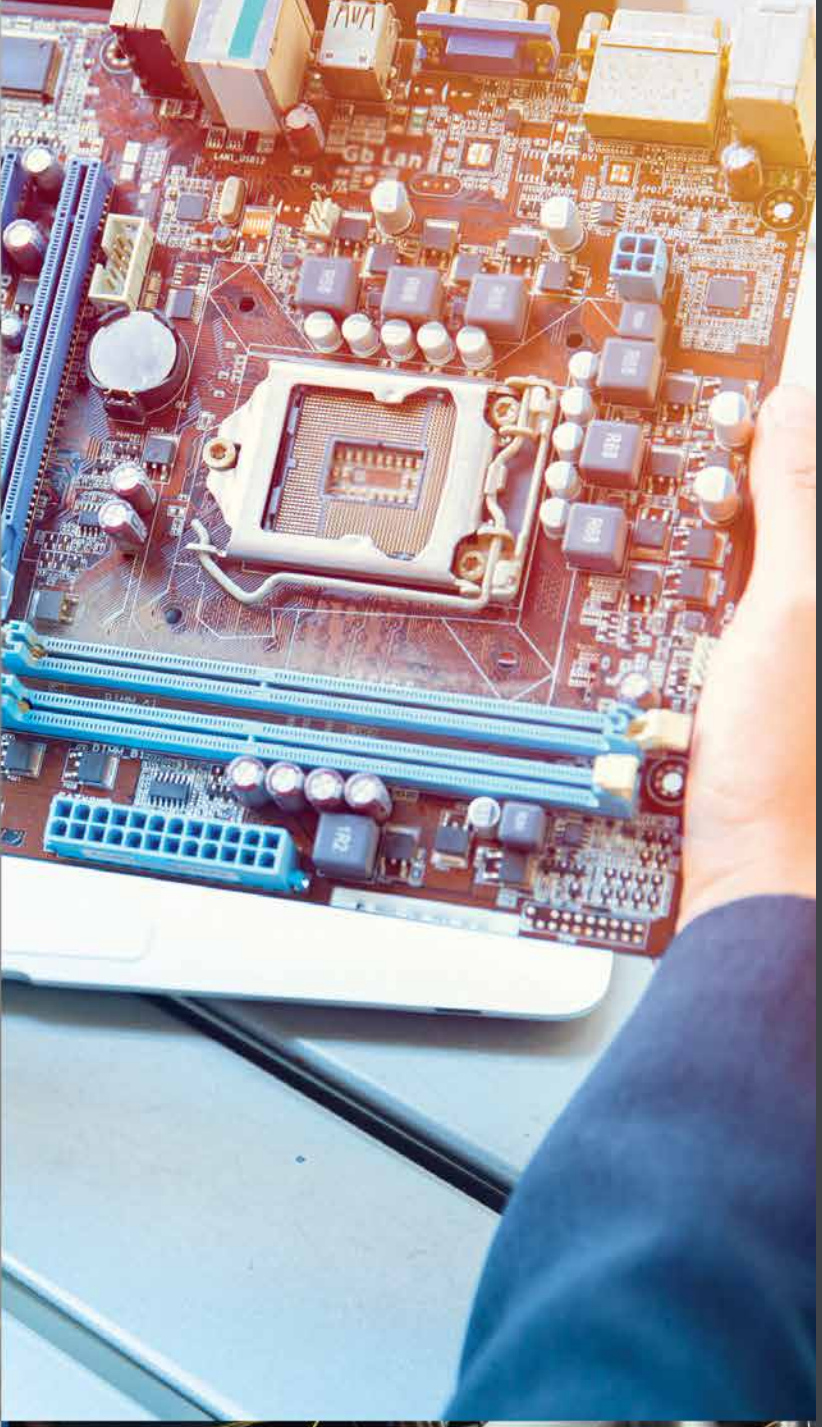

Manufacturing: A Changing Middle-Skill Workforce

for an Industry in Transition

CENTER FOR A COMPETITIVE WORKFORCE

LAEDC

About CCW

About CCW

Center for a Competitive Worforce

The Center for a Competitive Workforce (CCW) was established in 2017 as a Strong Workforce Program regional project of the 19 community colleges in the Los Angeles region, in collaboration with the L.A./O.C. Center of Excellence for Labor Market Research (COE), hosted at Mt. San Antonio College, and the Los Angeles County Economic Development Corporation (LAEDC).

In partnership with the COE and the LAEDC Institute for Applied Economics, CCW has published multiple labor market reports. These publications analyze labor supply and demand data for middle-skill occupations in high-growth industries to inform and influence the expansion of new or modified career education, and workforce development programs and curricula.

CCW supports quarterly convenings with education, workforce, nonprofit, government and industry leaders in three of the L.A. region's most highly concentrated and fastest growing industry sectors—advanced transportation, bioscience and digital media/ entertainment—with the co-equal goals to strengthen industry engagement with community college faculty, and to connect more community college students to meaningful work-based learning opportunities.

This is one of the best ways to, constructively, prepare them for the 21st century jobs and careers, in the fast-emerging and rapidly-changing knowledge-intensive industries that will drive our regional economy, today and tomorrow.

In partnership with the regional directors for employer engagement, CCW is piloting seven advisory committees to further strengthen regional alignment of, and ongoing connections between, faculty and industry. CCW has developed two online platforms: a Biosciences Industry Portal, and a regional Workforce and Education Partner Portal which employs technology to increase the speed and richness of industry-college connections. The goal is to seamlessly access and deploy the economic intelligence gleaned through industry engagement, and to rapidly expand and scale the number of work-based learning and employment opportunities for career education students and graduates with certificates and degrees.

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Executive Summary

Manufacturing in the Los Angeles Basin

The Los Angeles Basin's competitive and rapidly changing economic landscape has given rise to a job market in which highly specialized knowledge and skills often mean the difference between success and failure. To help meet this challenge, the Center for a Competitive Workforce (the Center) set out to study the major industries driving regional growth, and pinpoint how education, government and industry stakeholders can calibrate the region's talent development systems and fuel a vibrant economy.

This report is the latest in a series of reports by the Center and the Los Angeles County Economic Development Corporation (LAEDC) and focuses on the manufacturing industry in the Los Angeles Basin (Los Angeles and Orange counties).

Why Focus on Manufacturing?

Manufacturing is an industry that is transitioning from traditional production skills to more specialized and multi-functional "high-tech" skills to adapt to significant disruption that has long been taking place. While employment levels over time have been steadily declining, manufacturing still plays a vital role in the L.A. Basin economy, generating jobs for hundreds of thousands of workers, providing incomes for households across the economic spectrum, converting or combining basic and intermediate inputs into outputs, and producing necessary and innovative products for consumption and export

IN THIS REPORT, THE CENTER:

- Analyzes the major shifts occurring in manufacturing
- Quantifies the industry's economic impact
- Identifies the jobs that represent the best targets for community college students in the region

Manufacturing

SUPPLY VERSUS DEMAND

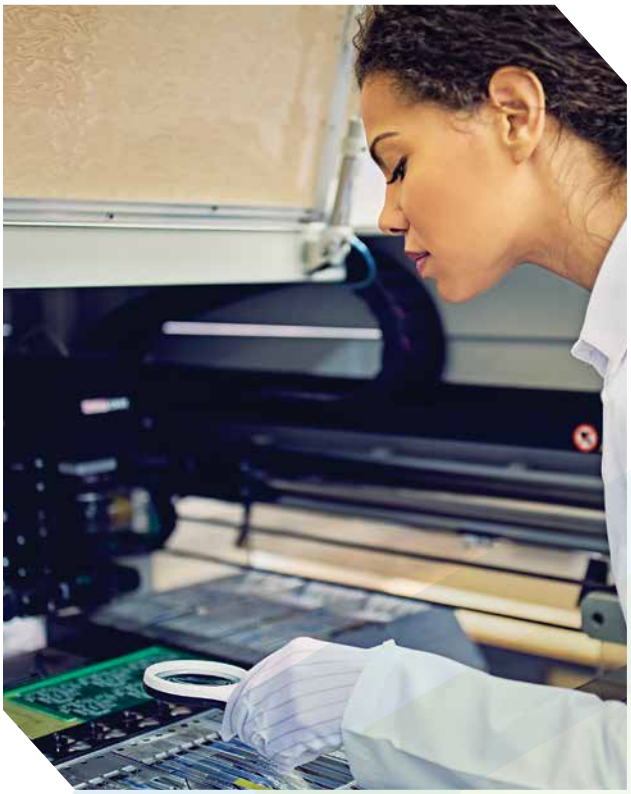
The Center addresses whether community college supply is meeting workforce demand. Based on regional community college completions, a looming workforce shortage appears to exist, resulting in an undersupply of close to 1,800 workers each year over the studied time period (2017-2022) to fill job openings in the identified target middle-skill manufacturing occupations in the region. Close to 3,600 annual openings are projected for the target middle-skill occupations across all industries (with 2,690 of these annual openings across the 21 component industries in the manufacturing sector). But community college completions only totaled 1,764 awards in the 2017-2018 academic year.

The supply-and-demand comparison reveals that an oversupply may exist for the target occupations grouped together in the concentration of architecture and engineering in the Los Angeles Basin. Meanwhile, there may be an undersupply of community college students to fill the target occupations grouped together in the concentrations of installation, maintenance and repair, and production.

WHERE WILL THE JOBS BE?

The highest number of openings will mostly be in occupations related to high-tech manufacturing. The greatest growth in employment is expected to occur in the computer and electronic product manufacturing (1,600 new jobs), followed by food manufacturing (1,090 new jobs) and transportation equipment manufacturing (850 new jobs).

Analysis of the skills classifications for total job openings over the next five years reveals that over 40 percent of projected openings will be for middle-skill occupations, which reinforces the selection of this industry as a valid target for community college programs.



OCCUPATION PROFILES

This report identifies ten (10) promising occupations for middle-skill workers, which are defined as those who possess more educational attainment than a high school diploma but less than a bachelor's degree, across eleven nondurable goods manufacturing and ten durable goods manufacturing component industries that make up the manufacturing sector. Some in-demand middle-skill occupations to take note of include machinists; welders, cutters, solderers and brazers; and industrial machinery mechanics.

RISE OF AUTOMATION

Detailed occupations experiencing the deepest declines in manufacturing are becoming obsolete due to advances in technology. For example: automation and collaborative robotics are decreasing demand for assemblers; digital processes adopted in the printing industry are reducing the need for printing press workers and photographic process workers; and many tasks previously performed by electronic drafters are now being done by the engineers themselves. But advances in technology are not always labor displacing; for instance, employment growth for avionics technicians is related to the ever-increasing use of more complex computer systems which require trained individuals to perform maintenance and repairs.

ADDITIONAL TRENDS

Employment declines in manufacturing since the turn of the 21st century may be more related to the transformational shifts of increased adoption and deployment of automation, process compression and offshoring. These are structural, process and/or business model changes that are occurring in the industry itself rather than to a loss of demand for manufactured products.

Going forward, technology-intensive manufacturing industries, such as computer and electronic product manufacturing, chemical manufacturing (which includes pharmaceuticals), medical equipment and supplies manufacturing, and other high-tech manufacturing will experience the most growth.

COMMUNITY COLLEGE CHALLENGES

Local colleges have capacity or resource constraints in terms of availability of qualified instructors, acquisition costs of new technology, and space, which affect the colleges' abilities to respond to the demand for new workers.

Manufacturing Report:

ADDITIONAL KEY FINDINGS

GOOD PAY

Employees working in manufacturing typically earn higher than average wages compared to the average private-sector wage in the region. Employees in manufacturing earned, on average, $76,250, which is more than the regional average across all industries, $62,550. Computer and electronic product manufacturing pays on average $128,720 per year. Manufacturing wages are higher for all levels of educational attainment relative to the regional average.

ECONOMIC IMPACT

Manufacturing generates just under $354 billion in economic output annually in the Los Angeles Basin, and accounts for 15.8 percent ($158.9 billion) of the LA Basin's gross regional product of more than $1.0 trillion. In 2017 (the most recent data available), the manufacturing industry spent $47.6 billion on labor payments and $151.4 billion on purchases of intermediate inputs.

AGING WORKFORCE

A large share of the manufacturing workforce in the Los Angeles Basin skews older; more than a quarter (28.5 percent) of workers are age 55 and older; an additional 26.0 percent are 45 years to 54 years of age; and only 22.3 percent of workers are 22 years to 34 years of age.

STILL OFFERS JOB OPPORTUNITIES

Manufacturing employs over 400,000 workers in the industry across all skill levels in the L.A. Basin. Middle-skill occupations account for 39 percent of all manufacturing employment.

EMPLOYMENT CONCENTRATED

Manufacturing employment is more than two times greater in Los Angeles County than in Orange County. There are 346,400 payroll employees in manufacturing in Los Angeles County, compared to 157,840 payroll employees in Orange County.

REQUIRING MORE EDUCATION

Larger shares of workers hired have a bachelor's degree or higher, or have an associate degree and some college, compared to those hired in 1992 (the oldest data available).

HIGH-TECH INDUSTRIES DOMINATE

Aerospace products and parts manufacturing is a major employer of nine of the ten middle-skill target occupations identified in this report. Electronic instruments manufacturing and semiconductor and electric components are also major employers of the middle-skill target occupations.

RISKS TO INDUSTRY

- Tariffs and their impact on trade
- Tariffs and their impact on trade
- Price volatility
- Uncertainty about the future
- Regulatory environment when compared to other states
- Labor costs versus less expensive regions/nations
- Conversion of industrial land base
- Offshoring

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Table of Contents

Manufacturing

An industry transforming

This manufacturing report and other industry reports are intended to establish a baseline from which the Center and the region's community colleges can further build their knowledge and, working in partnership with industry, amplify their understanding about the region's labor markets and the middle-skill workforce gaps, as gauged by the difference between industry needs and community college completions.

