Mining Machinery Manufacturing	618
Printing and Related Support Activities	607
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	472
Medical Equipment and Supplies Manufacturing	429
Glass and Glass Product Manufacturing	413
Other Miscellaneous Manufacturing	369
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	354
Plastics Product Manufacturing	345
Motor Vehicle Parts Manufacturing	309
Communications Equipment Manufacturing	239
Veneer, Plywood, and Engineered Wood Product Manufacturing	229
Animal Food Manufacturing	205
Coating, Engraving, Heat Treating, and Allied Activities	197
Cement and Concrete Product Manufacturing	195
Dairy Product Manufacturing	163
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	149
Total Employees	17,049

Source: California Employment Development Department (EDD)

Appendix ID

Marin County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Beverage Manufacturing	388
Dairy Product Manufacturing	329
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	297
Other Food Manufacturing	288
Bakeries and Tortilla Manufacturing	287
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	222
Clay Product and Refractory Manufacturing	189
Cut and Sew Apparel Manufacturing	111
Other Miscellaneous Manufacturing	110
Printing and Related Support Activities	103
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	67
Textile Furnishings Mills	53
Office Furniture (including Fixtures) Manufacturing	42
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	38
Medical Equipment and Supplies Manufacturing	27
Other Nonmetallic Mineral Product Manufacturing	19
Other Textile Product Mills	17
Architectural and Structural Metals Manufacturing	13
Plastics Product Manufacturing	13
Other Wood Product Manufacturing	8
Commercial and Service Industry Machinery Manufacturing	7
Semiconductor and Other Electronic Component Manufacturing	4
Total Employees	2,632

Source: California Employment Development Department (EDD)

Notes: Due to confidentiality, only 22 subindustries contain employment data

Appendix IF

San Francisco County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	1,361
Other Food Manufacturing	1,084
Bakeries and Tortilla Manufacturing	1,057
Beverage Manufacturing	785
Cut and Sew Apparel Manufacturing	619
Printing and Related Support Activities	544
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	482
Other Miscellaneous Manufacturing	358
Semiconductor and Other Electronic Component Manufacturing	319
Medical Equipment and Supplies Manufacturing	215
Sugar and Confectionery Product Manufacturing	215
Architectural and Structural Metals Manufacturing	195
Animal Slaughtering and Processing	193
Pharmaceutical and Medicine Manufacturing	161
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	135
Other Textile Product Mills	119
Cement and Concrete Product Manufacturing	118
Industrial Machinery Manufacturing	110
Other Wood Product Manufacturing	109
Seafood Product Preparation and Packaging	97
Office Furniture (including Fixtures) Manufacturing	91
Animal Food Manufacturing	85
Other Leather and Allied Product Manufacturing	79
Fruit and Vegetable Preserving and Specialty Food Manufacturing	68
Coating, Engraving, Heat Treating, and Allied Activities	64
Total Employees	9,356

Source: California Employment Development Department (EDD)

Appendix IG

San Joaquin County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Beverage Manufacturing	2,425
Other Food Manufacturing	1,407
Architectural and Structural Metals Manufacturing	1,362
Plastics Product Manufacturing	1,224
Other Wood Product Manufacturing	1,025
Animal Slaughtering and Processing	1,014
Cement and Concrete Product Manufacturing	981
Fruit and Vegetable Preserving and Specialty Food Manufacturing	859
Converted Paper Product Manufacturing	706
Bakeries and Tortilla Manufacturing	635
Glass and Glass Product Manufacturing	611
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	588
Animal Food Manufacturing	490
Motor Vehicle Body and Trailer Manufacturing	429
Coating, Engraving, Heat Treating, and Allied Activities	325
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	317
Other Fabricated Metal Product Manufacturing	297
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	281
Industrial Machinery Manufacturing	275
Rubber Product Manufacturing	267
Agriculture, Construction, and Mining Machinery Manufacturing	255
Veneer, Plywood, and Engineered Wood Product Manufacturing	239
Printing and Related Support Activities	182
Foundries	149
Paint, Coating, and Adhesive Manufacturing	135
Total Employees	17,453

Source: California Employment Development Department (EDD)