In the manufacturing sector, labor and capital are both important; capital increasingly so.

Manufacturing involves the mechanical, physical, or chemical transformation of materials, substances or components into new products. Manufacturing has a very large presence in the region, with strong projections for a number of middle-skill occupations between 2017 and 2022.

For this reason, it offers significant opportunities for students attending community colleges in the region.

Manufacturing is fundamentally a process of transformation, of assembling, building, breaking down, combining or producing things. But the manufacturing industry itself is, and has been, undergoing its own transformation. The transformation of manufacturing has been driven by three phenomena: advances in material sciences; the explosion of computing power; and globalization.

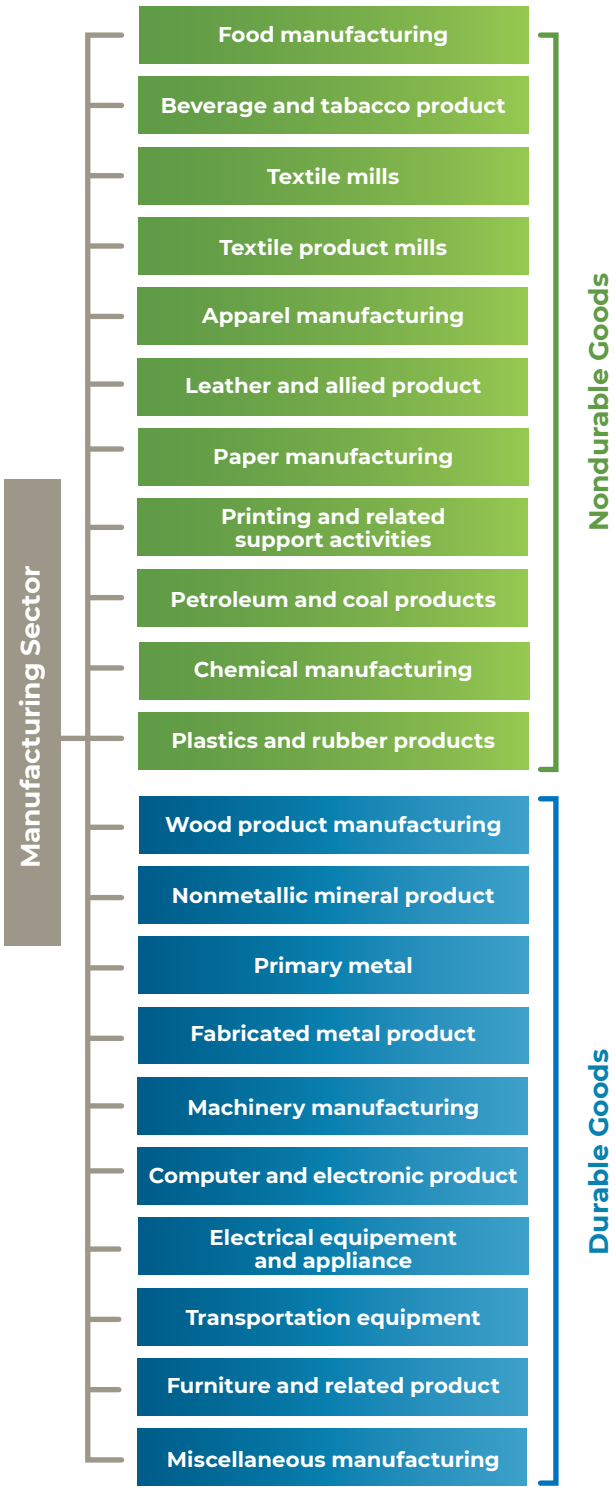
The first phenomenon broadened the universe of inputs into manufacturing, with more materials being studied, analyzed and mathematically modeled every day to be added to the database of potential inputs. The second trend revolutionized every aspect of manufacturing. Known as the "Third Industrial Revolution," the digitization of manufacturing is rapidly changing how products are designed, fabricated and used, with many citing the use and infusion of advanced technologies, such as machine learning, artificial intelligence (AI) and robotics, as the Fourth Industrial Revolution.

Combined, material knowledge and digitization has transformed manufacturing. Products are designed digitally and are engineered using the vast amounts of materials data, and their adaptive responses to environmental stimuli are also modeled and simulated before a single production mold is made and before a single production run is committed. This saves on the cost and process time typically involved in producing several iterations of prototypes, compressing the time to market for manufactured goods.

Lean manufacturing and advanced manufacturing refer to these advances in materials and process compression, reducing time to market and increasing product design and engineering efficiencies.

The third trend—globalization—has opened up new markets in which to sell goods, reduced input costs (labor, materials), and broadened opportunities. Advances in communications allow research and development teams to be assembled anywhere, communicating digitally, where human capital can be optimized by discipline, need and cost. The engineering may be done in the cloud, with a design team in Shanghai or Silicon Beach, while the manufacturing may take place in Vietnam or Valencia, depending on the costs and qualities of the inputs needed—such as land, labor and capital—and depending on whether local capability exists to deliver the quality of production needed.

Exhibit 1



The Manufacturing Sector Defined

The manufacturing sector includes the production of products and, in some cases, the assembly of components. Products produced range from bakery products to oil production and refining, to high-tech products.

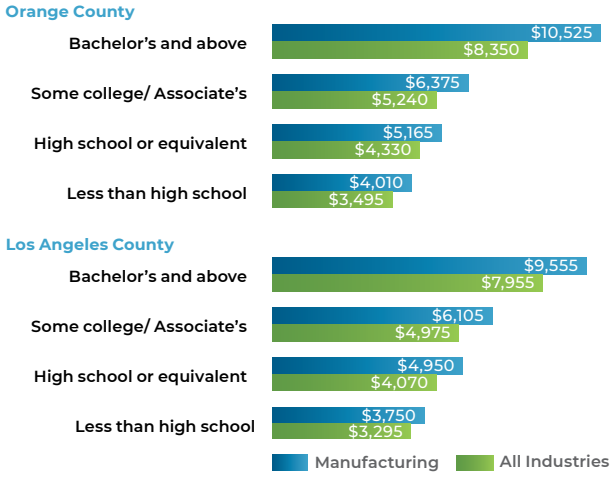
The subsectors in the manufacturing sector generally reflect distinct production processes related to material inputs, production equipment, and employee skills. The industries are often grouped into durable and non-durable goods: durable goods are those that last a long time, typically three years or more, and nondurable goods are those who have a short lifecycle, typically consumed immediately or in less than three years. Examples of nondurable goods (NAICS 322, 323, 324, 325, 326 and all of sector 31) include the subsectors of: food manufacturing, textile mills and chemical manufacturing. Examples of durable goods (NAICS 321, 327 and all of sector 33) include the subsectors of fabricated metal products, machinery manufacturing and transportation equipment manufacturing. Nondurable goods and durable goods are shaded orange and blue, respectively.

The Los Angeles Basin's manufacturing industries employ a wide range of workers by occupation, skill level, educational attainment, and experience.

There are distinct differences present across the component industries including size of operations and staffing patterns. Different industries, along with the different occupations within those industries, experience labor shortages and skills gaps uniquely.

Exhibit 2

Average Monthly Earnings 2017 by Educational Attainment , ages 25+ years



Manufacturing's Changing Workforce

Manufacturing generates $354.0 billion in economic output annually in the Los Angeles Basin, and accounts for 15.8 percent of the gross regional product (see the Manufacturing Still Matters in the L.A. Basin section for full analysis).

Approximately 41 percent of purchases made in the industry's supply chain are made using local vendors.

Manufacturing employs over 400,000 workers in the industry across all skill levels in the L.A. Basin. Across all levels of educational attainment, average monthly earnings in manufacturing in the Los Angeles Basin are higher relative to the combined average of all industries.While manufacturing industries in the L.A. Basin range across the spectrum, from high technology industries such as computer and electronic products, aerospace parts and products and medical devices, to low technology manufacturing such as apparel overall has lost nearly a third (30.3 percent) of its employment from 1990 to 2018. Virtually all manufacturing industries lost jobs, and some (apparel manufacturing and textile mills) lost close to half of their employment in the ten years since 2008 alone. Growing subsectors in manufacturing over the last decade (2007 to 2017) included beverage manufacturing (23 percent) thanks to the rise of micro-breweries, petroleum and coal products manufacturing (21 percent) which includes refineries, and miscellaneous manufacturing (4 percent), which includes medical equipment and supplies.

There are many diverse occupations in the manufacturing sector, with jobs in accounting, sales, office and administrative services, on the production line and in engineering and computer sciences. Given the wide range of occupations, it is expected that a diversity of knowledge, skills and abilities would be needed.

Just under 45 percent of all manufacturing jobs are in production occupations. These include such roles as machinists, welders and cutters, team assemblers, machine operators, inspectors, testers, production helpers, and many others. At the national level, more than 51 percent of all manufacturing workers are in production occupations, suggesting a higher degree of automation in the L.A. Basin than in the rest of the nation.

Exhibit 3

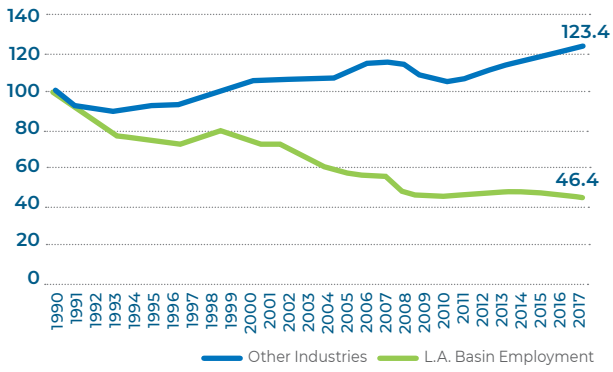
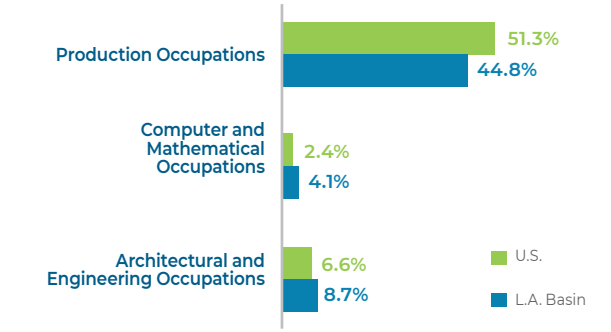


Exhibit 4



Among the consequences of the transformational change in manufacturing have been disruptive employment effects. As stated above, employment declines in manufacturing since the turn of the 21st century may be more related to the transformational shifts of increased automation, process compression and offshoring than to a loss of demand for manufactured products.

Automated capital is increasingly replacing labor, while the remaining labor itself has become more productive. As a result, the value of manufacturing output has increased even as manufacturing employment levels have fallen. Workers who are still employed in the industry are typically those with more specific technical skills that allow them to take advantage of the technology investments of their firms, which implies that there is a dramatic need to support the technical education of potential workers.

Computer and mathematical occupations account for more than four percent (4%) of all manufacturing jobs, and architectural and engineering occupations (mostly engineering) are almost nine percent (9%) of all jobs. At the national level, the share of workers in architectural and engineering occupations is less than seven percent (7%), and computer and mathematical occupations are 2.4 percent, supporting the notion that manufacturing is more technologically intensive than other areas.

Skills required by workers have become more advanced, requiring increased education, upskilling and training. From 1992 to 2017, the share of manufacturing workers hired who had earned a bachelor's degree or higher increased by 4.3 percent, and those hired with an associate degree or some college increased by 2.5 percent.

Simulation and digitization have eliminated the need for many incremental prototypes but have led to the rise of both software engineers, who program the modeling and simulation systems that replace the prototyping and mold development steps, and mechanical and structural engineers, who use these systems to program engineering software.

Manufacturing's transformation has also reduced the need for production workers, as automation has reduced the number of workers on production lines from many to a single technician with a computer numerical control device (CNC) monitoring an automated production line that runs continuous shifts, without breaks.

There are a number of trends taking place in manufacturing that impact the industry's workforce including the use of contingent workers (domestic outsourcing), automation, robotics, and further advancements in digital technologies, along with other capital-labor substituting technologies.

Exhibit 5

U.S. Manufacturing 1990 to 2017 (1990=100)

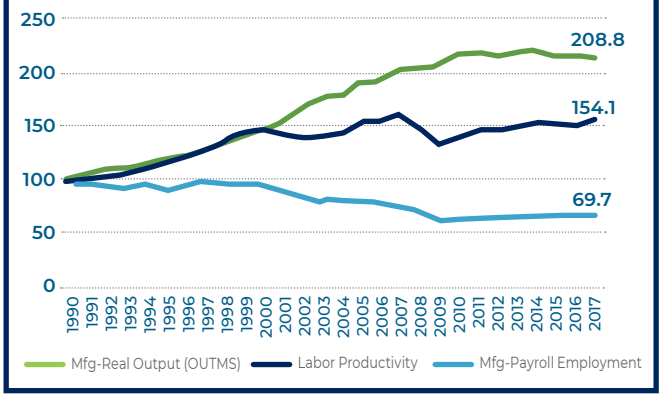
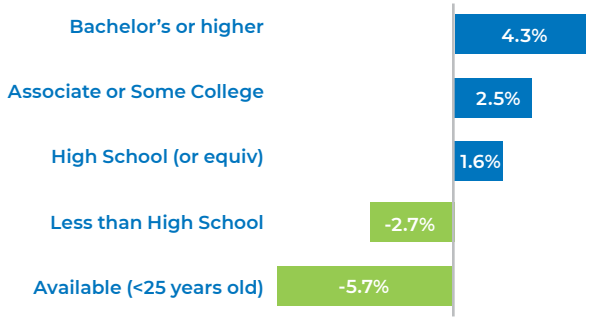


Exhibit 6

Manufacturing Workers Hired in 1992 & 2017

Change in Distribution of Educational Attainment



Manufacturing | An industry transforming.

A number of occupations in manufacturing across all skills levels are vulnerable to automation in the next decade. AI and algorithms, machine learning, big data, cloud computing, and the internet of things, which allows real-time connectivity, are all impacting the industry. Indeed, a large number of occupations in manufacturing already include a degree of automation into their job duties, including refinery operators and robotics technicians. The industry is poised for further digital transformation from everchanging advanced technologies and should expect to experience continued disemployment (the job goes away) in occupations where tasks are repetitive and are classified as low-skilled. Conversely, increased opportunities will exist for individuals who possess the kind of highly technical, advanced and/or specialized skills employers are looking for as jobs are redefined and increasingly more job-related activities become automated.

Since a significant portion of the manufacturing workforce is aging, attrition over the next decade stands to be a significant issue. Close to half (48.1 percent) of the workforce in manufacturing is between the ages of 45 and 64 and an additional six percent (6%) are over 65 years old; only 22.3; percent of workers are 22 years to 34 years of age. As these older cohorts separate from the industry, they are taking their decades of experience. For example, 38 percent of aerospace engineering and operations technicians and 34 percent of industrial machinery mechanics are 55 years and older, both occupations are projected to have significant openings over the next five-years.

Technical training, apprenticeships, and other work-based learning experience, and job readiness skills, which include communication, critical thinking and problem-solving skills are identified amongst the most desirable qualifications by manufacturing employers.

Looking forward, the future of work in manufacturing will require individuals to be adaptable, to acquire specialized skills needed in their specific industry, including any industry-recognized certifications, and to quickly learn to use new technologies as they are adopted. In this way, workers in the manufacturing industry will have a better chance of remaining relevant and, most importantly, employed in an industry poised to continue to experience significant changes related to technological innovation.

Exhibit 7

Current Degree of Automation

HIGHLY AUTOMATED

- Biofuels Processing Technicians
- Petroleum Pump System Operators, Refinery Operators, and Gaugers
- Robotics Technicians

MODERATELY AUTOMATED

- Textile Bleaching and Dyeing Machine Operators and Tenders
- Cooling and Freezing Equipment Operators and Tenders
- Forging Machine Setters, Operators, and Tenders, Metal and Plastic

SLIGHTLY AUTOMATED

- Electrical Engineering Technicians
- Electronics Engineering Technologists
- Industrial Safety and Health Engineers

VERY LITTLE AUTOMATION

- Structural Metal Fabricators and Fitters
- Welders, Cutters, and Welder Fitters

Exhibit 8

Age Distribution of Workforce

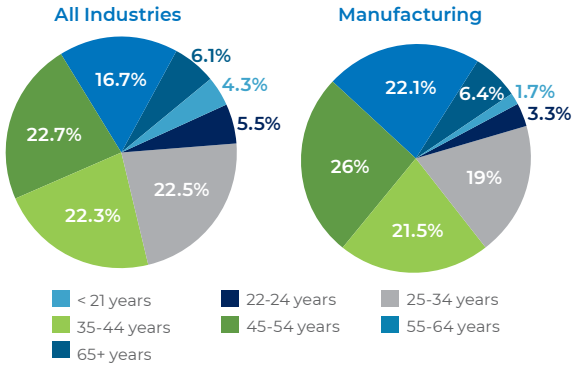
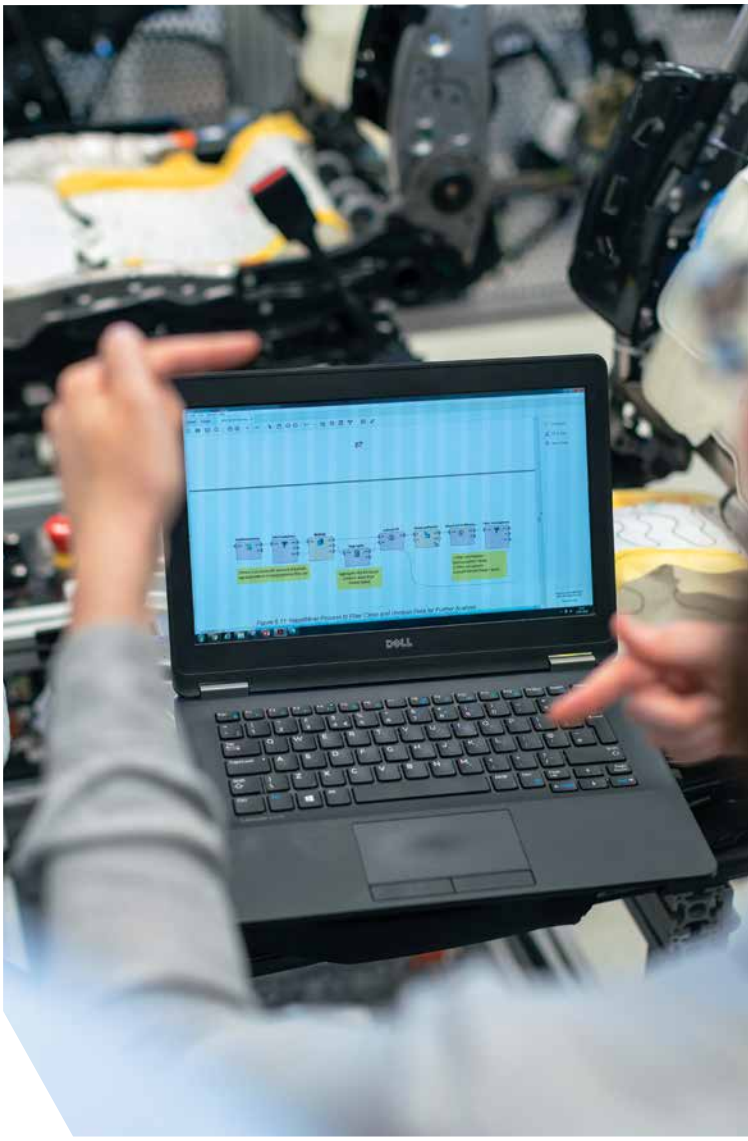


Exhibit 9

Skills in Demand by Employers

- Biofuels Processing Technicians
- Critical thinking
- Problem solving/ decision making
- Interest and Aptitude for Technology
- Team work/collaboration
- Attention to detail
- Dependability
- Ability to be cross trained
- Oral and written communication
- Job readiness



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Sizing Things Up

Sizing Things Up | The industry defined.

Analyses of trends in the manufacturing sector provides insight into the challenges and opportunities facing the industry's workers and employers. Understanding where the jobs are now, and in the future, is critical to tailor training and career education programs, as well as regional policies to prepare for these changes and to fill the jobs of the future with a workforce that is competitive in a fast-changing global economy.

In this section, job counts, changes in payroll employment and wages are discussed for the two counties comprising the Los Angeles Basin: Los Angeles and Orange.

Industry Employment

Employment in manufacturing is a measure of the number of jobs provided by businesses in the industry. Industry employment can be estimated at different levels of industry classifications and can be used to determine the industry composition and identify large employing industries, track relative competitiveness and observe employment trends for the varying types of manufacturing.

Industries in the manufacturing sector employ 421,910 private payroll workers (2017) in the Los Angeles Basin, accounting for 8.3 percent of total regional employment. Manufacturing workers in the region account for 38 percent of all manufacturing employment in California and four percent (4%) of manufacturing employment nationwide.

The first level of detail in manufacturing is the three-digit industry subsector. There are twenty-one manufacturing subsectors: eleven nondurable and ten durable goods manufacturing subsectors.

Manufacturing workers in the Los Angeles Basin account for 38 percent of all manufacturing workers statewide.

Exhibit 10

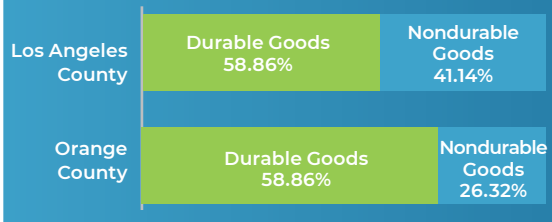
Manufacturing Employment 2017 Los Angeles Basin

NAICS	Industry	Share of Mfg Jobs
Nondurable Goods Manufacturing		**36.3%**
311	Food manufacturing	9.5%
312	Beverage and tobacco products	1.7%
313	Textile mills	1.0%
314	Textile product mills	1.0%
315	Apparel manufacturing	6.5%
316	Leather and allied product manufacturing	0.4%
322	Paper manufacturing	1.7%
323	Printing and related support activities	4.1%
324	Petroleum and coal products	1.1%
325	Chemical manufacturing	5.4%
326	Plastics and rubber products	3.9%
Durable Goods Manufacturing		**63.7%**
321	Wood product manufacturing	0.9%
327	Nonmetallic mineral product manufacturing	1.5%
331	Primary metal manufacturing	1.4%
332	Fabricated metal product manufacturing	13.0%
333	Machinery manufacturing	4.6%
334	Computer and electronic product	14.8%
335	Electrical equipment, appliance and components	3.0%
336	Transportation equipment manufacturing	12.4%
337	Furniture and related product manufacturing	3.6%
339	Miscellaneous manufacturing	8.5%
Total – Manufacturing Sector		**100%**

Source: BLS, QCEW, LAEDC

Exhibit 11

Manufacturing employment distribution in LA and Orange counties in 2017



A mix of high-tech and low-tech industries, the three largest employing industry subsectors (computers and electronic product manufacturing, fabricated metal product manufacturing, and transportation equipment manufacturing) accounted for 40 percent of the L.A. Basin's total manufacturing employment in 2017.

The composition of manufacturing employment in the two LA Basin counties varies moderately; while, the size of the industry in the two geographies is significantly different. The manufacturing industry in Los Angeles County has more than double the number of workers in Orange County; there are 2.1 manufacturing employees in Los Angeles County for every one manufacturing employee in Orange County. Consequently, there will be differences in the number of middle-skill employment opportunities in each county.

Total employment in the industry as a whole has been continuously declining over the last decade, at an average annual rate of -1.9 percent per year. From 2007 to 2017, employment in manufacturing significantly underperformed compared to total payroll employment growth (4.7 percent) across all industries in the LA Basin, shedding over 118,260 jobs, a decline of 19 percent. However, certain individual manufacturing industries within the sector have experienced positive job growth over the period, including beverage manufacturing (23 percent); petroleum and coal products manufacturing (21 percent); and miscellaneous manufacturing (4 percent). Together, these three sub-sectors added over 4,000 new jobs over the decade.

Wages in the Industry

Employees working in manufacturing typically earn higher than average wages compared to the regional economy. Overall, employees in manufacturing industries earned, on average, $76,250, which is more than the regional average across all industries ($62,550).

Still, this is just an average across all manufacturing industries, so some sub-industries pay significantly higher, and others significantly lower wages. For example, petroleum and coal products manufacturing pays on average $143,260 per annum (includes benefits and overtime), while average annual wages in textile mills is $43,860.

Exhibit 12

Change in Payroll Employment from 2007 to 2017

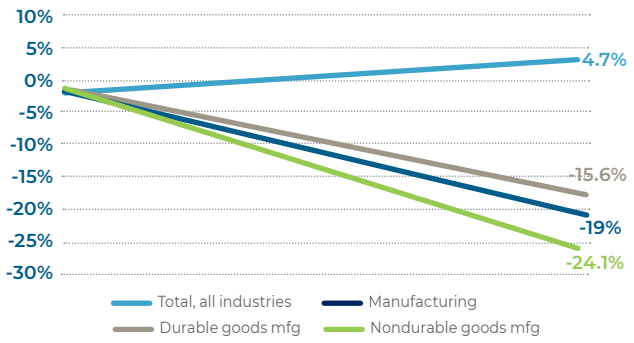


Exhibit 13

Compensation per Employee of Manufacturing Industries Los Angeles Basin 2018

NAICS Industry		Compensation per Employee
Nondurable Goods Manufacturing		**$55,180**
311	Food manufacturing	$50,480
312	Beverage and tobacco products	$63,880
313	Textile mills	$43,860
314	Textile product mills	$48,990
315	Apparel manufacturing	$47,260
316	Leather and allied product manufacturing	$47,040
322	Paper manufacturing	$68,040
323	Printing and related support activities	$51,370
324	Petroleum and coal products	$143,260
325	Chemical manufacturing	$70,140
326	Plastics and rubber products	$54,770
Durable Goods Manufacturing		**$83,920**
321	Wood product manufacturing	$44,210
327	Nonmetallic mineral product manufacturing	$56,590
331	Primary metal manufacturing	$65,530
332	Fabricated metal product manufacturing	$60,950
333	Machinery manufacturing	$75,210
334	Computer and electronic product	$128,720
335	Electrical equipment, appliance and components	$73,740
336	Transportation equipment manufacturing	$103,660
337	Furniture and related product manufacturing	$47,550
339	Miscellaneous manufacturing	$71,010
Total – Manufacturing Sector		**$76,250**

Source: BLS, QCEW, LAEDC

Real wages in manufacturing grew overall by 13.4 percent, more than the growth of all industries in the Los Angeles Basin, where inflation-adjusted (real) wages increased by just over five percent (5%).

Over the last decade, wage growth has been fastest in high-tech manufacturing industries, such as: computer and electronic products, transportation equipment, and electrical equipment and appliance manufacturing, with 23 percent, 16 percent and 14 percent growth respectively; fashion-related manufacturing industries (textile and textile product mills and apparel manufacturing) with 21 percent growth; and primary metal manufacturing with 21 percent growth.