Appendix IH

San Mateo County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	1,705
Bakeries and Tortilla Manufacturing	1,490
Medical Equipment and Supplies Manufacturing	1,365
Printing and Related Support Activities	961
Sugar and Confectionery Product Manufacturing	677
Other Food Manufacturing	538
Semiconductor and Other Electronic Component Manufacturing	489
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	442
Beverage Manufacturing	331
Other Miscellaneous Manufacturing	328
Architectural and Structural Metals Manufacturing	315
Other Electrical Equipment and Component Manufacturing	305
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	225
Aerospace Product and Parts Manufacturing	213
Cement and Concrete Product Manufacturing	183
Plastics Product Manufacturing	172
Cut and Sew Apparel Manufacturing	154
Other General Purpose Machinery Manufacturing	148
Coating, Engraving, Heat Treating, and Allied Activities	147
Communications Equipment Manufacturing	114
Other Wood Product Manufacturing	77
Dairy Product Manufacturing	72
Metalworking Machinery Manufacturing	61
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	48
Industrial Machinery Manufacturing	36
Total Employees	10,835

Source: California Employment Development Department (EDD)

Appendix IJ

Santa Clara County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Computer and Peripheral Equipment Manufacturing	56,537
Semiconductor and Other Electronic Component Manufacturing	39,243
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	16,151
Industrial Machinery Manufacturing	7,196
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	4,995
Communications Equipment Manufacturing	3,573
Medical Equipment and Supplies Manufacturing	3,295
Architectural and Structural Metals Manufacturing	3,073
Pharmaceutical and Medicine Manufacturing	3,052
Other Electrical Equipment and Component Manufacturing	2,829
Bakeries and Tortilla Manufacturing	1,598
Audio and Video Equipment Manufacturing	1,471
Coating, Engraving, Heat Treating, and Allied Activities	1,458
Commercial and Service Industry Machinery Manufacturing	1,340
Printing and Related Support Activities	1,311
Beverage Manufacturing	1,137
Motor Vehicle Manufacturing	847
Other Miscellaneous Manufacturing	833
Cement and Concrete Product Manufacturing	618
Electrical Equipment Manufacturing	552
Other General Purpose Machinery Manufacturing	541
Other Food Manufacturing	507
Office Furniture (including Fixtures) Manufacturing	496
Other Nonmetallic Mineral Product Manufacturing	487
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	479
Total Employees	157,626

Source: California Employment Development Department (EDD)

Appendix IK

Solano County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Pharmaceutical and Medicine Manufacturing	3,003
Architectural and Structural Metals Manufacturing	1,397
Fruit and Vegetable Preserving and Specialty Food Manufacturing	1,028
Beverage Manufacturing	554
Other Wood Product Manufacturing	481
Boiler, Tank, and Shipping Container Manufacturing	376
Other General Purpose Machinery Manufacturing	363
Animal Slaughtering and Processing	266
Cement and Concrete Product Manufacturing	263
Bakeries and Tortilla Manufacturing	259
Other Food Manufacturing	257
Plastics Product Manufacturing	250
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	170
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	145
Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	104
Industrial Machinery Manufacturing	102
Other Fabricated Metal Product Manufacturing	79
Converted Paper Product Manufacturing	46
Paint, Coating, and Adhesive Manufacturing	41
Coating, Engraving, Heat Treating, and Allied Activities	38
Cutlery and Handtool Manufacturing	38
Printing and Related Support Activities	34
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	32
Office Furniture (including Fixtures) Manufacturing	25
Semiconductor and Other Electronic Component Manufacturing	22
	2
Total Employees	9,375

Source: California Employment Development Department (EDD)

Appendix IL

Sonoma County - Top 25 Sub-Industries by Employment

Sub-Industry	Employee s
Beverage Manufacturing	8,010
Fruit and Vegetable Preserving and Specialty Food Manufacturing	1,528
Medical Equipment and Supplies Manufacturing	1,010
Bakeries and Tortilla Manufacturing	974
Semiconductor and Other Electronic Component Manufacturing	826
Commercial and Service Industry Machinery Manufacturing	757
Other Food Manufacturing	516
Plastics Product Manufacturing	477
Dairy Product Manufacturing	445
Printing and Related Support Activities	396
Other Wood Product Manufacturing	356
Industrial Machinery Manufacturing	323
Household and Institutional Furniture and Kitchen Cabinet Manufacturing	289
Metalworking Machinery Manufacturing	260
Other Miscellaneous Manufacturing	241
Pharmaceutical and Medicine Manufacturing	208
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	199
Other Fabricated Metal Product Manufacturing	198
Office Furniture (including Fixtures) Manufacturing	164
Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	157
Communications Equipment Manufacturing	147
Other General Purpose Machinery Manufacturing	144
Clay Product and Refractory Manufacturing	135
Cement and Concrete Product Manufacturing	132
Boiler, Tank, and Shipping Container Manufacturing	131
	2
Total Employees	19,175