Competitiveness and Regional Advantage

A region's competitiveness in an industry is a function of many factors, including: the attractiveness and value of the product(s)/service(s) produced/delivered; the costs of inputs such as labor, land and energy; the productivity of individual firms; and the geographic concentration of the industry, where regionally-concentrated industries are likely to be more competitive than those same industries in other economic regions without high concentration.

A higher employment concentration is an indication that the industry is relatively more concentrated regionally than the national average. This is evidence of clustering of activity. One interpretation of such concentration is that existing conditions in the region are conducive to the success of that industry. Competitive advantage can be the result of welldeveloped supplier networks, a supply of skilled labor, proximity to transportation networks, adequate infrastructure or access to natural resources.

Such relative concentration is measured by location quotients (LQ).[1] An LQ for an industry in the L.A. Basin shows the percentage of total employment in an industry compared to the percentage across the nation. A location quotient of 1 would indicate that the local industry concentration is identical to that of the larger region.

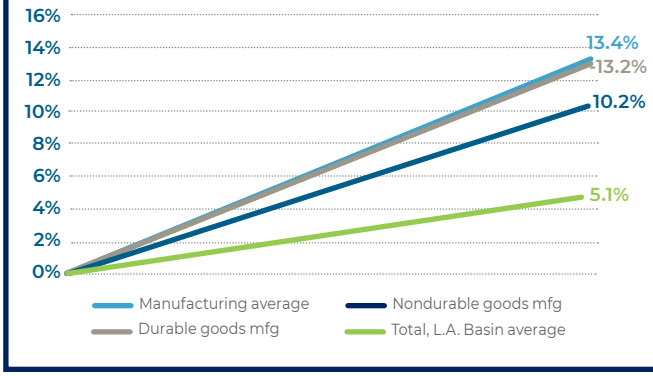
Based on analysis, the LA Basin's manufacturing industries are varied in their concentration vis-à-vis the nation, with most component industries' location quotients about on par with or slightly below the average concentration (around an LQ of 1.0) of the manufacturing industry nationwide. Seven component industries show higher concentrations, with an LQ of 1.2 or higher.

Although manufacturing employment is on the decline across the nation, the L.A. Basin remains a relatively concentrated center of manufacturing across many product lines, including: apparel and textiles; leather products; printing and related support activities; petroleum and coal products; computer and electronic products; and miscellaneous manufacturing, which includes jewelry, toy and medical equipment and supplies manufacturing.

Exhibit 15 shows the manufacturing industries in the L.A. Basin by their 2017 employment location quotients compared to the nation. This allows us to see how competitive the region is compared to the same industries across the nation as a whole.

The manufacturing sub-industry with the highest location quotient in the L.A Basin in 2017 was apparel manufacturing, with a location quotient of 7.3 vis-à-vis the nation. Though employment has declined significantly over the last decade, this industry is still undeniably one in which the region has a competitive advantage.

Exhibit 14



[1] *Location quotients are used to measure industry competitiveness.*

The industry with the second highest location quotient is computer and electronic product manufacturing, with a location quotient of 1.7 vis-à-vis the nation. The L.A. Basin is a significant manufacturer of navigational and control instruments, including radar, guidance, aeronautical and sonar systems (which are component industries of the computer and electronic products manufacturing sub-sector).

Exhibit 15

Top Competitive Industries in Los Angeles Basin in 2017 (Location Quotients v. US)

NAICS	Industry	US
311	Food manufacturing	0.7
312	Beverage and tobacco products	0.8
313	Textile mills	1.2
314	Textile product mills	1.1
315	Apparel manufacturing	7.3
316	Leather and allied product	1.7
321	Wood product manufacturing	0.3
322	Paper manufacturing	0.6
323	Printing and related support activities	1.2
324	Petroleum and coal products	1.2
325	Chemical manufacturing	0.8
326	Plastics and rubber products	0.7
327	Nonmetallic mineral product	0.4
331	Primary metal manufacturing	0.5
332	Fabricated metal product	1.1
333	Machinery manufacturing	0.5
334	Computer and electronic product	1.7
335	Electrical equipment and appliance	0.9
336	Transportation equipment	0.9
337	Furniture and related product	1.1
339	Miscellaneous manufacturing	1.6
Total – Manufacturing		**1.1**

Source: BLS, QCEW, LAEDC

Manufacturing Still Matters in the L.A. Basin

Manufacturing is contributing prominently to the region's labor market, numerous target industries, and state and local tax coffers.

The extent to which an industry's economic impact extends to other sectors of the economy and into local households depends on the share of industry revenue recirculated within the region. The total economic contribution of the manufacturing industry to the economy of the Los Angeles Basin is magnified through its supply chain and payroll spending.

Where the Manufacturing Industry Spends Its Revenues

Firms generate revenues through sales of their products and services, and use those funds to purchase the inputs needed to produce their products and services, pay workers and taxes, and generate a return on capital in the form of profits.

In 2017 (the most recent data available), the manufacturing industry spent $47.6 billion on labor payments and distributed $33.7 billion in profits. Purchases of intermediate inputs into production reached to over $151.4 billion, accounting for 64.1 percent of all outlays. Profits represent 14.2 percent of all outlays.

The overall impact that an industry has on the broader regional economy depends upon the expenditures made within the region. In general, outlays for labor costs occur locally, and households are supported by these earnings.

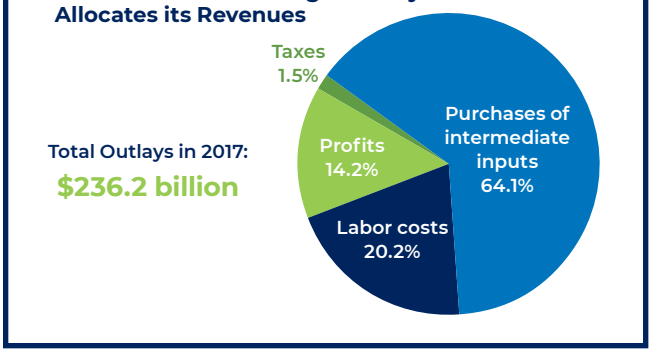
If most of the inputs used in production are purchased from local suppliers, those firms experience increased demand for their products and can ramp up hiring, thereby supporting additional households in the region. If, on the other hand, most of the inputs are purchased elsewhere in the nation, then these purchases have no impact locally (other than perhaps in their transportation and storage) and the industry itself generates fewer indirect effects.

Together, labor costs and regional purchases of intermediate inputs determine the spillover, or multiplier, impacts of the industry.

Manufacturing impacts a broad spectrum of industries through its supply chain.

Exhibit 16

How the Manufacturing Industry Allocates its Revenues



Sources: BEA; Analysis by LAEDC

Manufacturing Still Matters in the L.A. Basin

The Manufacturing Industry's Regional Economic Contribution

The contribution of the manufacturing industry to the regional economy is measured by analyzing its direct activity, as well as indirect and induced activity.

This contribution is dependent on the payments made to suppliers of intermediate goods and services in the region and payments made to workers, who usually live locally and spend most of their incomes on household purchases from local suppliers.

In addition to the 421,910 direct payroll jobs in the manufacturing industry, there were 100,430 contingent workers in the industry.

An additional 326,810 jobs were supported in 2017 through indirect effects of supply chain purchases (those made outside the industry). Close to 358,440 jobs were supported through the household spending of employees in the industry and its supply chain.

Labor income (which includes wages and benefits) earned by all manufacturing-supported employment in the Los Angeles Basin reached $93.0 billion in 2017. This accounts for just under 16 percent of all labor income paid in the region.

The industry produced $158.9 billion in value-added, which accounted for 15.8 percent of the Los Angeles Basin's gross regional product.

The overall impacts of the manufacturing industry are widely distributed across many sectors of the economy through indirect and induced effects, including construction, food services, manufacturing industries, real estate, rental, leasing, wholesale trade, professional and technical services, and administrative support and waste services.

The manufacturing industry's total fiscal impact in 2017—including direct, indirect and induced activity—exceeded $35 billion. This includes, for example, property taxes paid by firms and households, sales taxes on consumption purchases, personal and corporate income, and payroll taxes paid for and by employees.

Exhibit 17

Direct, Indirect and Induced jobs resulting from the manufacturing industry

1,207,590
TOTAL JOBS

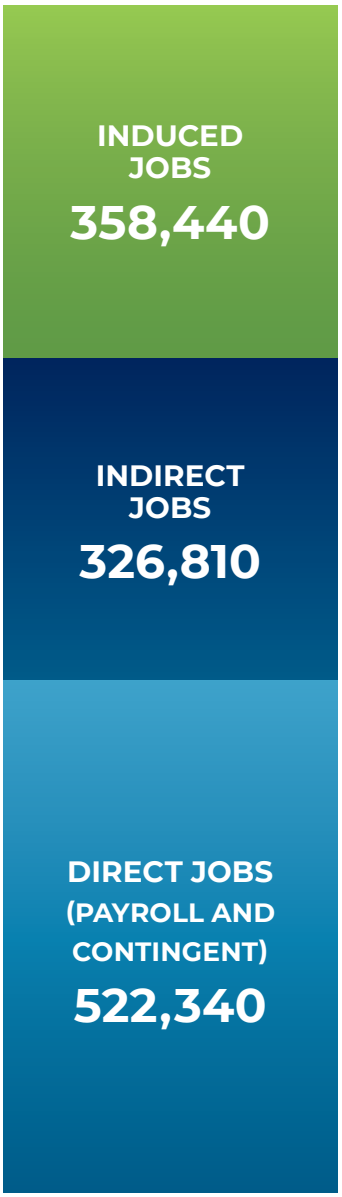


Exhibit 18

The manufacturing industry's total economic contribution, 2017

	Direct	Total	% of LA Basin Total
Output	$236.2B	$ 354B	22.00%
Employment (jobs)*	522,340	1,207,590	13.90%
Labor Income	$47.6B	$93B	15.90%
Value-Added	$84.8B	$158.9B	15.80%

**Includes contingent workers*

Source: Estimates by LAEDC

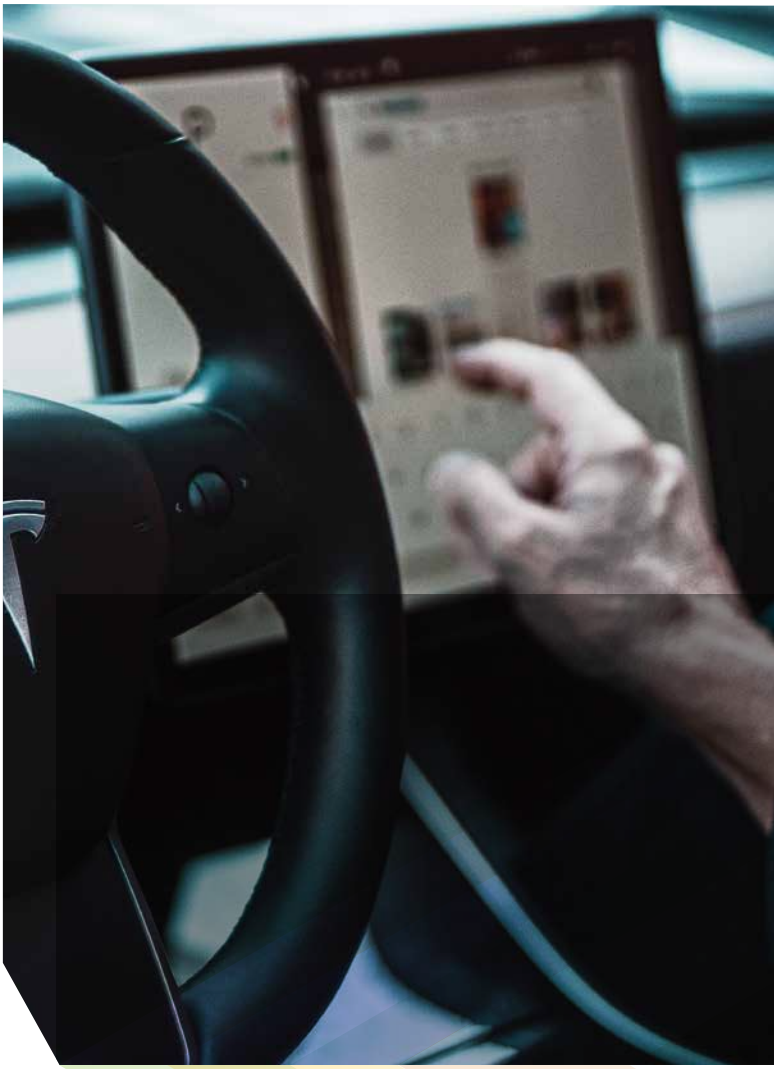
Exhibit 17

The manufacturing industry's total fiscal impacts by type

By Type of Tax:	
Personal income taxes	$10.9B
Social insurance	$10.6B
Sales and excise taxes	$5.3B
Property taxes	$3.8B
Corporate profits taxes	$3.2B
Other taxes	$2B
Total	**$35.8B**

By Type of Government:	
Federal	$22.1B
State	$7.9B
Counties	$4B
Cities	$1.8B
Total	**$35.8B**

Source: Estimates by LAEDC



Manufacturing Still Matters in the L.A. Basin

Manufacturing Supply Chain Analysis

The intermediate purchases of the manufacturing industry comprise an important part of the overall economic contribution of the industry. It was shown above that these accounted for 64.1 percent of the industry outlays, or $151.4 billion, in 2017.

Gross inputs are a combination of goods and services. In this industry, over half (51.4 %) of intermediate goods are other manufactured goods, including component parts and other manufactured finished goods, which are then used as an input in the production process for more complex manufactured goods (see panel in exhibit below). Natural resources and mining accounted for just over 16 percent of intermediate inputs. Trade, transportation and utilities, and professional business services, respectively, accounted for 14 percent and 12 percent of intermediate inputs, which includes warehousing and logistics services, power and electric, and engineering services. Financial activities-related services, such as insurance and credit intermediation accounted for close to 3 percent of intermediate inputs, and the remaining 4 percent of inputs were provided by other industries.

Regional Purchase Gap

The ability of a region to fill the demands of its industries speaks to the richness and diversity of the regional economy. Not all regions can effectively compete, or wish to compete, with suppliers of specific goods and services based elsewhere. Industries making purchases of goods elsewhere are clearly benefiting from lower costs, better quality or other advantages to importing intermediate goods rather than purchasing from local firms.

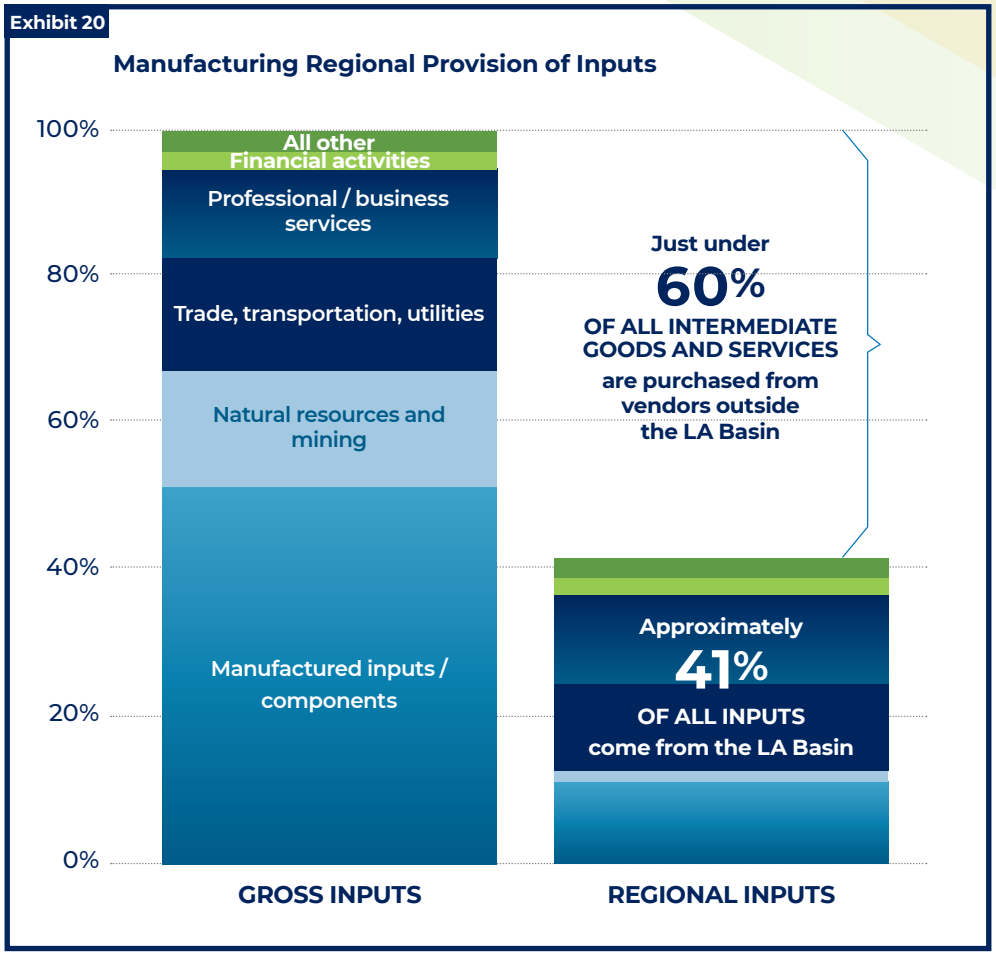
The percent of all inputs purchased regionally are shown in the right panel of Exhibit 20. In general, financial services, which includes insurance, and professional and business services are purchased from regional suppliers. Firms in the manufacturing industry purchase about 90 percent of these services from regional suppliers. Similarly, the region is able to supply the manufacturing industry with most of its trade, transportation and utilities needs locally, with regional purchases accounting for more than 87 percent of the industry's total purchases of these services.

In contrast, just 23 percent of the industry's purchases of manufacturing-related goods and services occur in the Los Angeles Basin. Because this represents the largest share of the industry's intermediate inputs, the impact on the overall regional supply pipeline is significant in magnitude related to this lost opportunity. In terms of value, the industry spends about $59.8 billion with firms outside the region.

The percentage of intermediate goods and services that an industry is able to purchase from local suppliers has a direct impact on its contribution to the region's economic activity. The higher that percentage, the larger the multiplying effects that its revenues will have, which translates to increased wealth generation for the region.

About 90 percent of the manufacturing industry's purchases of professional and business services and financial services, which includes insurance, are from firms in the Los Angeles Basin.

Exhibit 20



Demand-Side Analysis

To determine where the manufacturing sector is headed, a growth forecast of its sub-industries over the next five years is used to extrapolate future demand for workers.

Between 2017 and 2022, manufacturing as a whole is projected to grow in the Los Angeles Basin by 2,300 net new jobs. This growth is being led by industries manufacturing durable goods. The highest growth by number of jobs is forecasted to occur in the computer and electronic product manufacturing (1,600 new jobs), followed by food manufacturing (1,090 new jobs) and transportation equipment manufacturing (850 new jobs). The highest number of jobs by proportion is forecasted to be created in beverage manufacturing (2.7 percent). Two component industries are predicted to experience the deepest decline in payroll employment, textile mills and apparel manufacturing, by 6.1 percent (-270 jobs) and 5.2 percent (-1,660 jobs), respectively. The industries included in the manufacturing sector are discussed individually in the Industry Forecast section found later in this report.

The number of projected new jobs can be combined with job openings from replacements and retirements to provide an overall estimate of employer hiring needs. Most of the job openings expected over the next five years will be due to workers changing jobs or retiring, rather than the creation of new jobs in the manufacturing sector.

Overall, 150,770 total job openings will be created in the manufacturing industry in the Los Angeles Basin over the next five years, of which an estimated 148,470 will be replacement workers.

The highest number of openings will be in production occupations. These are forecasted to be occupations that include: machinists; and welders, cutters, solderers and brazers.

Manufacturing is projected to add 2,300 net new jobs in the LA Basin by 2022.

Exhibit 21

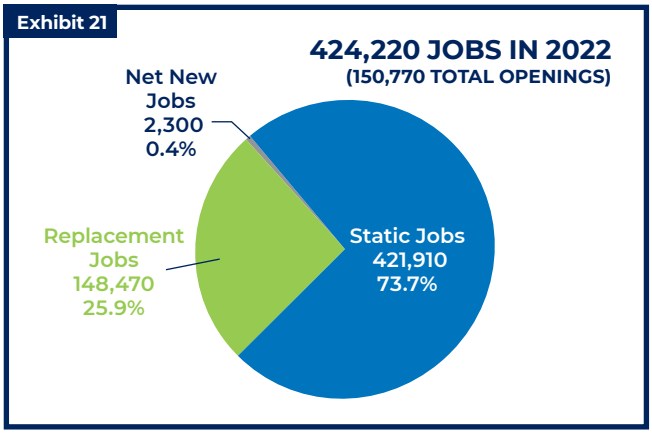
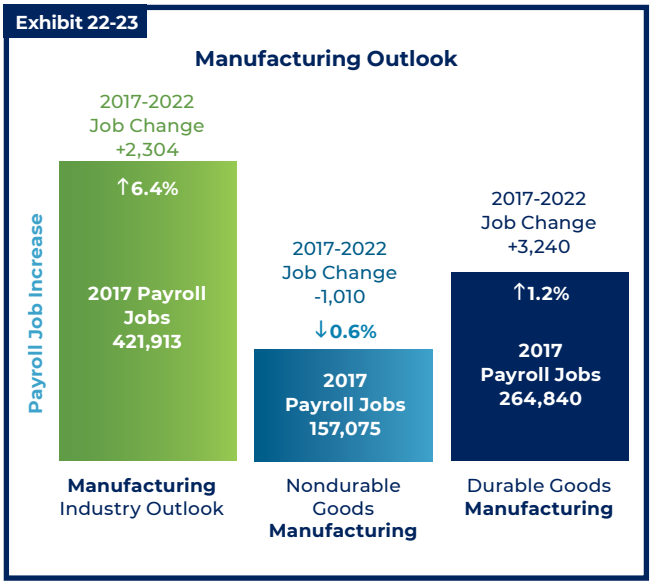


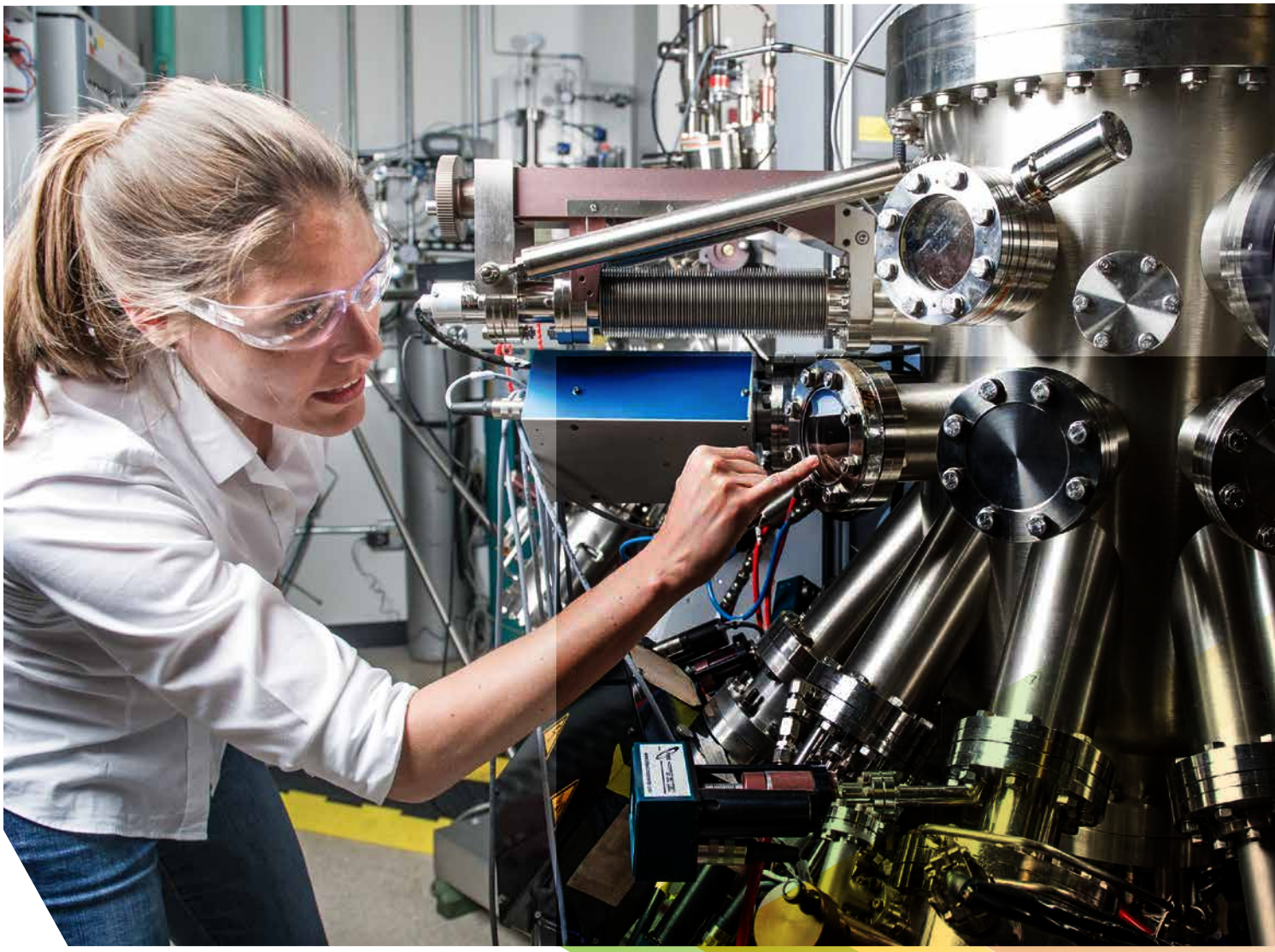
Exhibit 22-23



Demand-side Analysis

Manufacturing Outlook				
Non-durable		**2017 Payroll Jobs**	**2017-2022 Job Change**	**%**
311	Food Manufacturing	42,270	1,090	2.6%
312	Beverage and tobacco product	1,610	40	2.7%
313	Textile mills	4,370	-270	-6.1%
314	Textile product mills	4,760	-180	-3.8%
315	Apparel manufacturing	32,100	-1,660	-5.2%
316	Leather and allied product	1,370	-50	-3.4%
322	Paper manufacturing	5,870	15	0.2%
323	Printing and related support activities	19,450	-370	-1.9%
324	Petroleum and coal products	3,560	90	2.5%
325	Chemical manufacturing	23,870	490	2.0%
326	Plastics and rubber products	17,840	-130	-0.7%
Durable		**2017 Payroll Jobs**	**2017-2022 Job Change**	**%**
321	Wood product manufacturing	3,340	30	0.9%
327	Nonmetallic mineral product	6,000	70	1.1%
331	Primary metal manufacturing	5,610	-40	-0.8%
332	Fabricated metal product	54,480	-90	-0.2%
333	Machinery manufacturing	18,930	230	1.2%
334	Computer and electronic product	61,480	1,610	2.6%
335	Electrical equipment and appliance	12,810	150	1.1%
336	Transportation equipment	51,880	850	1.6%
337	Furniture and related product	16,210	-40	-0.2%
339	Miscellaneous manufacturing	34,110	470	1.4%

Source: BLS, QCEW; forecast by LAEDC



Demand-side Analysis

Currently, middle-skill jobs comprise close to half of all jobs in manufacturing industries. Similarly, analysis of the skills classifications for total job openings over the next five years reveals that over 43 percent of projected openings will be for middle-skill occupations, reinforcing the selection of this industry as a valid target for community college programs.