Source: California Employment Development Department (EDD)

Appendix IM

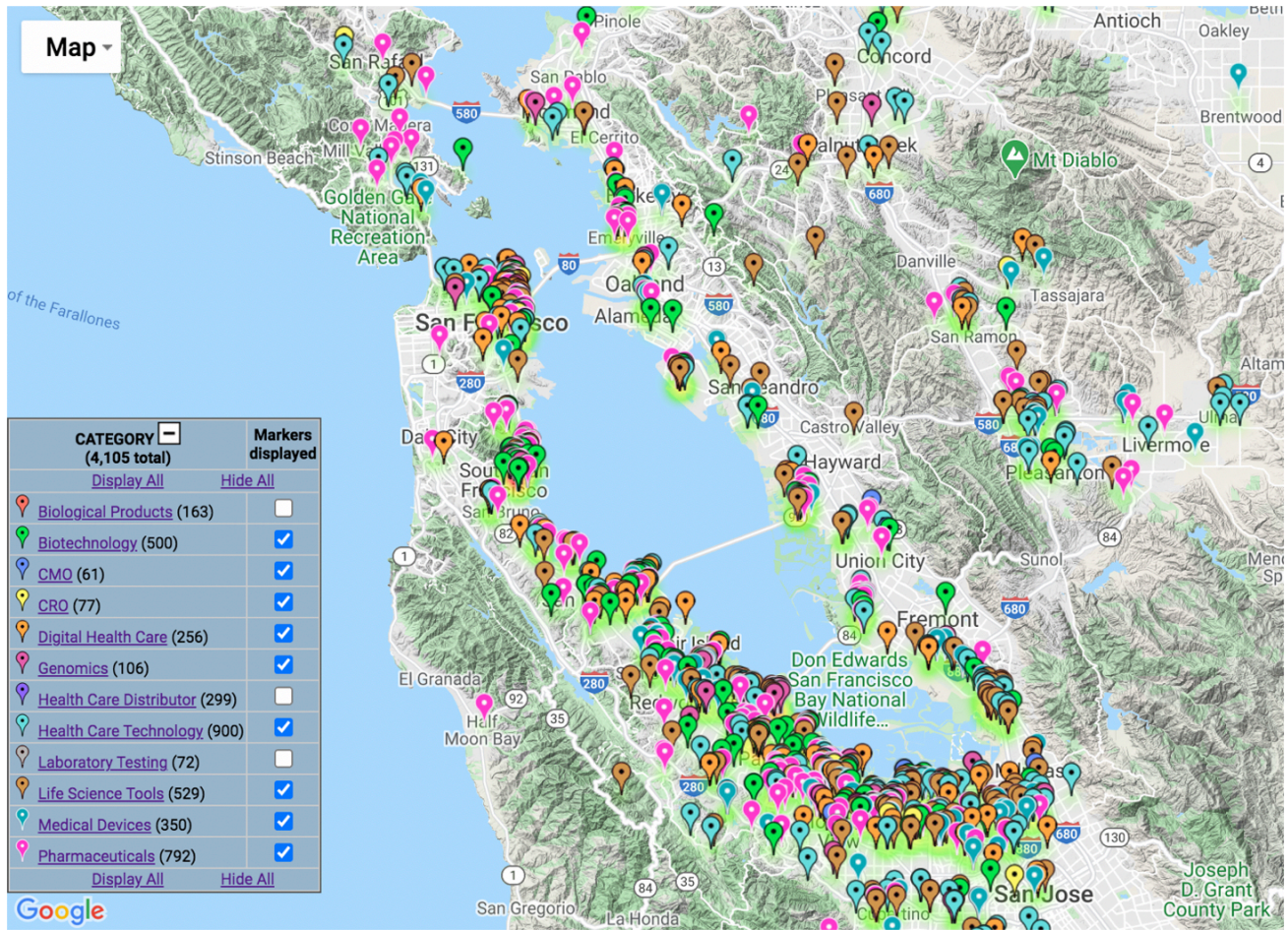
Stanislaus County - Top 25 Sub-Industries by Employment