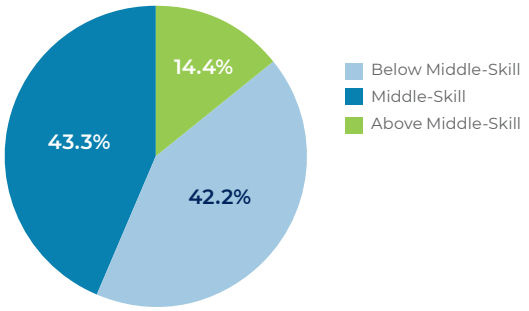
Middle-skill occupations in manufacturing are diverse, ranging from sheet metal workers to bakers and CNC machine tool programmers. Job duties and core job competencies vary along with wages, as do employment status (full- and part-time status) across industry occupations.

The manufacturing industry has a number of middle-skill occupations that have significant employment churn and relatively higher numbers of replacement jobs annually. This is important to note, as the net change in new jobs can be negative, but in occupations with a lot of movement, there can still be a high number of total openings in an occupation. For example, retirements represent additional job opportunities not related to growth. In the event that the predicted net change in jobs in this particular occupation were to slow and dipnegative, the large number of openings from individuals changing jobs and retiring would still provide opportunities for job seekers.

In addition to offshoring, domestic outsourcing exists in manufacturing. This when firms decide to contract with other local firms or individuals to provide goods or services. For example, manufacturing firms may use staffing agencies to fill their workforce needs. These temporary workers often earn lower wages, have less job stability and enjoy fewer benefits compared to workers directly hired by the manufacturing firm itself. Widespread use of domestic outsourcing can depress employment and wage growth in an industry over the long-term, especially for lower-skilled workers.

Exhibit 24

Job Openings 2017-2022



Characteristics of Manufacturing Workers Hired

Observing the characteristics of workers hired in the industry can reveal who is getting selected to fill vacant positions. The composition of all hires (the sum of new hires and recalls) in manufacturing in the Los Angeles Basin varies according to educational attainment, age, and race and ethnicity.

Manufacturing provides a wide range of jobs to individuals with different levels of education. Close to a quarter (22 percent) of all hires, which include the estimated number of workers who started a new job in 2017 (new hires and recall employees), had the educational attainment of some college, a postsecondary non-degree award, or an associate degree. These hires are filling middle-skill positions in the industry. Workers with a bachelor's degree or higher represent higher represent almost 19 percent, and those with a high school diploma or less account for an additional 41 percent.

Just over 63 percent of all hires in the industry in 2017 were in their prime working years, between 25 years and 54 years of age. The largest shares of new hires fall in the age groups of 25 to 34 years and 35 to 44 years, with 26 percent and 19 percent, respectively. Additionally, there are employment opportunities in the industry for older workers as well. Indeed, 18 percent of all manufacturing workers hired in the Los Angeles Basin were 55 years and older, providing the community colleges with new opportunities and target populations from which to draw through "continuing education" programs. On the other end of the age spectrum, approximately 9 percent of all hires were 22 to 24 years of age.

The workforce in manufacturing is diverse in both race and ethnicity. Close to 64 percent of all hires in 2017 reported their ethnicity as Hispanic or Latino (all races). Workers reporting their race as white account for 21 percent of all hires in the industry, and Asians and black/African- American workers account for 11 percent and three percent (3%), respectively.

Middle-skill occupations account for 39 percent of all manufacturing employment.

Exhibit 25

New Hires in 2017
Educational Attainment

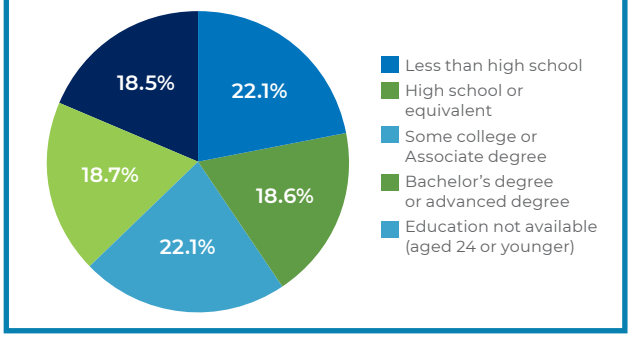


Exhibit 26

New Hires in 2017
By Age Group

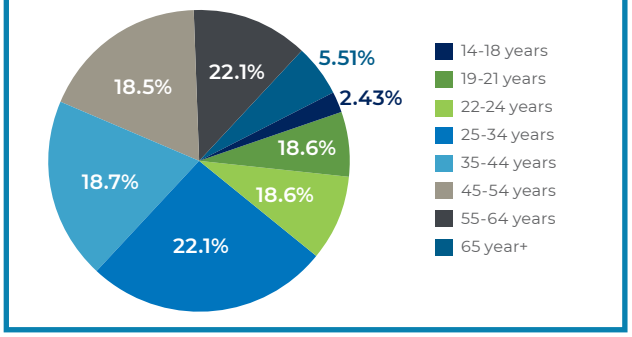
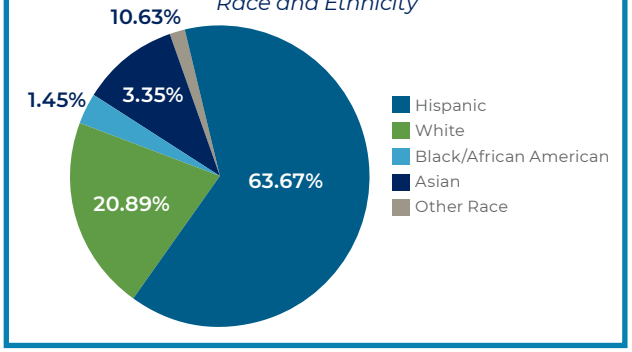


Exhibit 27

New Hires in 2017
Race and Ethnicity



Demand-side Analysis

Occupational Movement in the Industry

Manufacturing has been impacted by technology-driven changes. Each occupation has been affected differently based upon the duties performed and the industry in which they work.

Identifying manufacturing occupations that have experienced employment change, both positive and negative, can help us to identify trends that may be transforming the industry's workforce. For this reason, we look at the employment change in detailed occupations from 2012 to 2017, along with their forecasted employment, to identify those exhibiting robust growth and those that may be on a decline. Secondarily, based upon the jobs identified, we attempt to identify the underlying cause of these rates of change.

There are 290 detailed occupations in the manufacturing sector, 93 of which are classified by the California Community Colleges Centers of Excellence for Labor Market Research as middle-skill occupations. These middle-skill occupations account for 39 percent of all workers in the sector. Between 2012 and 2017, the fastest growing middle-skill occupations were avionics technicians (2,580 percent) and ophthalmic laboratory technicians (379 percent), while the middle-skill occupations that added the most jobs over the period were secretaries and administrative assistants (17,050 jobs) and production, planning, and expediting clerks (7,100 jobs).

Several of the manufacturing industry occupations exhibiting the most robust growth (ophthalmic laboratory technicians; molders, shapers and casters (except metal and plastic); and medical equipment repairers) are commonly found in the biomedical manufacturing industry, which is forecast to grow by 2.7 percent and 2.3 percent in Los Angeles County and Orange County, respectively, between 2017 and 2022. Employment growth for avionics technicians is related to the ever-increasing use of digital technologies in aircraft, which requires more maintenance and repair of complex computer systems.

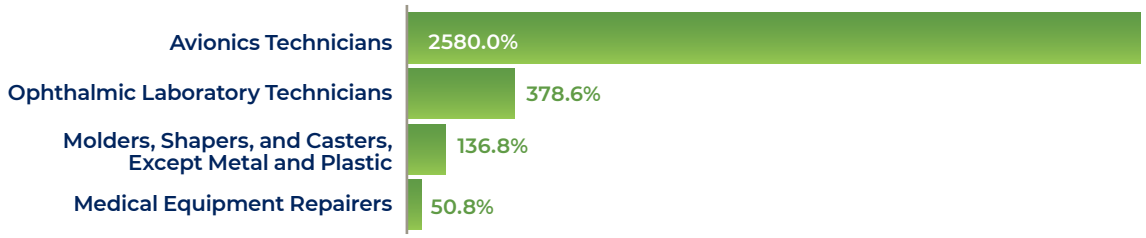
Detailed occupations experiencing significant declines over the period include: aircraft structure, surfaces, rigging, and systems assembler; prepress technicians and workers; photographic process workers and processing machine operators; and electrical and electronics drafters. Technology is pushing workers out of these occupations. Prepress technicians and workers, and photographic processing workers and machine operators are long-time examples of jobs that are becoming obsolete; printing presses and photo processing have become largely digital. Technology is allowing engineers to increasingly perform tasks that were previously done by drafters. Finally, productivity gains related to advances in automation and collaborative robotics are negatively impacting demand for assemblers.

Technological Trends in Manufacturing: What is Changing in the Workplace

Many diverse manufacturing industries comprise the sector. Each has its own unique growth trajectory, occupational composition, technological innovations, and disruptive forces. Examining what is taking place in each industry can help predict how these trends may impact the workforce. In the "Industry Forecast" section later in this report, additional quantification of the component industries in the manufacturing sector, including industry size, and the characteristics of hired workers is provided.

Exhibit 28

Middle-skill jobs with fast growth 2012-2017



Middle-skill jobs with deep declines

Demand-side Analysis

Food and Beverage Manufacturing

In the face of a constantly growing world population, food manufacturers are using new technology to help produce more efficiently and sustainably, and satisfy ever-increasing demand. At the forefront of these efforts are innovations in robotics and artificial intelligence. These serve a wide variety of purposes: eliminating safety issues in more dangerous jobs like butchery; reducing food waste by operating the assembly of packets and placing food into them; and monitoring crop yields and soil levels on farms with drones and tracking systems.

Technology is also allowing manufacturers to focus on sustainability by exploring alternatives to traditional foods and packaging. Plant-based alternatives with lower carbon footprints, such as the Impossible Foods line, are growing in popularity, and experiments with edible, micro, or even bacteria-fighting packaging are being considered instead of traditional plastics.

Another new technology in the industry is three-dimensional printing, which can help target specialized needs for certain segments of consumers while also aiding sustainability. As the modern consumer is becoming more attuned to the environmental impacts of products and developing an interest in how their products are sourced, tracking technologies through block chain and more are providing insight into how their food is grown and shipped. Overall, the food manufacturing industry is continuously improving its productivity to keep up with the expanding population, and technology is helping them improve both the quality and quantity of its supply.

The beverage manufacturing industry faces many of the same challenges as food manufacturing, and technology will again play a key role in meeting demands. Smart technologies have become the driving force behind increasing efficiency in the industry, while also reducing production costs and enhancing safety. One rapidly spreading example is the smart sensor, which is being integrated into packaging lines to fill beverage packs in real-time and with great precision, without wasting any product or time.

A similar improvement is smart packaging that provides consumers with information regarding where their purchases originated and ensures supply chain validity. Another important addition to the industry is the Internet of Things, as manufacturers increasingly turn interrelated computing devices, digital machines and data analytics to optimize their production methods and keep themselves competitive. Massive companies like Coca-Cola are harnessing the benefits of analytics in many ways, as they use data and algorithms to balance weather data, crop yields, and other variables to ensure that their products maintain a uniform taste and quality throughout the year.

Fashion-Related Manufacturing

Fashion-related manufacturing includes the sub-industries of textile mills, textile product mills, apparel manufacturing and leather and allied product manufacturing.

The rise of technology has not been as advantageous (labor augmenting) for the workers plying in textile mills and textile product mills industries. Many jobs have been lost to automation as machines take over the tasks that were formerly performed by humans, allowing producers to cut costs and increase their output. However, further innovations with technology are behind the continuing transformation of the modern textile mill.

Digital printing of textiles has become a low-cost, time-saving solution that allows for mass production at a high quality, while also making design alterations much quicker. At a more conceptual level, many manufacturers believe that the future of the industry will depend on how they can innovate with fabrics and use the Internet of Things to improve garments. Warwick Mills is at the forefront of this trend, with a project to embed semi-conductors and fibers into fabrics to enable communication, sensing, energy storing, and many more functions within the clothing we wear. Other examples include placing sensors into mattresses to track sleep patterns and health. These "functional fabrics" or "smart garments" may well become the future of the textile industry, meaning that technology will have a massive role to play for producers and their workforce.

In the modern apparel industry, perhaps more important than responding to consumer demand is predicting what the modern consumer will want next. Brands are attempting to become better at collecting user data, sales performance, harnessing customer feedback, optimizing the supply chain, and more. As such, the technology of machine learning is critical for the evolving apparel manufacturer. AI systems are being incorporated into the production line to optimize development and sales while reducing costs and waste wherever possible. Moreover, these systems are using algorithms to identify new trends and styles based on consumer selections of favorite colors, patterns, and textiles. It has become much easier for manufacturers to turn this data into sales immediately, as three-dimensional printing and rendering allows for the customization and

production of new designs that the customer desires. This form of printing allows brands to manufacture on-demand, which also helps firms reduce fabric waste and maintain a lean inventory. In traditional apparel manufacturing, innovations to sewing machines, including automated functions for laser-cutting, fusing, buttonhole producing and seam bonding, are streamlining the factory process. As with textile manufacturing, the newest trend is integrating new technologies into clothing and fabrics, as the introduction of smart watches has shown that wearable technology and smart clothing are both feasible and in-demand. It is expected that producers in apparel will continue to incorporate these trends into their new designs, and technology will aid them in these efforts.

The leather industry has faced immense regulatory pressure due to its use of livestock and the chemical byproducts of traditional leather manufacturing. With little to no regulation on the disposal of wastewater and leather byproducts in most nations where producers operate, there have been significant concerns about the industry's environmental damage and adverse impacts on human health. As such, new technology in the leather manufacturing industry revolves around making the product more eco-friendly, sustainable, and cost-effective. New players in the market have developed methods for producing leather with much less water and chrome, two key components behind the environmental damage. Some have even begun experimenting with the biofabrication of leather products, where cells are grown in a lab and layered to produce leather. The future of the industry will likely revolve around the effectiveness of these solutions and manufacturers' ability to tackle environmental issues and reduce costs through the use of technology.

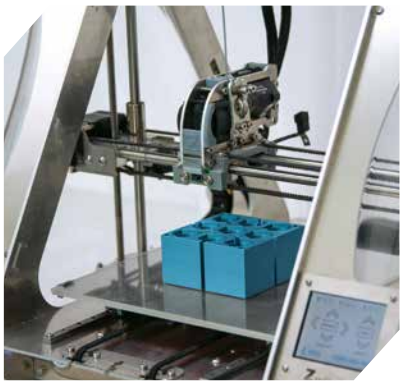
Paper, Wood Products and Furniture Manufacturing

Wood product, paper, and furniture manufacturing are industries that rely mainly on the traditional methods of production; as such, none have adopted revolutionary new technologies on a massive scale.

Technology has helped wood product manufacturing by allowing more nuanced and detailed production methods. Some of the products created include super high-gloss cabinetry and textured laminates with integrated patterns. Three-dimensional printing has also gained popularity in wood production to allow for greater flexibility in design and cost-effectiveness. As with many other industries, the integration of technology into the workplace has an adverse effect on employment; the automation of processes in labor mills has taken jobs from workers over the past few years. There are gains to be made from innovation in these industries, and firms that can harness new technology to improve their products and production lines are primed to succeed.

Printing and Related Support Activities

Printing technology is improving constantly, with new innovations enabling ever-better products and packaging. The major trend for years has been three-dimensional (3D) printing, which renders threedimensional objects from raw material and is useful both at the commercial level and at a smaller, more personal scale. 3D printing has applications in a wide range of industries such as fashion, health, food, and architecture; and, the possibilities are practically endless as the technology further develops. At the two-dimensional level, digital printing is overtaking the traditional style of offset printing by offering fast, high-quality designs at reasonable costs. Laser printing takes this process even further by yielding exceptional graphics and text through electrostatic digital printing methods. Further innovations include nanotechnology for printing, and the use of nano-ink to allow for prints in extremely bright colors; this combines the flexibility of digital printing with the quality of offset. Other new forms of ink are being experimented with as well, such as the use of water-based inks on flexible packaging, which improve biodegradability and recycling. Printing is an industry that stands to greatly benefit from technology, and the future is bright for new types of print and packaging products and offerings.



Petroleum and Petroleum Products Manufacturing

Petroleum and petroleum products manufacturing industries are constantly attempting to innovate to be compliant with regulations, while also improving their output and product quality, and technology is aiding these efforts in many ways. Access to sensor technology and the Internet of Things is a massive innovation in petroleum manufacturing, as sensors can measure anything from temperature and pressure to corrosion and hazardous leaks and communicate these measurements wirelessly to an operations center. The ability to centralize the management of these assets at one location and use sensors to operate in distant, dangerous, and inaccessible environments is a tremendous advantage for companies. Sensors are also being used to improve the efficiency and reliability of machines, including monitoring equipment degradation to predict when it will fail. Meanwhile, exploration and production solutions that leverage data and generate high-fidelity representations of assets in the ground are helping producers avoid nonproductive drilling and wasteful exploration spending, allowing them to instead perform operations where production will be maximized. New methods of production are being used to access reserves of oil and gas from lowpermeability geological formations where extraction was previously too expensive. These important operations are using technology in a variety of ways to improve their operations, with the aim of increasing sustainability and productivity.

Demand-side Analysis

Chemical Manufacturing

Businesses in the chemical manufacturing industry are using technology to upgrade and refine their production processes in a wide variety of ways. Most of these approaches involve digital transformation initiatives driven by big data and enterprise resource planning software. Through advanced analytics and smart manufacturing, businesses are using technology to aid them in making informed operational decisions that will increase efficiency and reduce costs; they are also digitally modeling improved production processes and adjusting plant parameters to optimize performance based on these models.

Manufacturers are employing Internet of Things systems with interconnected chips, sensors, and tools to allow for real-time operations monitoring, remote diagnosis of problems, and efficient asset allocation. When combined with AI technology and voice-search applications, enterprise resource planning technology is helping chemical businesses to massively transform their plant operations, providing greater accuracy, security, reliability, and profitability. Digital technology trends are also changing demand markets for chemicals; for example, there are growing markets for polymers and chemicals used in 3D printing, and new forms of precision agriculture require the development of fine-tuned crop-protection chemical treatments. Overall, the rise of technology has been extremely positive for chemicals manufacturing by allowing for countless new innovations and improved operations.

An important component industry of chemical manufacturing is pharmaceutical and medical manufacturing. The pharmaceutical and medical manufacturing workforce suffers from challenges similar to those of aerospace manufacturing; namely, a lack of adequately trained workers entering the industry and the need for worker re-tooling and upskilling to keep up with technological advancement. The pharmaceutical business requires employees that can think in new ways, as the products being developed are all novel, meaning they have never been manufactured and tested before. It is critical for lines of communication to be maintained across departments in this industry, as firms face pressure for their therapies to be produced correctly, meet delivery timelines, and comply with strict regulatory standards. Communication and interpersonal skills are extremely important, as experienced employees with institutional knowledge work alongside a new generation of workers that are adept with digital solutions; together it becomes easier to approach problems from multiple angles. Technology will also be essential to improving efficiency, as well as chemical, biological and/or therapeutic target reliability; one such example is big data, which is increasing in importance by helping chemical engineers and technicians assess real-world evidence in developing new medicines. Moving forward, firms must continue finding ways to re-tool employees currently in the workforce so that they can adapt to new innovations.

Plastics and Rubber Products Manufacturing

Plastics and rubber companies are harnessing many of the same technologies as their manufacturing counterparts to design and produce new and improved products. At the forefront is 3D printing technology, which the industry is employing to create new model and mold parts with improved mechanical properties. As additive manufacturing becomes more detailed and adaptable, plastics and rubber producers will be able to devise even better designs and continuously update their offerings for consumers.

Metal Manufacturing

Metal manufacturing includes primary metal manufacturing and fabricated metal product manufacturing. Primary metal manufacturing and fabricated metal manufacturing are using technology in a range of exciting ways to drive progress in their industries. At the forefront of this growth is the adoption of 3D printing as a full-blown industrial manufacturing tool, helping to reduce costs and producing more sustainable materials at a quality comparable to steel and other traditional metals. This has been successful in major projects such as building construction, but also when creating new light-steel grades in, for example, automobiles. There are also advances in high technology making the workforce more efficient and able to produce at a higher quality; for example, tube laser technology that produces intricate cuts in metal at rapid speeds. At the decision-making level, cloud-based functionalities and the implementation of sensors and chips in the production process are allowing managers to improve their processes based on data and analytics. Digital technology is also transforming business-consumer relationships, giving purchasers of primary metals the information necessary to adjust and optimize their own production methods based on product data. However, the introduction of advanced robotics and automations have for years been driving down employment rates in these industries; although the production index for metals manufacturing has been relatively consistent, employment has steadily declined throughout the past couple of decades. Technology has been an aid for many segments of these metals industries, but workers themselves have been negatively affected by its increased usage.

Machinery Manufacturing

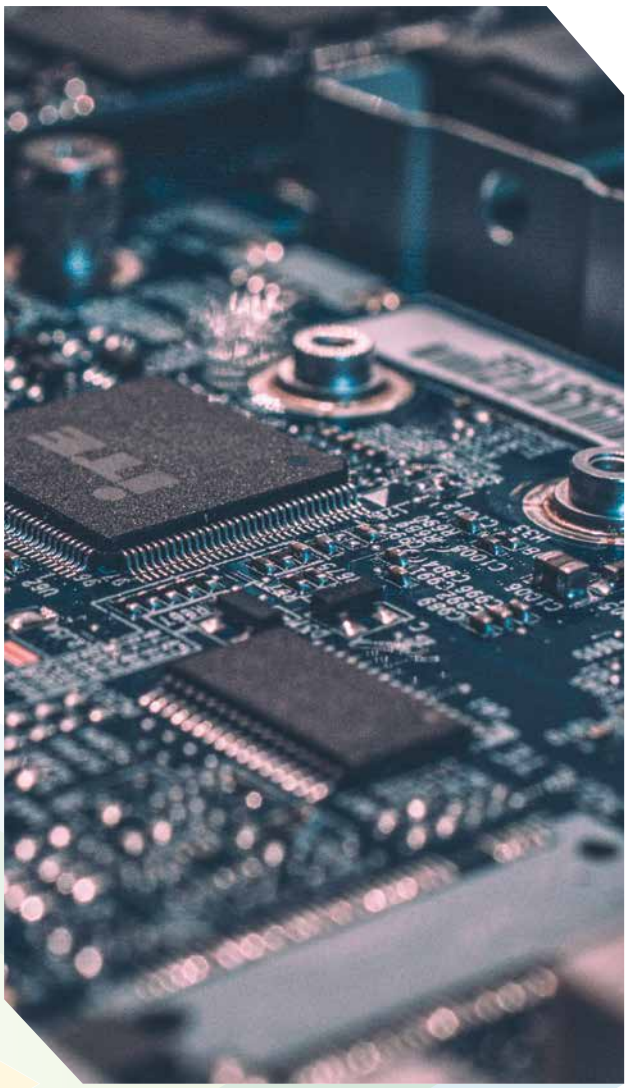
Technology used in machinery manufacturing is a combination of the many advances taking place across all manufacturing industries. New machines must be compatible with the Internet of Things systems to achieve cost reductions, efficiencies, increased safety, product innovation, and more; the more data that firms have at their disposal, the better they will be able to make informed business decisions. Predictive maintenance, which is important for manufacturing businesses in several industries, is also experiencing widespread adoption so that new machines and equipment are constantly monitored and breakdowns are less debilitating. Enterprise resource planning systems are automating business operations with accurate, real-time information, which helps managers to run their operations more effectively, while big data tools optimize production processes at a scale that was previously impossible. Across many segments of manufacturing, 3D printing has become prevalent and can substitute for traditional inputs or production processes. When adding all of these technological improvements together, an important conclusion is that the workforce must itself become more skilled and able to adopt and adapt to digital innovations. Firms that can train or find the workers that work most adaptably alongside technology will become more competitive and successful.

Demand-side Analysis

High-Tech Manufacturing

High-tech manufacturing includes computer and electronic product manufacturing and electrical equipment, appliance and component manufacturing.

The manufacturing of electronic products, equipment, applicants, and components follows similar technology trends to related industries in the manufacturing space. Robotics and automation are improving the efficiency and productivity of plants, while sensors in various equipment are allowing operations managers to access invaluable data that helps them further streamline production of electronics. These industries are currently responding to an extreme rise in popularity of smart technology and interconnected devices among consumers, and as such, are working to develop new products that integrate the Internet of Things into their functionality. At the production-level, some electronics manufacturing firms are using virtual reality technology for digital design, simulation and integration; this allows them to inspect design objects more carefully and eliminate design problems early on in the development process. Technology will continue to be an asset for electronics manufacturers as they respond to the growth in consumer demand for complex devices and products.



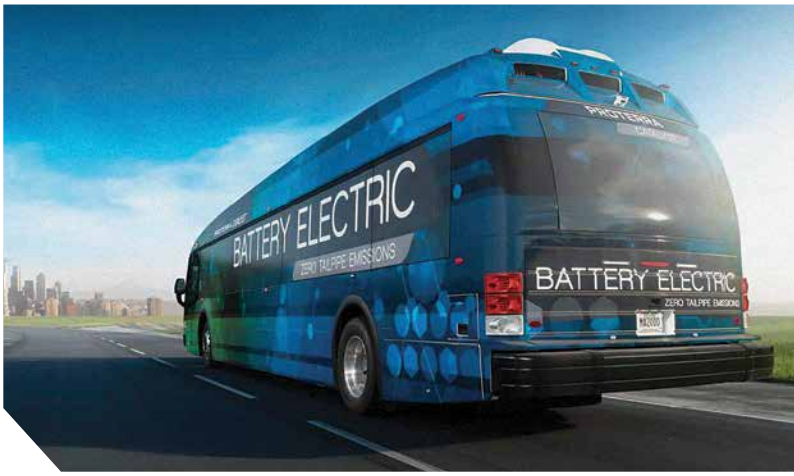
An important component of computer and electronic product manufacturing here in the L.A. Basin includes the search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing, which is part of the region's aerospace industry. Examples of products made in this manufacturing industry are aircraft instruments, flight recorders, navigational systems, as well as both radar and sonar systems and equipment. Those who purchase such instruments are mainly from the military or government – the Navy, Air Force, and Army are the top three spenders in this industry. Firms such as Lockheed Martin and Raytheon are the largest employers in the space, the workforce must necessarily be technologically adept and high-skilled to provide adequate services.

Transportation Equipment Manufacturing

Two important components of the transportation equipment manufacturing industry here in the LA Basin are aerospace manufacturing and the growing electric bus and vehicle manufacturing industries.