Sub-Industry	Employees
Food Manufacturing	10,888
Fruit, Vegetable, & Specialty Foods Mfg	4,413
Beverage & Tobacco Product Manufacturing	3,829
Beverage Manufacturing	3,829
Dairy Product Manufacturing	2,220
Fabricated Metal Product Manufacturing	1,852
Other Food Manufacturing	1,776
Snack Food Manufacturing	1,497
Fluid Milk Manufacturing	1,087
Paper Manufacturing	1,062
Converted Paper Product Manufacturing	1,062
Paperboard Container Manufacturing	1,062
Machinery Manufacturing	1,024
Dried and Dehydrated Food Manufacturing	969
Corrugated/Solid Fiber Box Manufacturing	915
Nonmetallic Mineral Product Mfg	810
Plastics & Rubber Products Manufacturing	710
Wood Product Manufacturing	668
Cheese Manufacturing	646
Ag., Construction, and Mining Machinery	640
Animal Food Manufacturing	615
Architectural and Structural Metals	606
Plastics Product Manufacturing	557
Chemical Manufacturing	376
Printing and Related Support Activities	372
Total Employees	22,749

Source: California Employment Development Department (EDD)

Appendix II:

Biomedical Industry Companies - Bay Area



Source: Biomedical Manufacturing Network, 2020

Appendix III:

Skill Needs as a Result of Changes in the Biomedical Industry

Biomedical Industry Segments	Workforce Skill Sets
Biotechnology	<p>Analyze genes signature for potential drug targets.</p> <p>Develop novel animal models and utilized established animal models to support multiple drug discovery projects in the Inflammation therapeutic area portfolio.</p> <p>Design, synthesis, purification, and characterization of small molecules for drug discovery programs.</p> <p>Conduct lab automation and robotics of biochemical and cell-based assays for profiling compounds and characterizing potential drug targets.</p> <p>Execute pilot and engineering runs; and Good Manufacturing Practices (GMP) commissioning of upstream processes.</p> <p>Implement methodologies for bacterial expression of recombinant proteins for GMP Production.</p> <p>Collect offline/online data and adjusted parameters according to experimental protocols in compliance with GMP.</p> <p>Complete necessary documentation and audits according to regulatory standards and policies.</p> <p>DNA isolation for 3730 DNA library by making bacterial cultures, pick bacterial colonies and isolate DNA.</p> <p>Trouble shooting and repair of DNA Synthesizers</p> <p>Process and React template DNA on 384 well plates using big dye for 3730 DNA sequencing.</p> <p>Operate robotic instrumentation, thermal cyclers and automated DNA sequencers.</p> <p>Perform molecular techniques such as DNA extraction, RT PCR,</p>

	<p>Pre and post amplification.</p> <p>Perform standard PCR assays.</p> <p>Perform quality control and preventative maintenance on instrumentation including ABI 3100, GeneAmp PCR System 9700 Thermal Cyclers, and pipettes.</p> <p>Produce dHPLC standards using PCR, for use in manufactured kits.</p> <p>Produce dHPLC standards using PCR based methods.</p> <p>Perform pathogen analyses using primary PCR methodology and other various pathogen detection methods.</p> <p>Use purification techniques and instruments in assay development to generate monoclonal antibody products for therapeutic use.</p> <p>Perform clinical assays, molecular biology, and microbiology research techniques.</p> <p>Design, execute and analyze experimental data; managed and maintained cell culture facility.</p> <p>Utilize aseptic technique conducting cell culture process steps in biological safety cabinets.</p> <p>Support cell culture, purification, and formulation process development.</p>
<p>Genomics</p>	<p>Establish data analysis best practices to interpret molecular patient data and prioritize clinically-actionable genetic variants.</p> <p>Perform biological screening, inclusive of data analysis and communicating pertinent results to other scientists.</p> <p>Conduct research, data analysis, database implementation, and management of historical records</p> <p>Develop imaging algorithms and post clinical data analysis frameworks for reduction of field defects and increase of clinical efficacy.</p>

	<p>Develop mutation detection algorithms in NGS and non-NGS data.</p>
	<p>Perform analysis of whole genome NGS data from different platform such as 454, Illumina, Pacbio, Ion torrent.</p> <p>Provide scientific QC for algorithmic methods of EST-derived gene prediction.</p> <p>Optimization of emulsion PCR, sequencing by ligation, and development of novel mate-paired library construction methods.</p> <p>Led formulation development for emulsion PCR with improved emulsion stability.</p> <p>Investigated nucleic acid-extraction methods for sample preparation before PCR.</p> <p>Optimize PCR amplification and detection conditions.</p>
<p>Digital Healthcare</p>	<p>Develop and maintain databases for use in data analysis and tracking.</p> <p>Perform data cleaning, extraction, processing, storage, manipulation, and analyses.</p> <p>Build and maintain SAS/SQL programming codes.</p> <p>Perform validation procedures to ensure data quality.</p> <p>Maintain detailed documentation of programming and analyses.</p> <p>Produce tables, graphs, and charts for reports and presentation.</p> <p>Communicate project results to managers and various users.</p> <p>Design and develop relational databases for collecting data and create data collection screens.</p> <p>Analyze data with statistical methods.</p>

	<p>Interpret results and provide written summaries of analyses.</p> <p>Collect, record, and summarize data on observable client behavior.</p> <p>Utilize small hand tools and/or precision devices and microscopes to aid in R&D of early stage</p> <p>Assemble device prototypes and sub-assemblies</p> <p>Design, fabricate, and assemble test and assembly fixtures</p> <p>Support pre-clinical lab prototyping needs</p> <p>Perform testing, experimentation, and analysis</p> <p>Communicate status of R&D activities, key learnings, and make design and assembly recommendations to engineering team members</p> <p>Support root cause analysis</p> <p>Perform various mechanical and electromechanical tests of varying degrees of difficulty</p> <p>Use basic lab equipment like an instron, and custom in-house made robotic test.</p> <p>Prototype of test fixturing, perform dry runs.</p> <p>Assemble electronic and mechanical components, including using tools like solder irons, machining tools, microscopes, etc.</p> <p>Assemble flexible component devices including braiding, reflow, fusing, tipping, bonding, etc.</p> <p>Support design verification activities of medical devices.</p>
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Source: Biomedical Manufacturing Network

Appendix IV

High School and Career and Technical Education Programs

Region/County	District/High School	Program
Bay Area/Alameda County	San Leandro Unified School District/San Leandro High School	Advanced Manufacturing
Bay Area/Alameda County	Livermore School District/Livermore High	Machine and Forming Technologies
Bay Area/Santa Clara County	Silicon Valley CTE/Metroed	Mechatronics, Welding
Bay Area/Santa Clara County	Eastside Union High School District/Piedmont Hills High School	Advanced Manufacturing
Bay Area/Santa Clara County	Independent Alternative School/SiaTech	Advanced Manufacturing
Bay Area/Santa Clara County	Campbell Union High School District/Westmont High School	Manufacturing Technology
Bay Area/San Mateo County	Jefferson Union High School District/Westmoor High School	Manufacturing and Product Development
Bay Area/Contra Costa County	Mt. Diablo Unified School District/Mt. Diablo High School	Manufacturing and Engineering Academy
Bay Area/Contra Costa County	Acalanes High School District/Acalanes High School	Design and Fabrication Technology
Bay Area/Contra Costa County	John Swett High School District/John Swett High School	Welding, CAD, Machine Technology, Industrial Maintenance Mechanic
Bay Area/Napa County	Napa Valley School District/Napa High School	Manufacturing and Product Development
Bay Area/Sonoma County	Santa Rosa City High School District/Santa Rosa High School	Manufacturing, CAD
Bay Area/Sonoma County	Petaluma City Schools/Petaluma High	Manufacturing Technology
San Joaquin Valley/Fresno County	Fresno Unified School District/Duncan Polytechnical High School	Innovative Design and Applied Technology Manufacturing Pathway
San Joaquin Valley/Fresno County	Career and Technical Education High School	Advanced Manufacturing

San Joaquin Valley/Fresno County	Center for Advanced Research and Technology	Engineering, Manufacturing and Robotics
San Joaquin Valley/Fresno County	Valley Regional Occupational Program (ROP) including Dinuba High, Parlier High, Sanger High, and Selma High	Manufacturing and Product Development
San Joaquin Valley/San Joaquin County	Stockton Unified School District/Franklin High School	Product Innovation and Design, Welding and Materials Joining
San Joaquin Valley/San Joaquin County	Manteca Unified School District/Manteca Adult School	Warehousing, Forklift, Advanced Manufacturing, Welding
San Joaquin Valley/San Joaquin County	Manteca Unified School District/BE.Tech Charter School	BE.Industrial (Design and Fabrication, Solidworks)
San Joaquin Valley/Stanislaus	Stanislaus County Office of Education/ Stanislaus Industrial Technology Institute	Supply Chain Technician

Community College Manufacturing Programs – Bay Area and San Joaquin Valley

Region/County	College	Program
Peninsula/San Mateo County	Skyline College	Biotechnology Manufacturing Assistant
Peninsula/San Mateo County	San Mateo College	CAD/Drafting
San Francisco County	City College of San Francisco	Manufacturing and Fabrication, Welding, Machining MakerSphere (Maker spaces and Maker Studies track)
South Bay/ Santa Clara County	De Anza College	CAD, Machine Technology, Quality Control Inspector
South Bay/Santa Clara County	Evergreen Valley College	Advanced Manufacturing
South Bay/Santa Clara County	Mission College	Mechatronics

South Bay/ Santa Clara County	San Jose City College	Laser and Machine Technology
East Bay/Contra Costa County	Diablo Valley College	Industrial Maintenance, Machine Technology
East Bay/Contra Costa County	Los Medanos College	Process Technology (PTEC), Welding
East Bay/Alameda County	Laney College	Biomanufacturing Program--transfer to a BS at Solano College, Machining, FabLab
East Bay/Alameda County	Chabot College	Machine Technology
East Bay/Alameda County	Contra Costa College	Biotechnology, Forklift, Operations, Logistics and Warehouse
East Bay/Alameda County	Los Positas College	Welding Technology AS
East Bay/Alameda County	Ohlone College	Biomanufacturing, Manufacturing Technician
North Bay/Napa County	Napa Valley College	CAD, Machine Technology, Welding
North Bay/Solano County	Solano Community College	CAD, Mechatronics, Welding Biomanufacturing Partnering with Vacaville on Biomanufacturing Center
North Bay/Sonoma County	Santa Rosa Junior College	CAD, diesel mechanic, machine technology, welding
San Joaquin Valley/Stockton	San Joaquin Delta College	Industrial Technology, Machine Technology, Welding
San Joaquin Valley/Fresno County	(State Center Community College District) Fresno City College	6-week forklift certification

San Joaquin Valley/Fresno County	Reedley College	Machine Tool Technology, Welding Technology, Manufacturing Maintenance Mechanics, Mechanized Agriculture
San Joaquin Valley/Fresno County	Clovis Community College	Mechatronics/Industrial Automation (Funding granted to build a new campus building to house CTE programs and build out Industrial Automation programs)
San Joaquin Valley/Madera County	Madera Community College	Machinist and Machine Tool Technology, Maintenance Mechanic
San Joaquin Valley/Stanislaus County	Modesto Junior College	Electrician Maintenance Electro-Mechanical Technician, Calibration and Instrumentation Technician, Machinery Maintenance, Machinist, Packaging Technician

Four-Year College Programs Supporting Manufacturing

Region/County	College	Program
San Luis Obispo County/San Luis Obispo* *Although not in the San Joaquin Valley, manufacturers there are connected due to the quality and specificity of their packaging program.	California Polytechnic State University (Cal Poly)	Packaging Program including Industrial Technology and Packaging, Consumer Packaging, and Value Chain
South Bay/Santa Clara County	Santa Clara University	Bioinnovation and Design Lab
South Bay/Santa Clara County	San Jose State	Industrial Engineering, Packaging, Biomedical Engineering
Fresno County/Fresno	Fresno State	Industrial Technology
Merced County/Merced	UC Merced	Machine Shop

Private Universities

Region/County	College	Program
Bay Area/Santa Clara County	Santa Clara University	Bioinnovation and Design Lab
San Joaquin Valley/Fresno and Tulare	San Joaquin Valley College	Maintenance Technician
San Joaquin Valley/Fresno and Stanislaus	Institute of Technology	Industrial Maintenance and Automated Technology
San Joaquin Valley/Stanislaus County	Modesto Technical College	Industrial Maintenance Technology, Industrial Refrigeration, Welding



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