The aerospace product and parts manufacturing industry is supported by continued demand for U.S.- built commercial aircraft, and as such, the average worker's wage is quite high. Within the state of California, total employment in 2018 was nearly 355,000 in aerospace and defense, and the industry contributed $123 billion in total output. However, aerospace manufacturing faces a major workforce challenge. In 2015 nearly half of the industry's workers were between the ages of 46 and 66, and only 20 percent were under 35 years old; this has only worsened recently. Moreover, aerospace firms require highly trained workers with a range of soft skills and technical expertise. As a result, the industry faces a labor shortage due to impending retirements and a lack of trained technical graduates to fill these positions as skills requirements become increasingly advanced. Firms are unable to address these labor shortage issues by outsourcing around the globe because of security requirements, but fortunately there are ways for the aerospace manufacturing industry to overcome the challenge domestically. Company-sponsored talent management and development programs have been critical in giving existing workers the skills needed for evolving manufacturing obligations; 34 percent of the workforce took part in some form of reskilling last year. Technology is also playing an important role in augmenting the role of workers. For example, predictive maintenance in factories is increasing the efficiency of the manufacturing environment, while three-dimensional printing reduces costs and cuts down on development time. There has also been increased consolidation in the aerospace industry, as manufacturers absorb smaller research-based companies to reduce costs and bring these functions in-house. To remain competitive, firms will need to exploit mature technologies in new ways and develop innovative new approaches to manufacturing; this will require a highly skilled workforce that can adapt to changing production needs and work alongside technology to increase efficiency and productivity.

The electric bus and vehicle manufacturing workforce is a complicated story, as it represents both an exciting future for the production of sustainable transport, but also a serious concern for automobile manufacturing workers. Electric vehicle powertrains are simple compared to internal combustion engines; the individual small components that go into engines today will not be necessary in a new generation of buses and cars. As such, the introduction of more electric vehicles on the auto factory floor will dramatically reduce the amount of labor necessary, and thus cut a significant portion of jobs. Though the bodies of electric vehicles are largely assembled in the same way as traditional vehicles, the largest impact will be at plants building engines and transmissions. This has already led to widespread protests from unionized auto workers, who fear that the shift to electric vehicles will displace their jobs and shift contracts and employment to non-auto companies that can build components for electric vehicle powertrains. While this could also represent a chance to retrain workers and create new, higher-skilled and higher-paying manufacturing jobs, these gains will not adequately offset the projected losses. The future electric vehicle manufacturing workforce will be required to have greater technical skill than traditional assembly workers and will likely focus on building batteries and electric drivetrains. Many workers will be retrained from existing vehicle manufacturing jobs, as most have shown a willingness to adapt to new methods of production, but jobs will inevitably be lost along the way.



Demand-side Analysis

Target Middle-Skill Occupations

Middle-skill occupations predicted to have significant job prospects over the next five years and that stand to benefit from investment into postsecondary non-degree and career education programs include: machinists; welders, cutters, solderers and brazers; and industrial machinery mechanics.

The top ten occupations by projected total openings in the Los Angeles Basin over the next five years are shown in the exhibit below.

Exhibit 29 **Target Occupations in the Manufacturing Industry**

SOC	Occupation	2017 Employment	Total Openings Manufacturing 2017-2022	Total Openings All Industries 2017-2022	Median Wage
51-4041	Machinists	16,290	4,960	5,610	$41,530
51-4121	Welders, Cutters, Solderers, and Brazers	8,630	2,580	3,900	$37,870
49-9041	Industrial Machinery Mechanics	8,010	1,250	2,460	$53,987
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	5,760	1,950	2,000	$36,909
17-3023	Electrical and Electronics Engineering Technicians	5,690	1,000	1,710	$61,449
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	2,110	330	630	$53,400
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	1220	490	530	$56,524
17-3013	Mechanical Drafters	1,410	320	440	$57,709
17-3026	Industrial Engineering Technicians	1,320	340	410	$69,967
17-3021	Aerospace Engineering and Operations Technicians	740	210	220	$70,555

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Supply-Side Analysis

Community Colleges' Talent Pool

From drafting technology to industrial systems technology/maintenance and welding technology, there are many different community college programs preparing students to access a diverse array of occupations in manufacturing. The wide scope of these community college programs provides a competitive talent pool for local employers in the Los Angeles Basin.

This section details community college program offerings and student completions related to middle-skill occupations in the region's manufacturing sub-industries. For a complete list of colleges with related program offerings, see Appendix A. Within each sub-industry, two to four occupations that offer promising career prospects for community college students were selected for closer examination. These occupations have positive employment outlooks and pay above the living wage in the region.

Although artificial and pervasive intelligence has had an impact on manufacturing industries, a broad array of locations across the nation and the Los Angeles Basin are experiencing a need for more manufacturing jobs in various industries such as automotive, metals, plastics, and production technology. Therefore, most community colleges in the Los Angeles Basin offer programs that funnel students into related occupations. In total, 13 community college programs in the region prepare students to enter occupations in manufacturing. In fact, during the 2017-18 academic year, these 13 programs conferred nearly 1,800 certificates and associate degrees. While student completions are not as high in manufacturing compared to other academic disciplines, overall demand for graduates in this field appears to exceed supply.

Over the next five years, the Los Angeles Basin can expect nearly 2,700 job openings annually for middle-skill occupations in manufacturing; and nearly 3,600 job openings across all industries. While the region may be facing a workforce shortage in coming years, there is projected to be an undersupply of nearly 1,800 workers to fill job openings in the manufacturing occupations examined in this report. However, when specific sub-industries within manufacturing are examined, in some cases there is an oversupply of students. Supply data in this report includes only community college completions (certificates and associate degrees). Since a centralized location hosting apprenticeship completions does not currently exist, these completions are not included in the report.

The following section will explore in depth which occupational clusters are meeting demand and which are falling short. Because manufacturing occupations exist across many different industries, occupations were categorized into the following three concentrations:

Occupation Concentrations:

- Architecture and Engineering
- Installation, Maintenance, and Repair
- Production

According to LaunchBoard data from the 2016-17 academic year, the most recent available, there were 13,368 unique students enrolled in one or more manufacturing courses in the Los Angeles Basin. Male students, accounting for 86 percent of enrollments, predominantly fill manufacturing courses. More than half of students in advanced manufacturing programs are Hispanic and nearly a quarter are white. The majority (69 percent) of manufacturing students are 29 or younger, with 69 percent of students being under 25 years old.

Supply-Side Analysis

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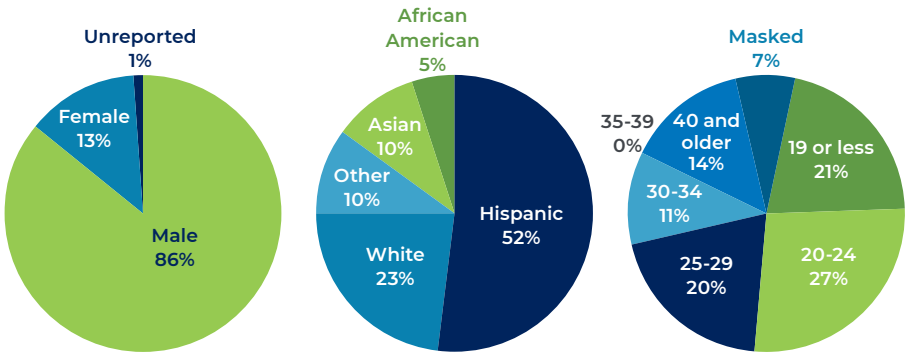
Students enrolled in one or more manufacturing courses in the Los Angeles Basin.



Architecture and Engineering

Within manufacturing sub-industries, 372 annual job openings are projected across four occupations related to architecture and engineering. Approximately 67 percent of all job openings for these four occupations will occur within the industry. Across all industries, there are 555 annual openings for architecture and engineering occupations. Architecture and engineering occupations have strong median wages, between $27.75 and $33.92 per hour.

There seems to be an oversupply of qualified middle-skill workers from community colleges to fill open architecture and engineering-related occupations, as there were 671 awards conferred in the 2017-18 academic year and 372 annual openings within manufacturing industries. The drafting technology program had the most completions out of the seven related training programs, with 321 awards conferred in the 2017-18 academic year. Of the seven programs that have historically trained for these four occupations, the electrical systems and power transmission program conferred the least, and there were no completions for aircraft electronics (avionics). On a larger scale, an oversupply of workers in the four architecture and engineering occupations exists, given the 671 awards conferred annually and the 555 annual job openings across all industries.

Exhibit 1: Employment, annual openings, and wages for architecture and engineering occupations in manufacturing and in all industries

SOC	Occupation	Manufacturing Industries		Across All Industries		Median Hourly Wage
		2017 Employ	Annual Openings	2017 Employ	Annual Openings	
17-3023	Electrical and Electronics Engineering Technicians	1,003	201	1,712	342	$29.54
17-3026	Industrial Engineering Technicians	335	67	411	82	$33.64
17-3013	Mechanical Drafters	315	63	435	87	$27.75
17-3021	Aerospace Engineering and Operations Technicians	205	41	219	44	$33.92
Total Employment		**1,858**	**372**	**2,777**	**555**	

Exhibit 2: Community college awards related to four architecture and engineering occupations

Program	2015-16 Awards	2016-17 Awards	2017-18 Awards
Drafting Technology	204	203	321
Engineering Technology, General	153	146	214
Electrical Systems and Power Transmission	25	1	4
Other Engineering and Related Industrial Technologies	27	55	66
Aeronautical and Aviation Technology	43	45	52
Mechanical Drafting	10	16	14
Aircraft Electronics (Avionics)	-	-	-
Total	**462**	**466**	**671**

Supply-Side Analysis

Installation, Maintenance, and Repair

Projections through 2022 show that there will be nearly 620 annual openings for the two installation, maintenance and repair occupations. Approximately 51 percent of this projected employment will occur within the manufacturing industry – 316 annual openings within manufacturing compared to 617 annual openings across all industries. With a median hourly wage between $25.67 and $25.96, these occupations present a valuable opportunity for community college graduates.

Exhibit 3: Employment, annual openings, and wages for installation, maintenance, and repair occupations in manufacturing and in all industries

SOC	Occupation	Manufacturing Industries		Across All Industries		Median Hourly Wage
		2017 Employ	Annual Openings	2017 Employ	Annual Openings	
49-9041	Industrial Machinery Mechanics	1,246	249	2,457	491	$25.96
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	332	66	627	125	$25.67
Total Employment		**1,578**	**316**	**3,084**	**617**	

Currently, four community college programs train students for the two installation, maintenance and repair occupations of interest. Collectively, the four programs listed in Exhibit 4 conferred 551 awards in 2017-18, with electronics and electric technology programs conferring the most awards (61 percent of all awards). On a larger scale, there appears to be an undersupply of workers for the two installation, maintenance, and repair occupations studied in this section, given the 551 awards conferred in 2017-18 and the 617 annual job openings across all industries.

Exhibit 4: Community college awards related to two installation, maintenance, and repair occupations

Program	2015-16 Awards	2016-17 Awards	2017-18 Awards
Electronics and Electric Technology	354	366	335
Industrial Systems Technology and Maintenance	102	132	104
Computer Electronics	52	59	111
Industrial Electronics	1	0	1
Total	**509**	**557**	**551**

Production

Within manufacturing sub-industries, nearly 2,000 job openings are projected annually through 2022 for the four production occupations studied in this section. Approximately 83 percent of all job openings for these four occupations exist within manufacturing sub-industries. It is estimated that half of all job openings within manufacturing are for machinists. The median wages for this occupational group are between $17.75 and $27.17.

Exhibit 5: Employment, annual openings, and wages for production occupations in manufacturing and in all industries

SOC	Occupation	Manufacturing Industries		Across All Industries		Median Hourly Wage
		2017 Employ	Annual Openings	2017 Employ	Annual Openings	
51-4041	Machinists	4,963	993	5,614	1,123	$19.97
51-4121	Welders, Cutters, Solderers, and Brazers	2,578	516	3,896	779	$18.21
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	1,953	391	2,002	400	$17.75
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	489	98	532	106	$27.17
Total Employment		**9,983**	**1,997**	**12,044**	**2,409**	

During the 2017-18 academic year, community colleges in the region conferred 542 awards in three related programs. Machinery and machine tools programs conferred the majority of completions (52 percent), while 40 percent of awards came from welding technology, and eight percent (8%) from manufacturing and industrial technology programs. There appears to be an undersupply of workers for the four production occupations, given the 542 awards conferred in 2017-18 and the approximately 2,409 annual job openings across all industries.

Exhibit 6: Community college awards related to four production occupations

Program	2015-16 Awards	2016-17 Awards	2017-18 Awards
Machining and Machine Tools	243	226	280
Welding Technology	208	228	218
Manufacturing and Industrial Technology	49	42	44
Total	**500**	**496**	**542**

Conclusions & Recommendations

The process of manufacturing goods is being transformed through an abundance of affordable computing power, an explosion of material sciences and an increasingly accessible global marketplace of ideas, workers, capital and factories. This transformation is changing the demand for labor—both its quantity and its quality—even as the value of production keeps rising.

Manufacturing continues to be an important part of our regional economy. Overall, 150,770 total job openings will be created in the manufacturing sector in the Los Angeles Basin over the next five years, with employers seeking to fill many of those openings with middle-skill workers. Nearly 40 percent of employment in the LA Basin's manufacturing sector falls into three component industries: computer and electronic product manufacturing; fabricated metal product manufacturing; and transportation equipment manufacturing. These component industries combined employed just under 200,000 workers in the Los Angeles Basin in 2017. Computer and electronic product manufacturing accounts for 74,200 jobs alone.

The high percentage of middle-skill jobs that comprise the manufacturing sector makes prioritizing this industry for the development of training and educational programs particularly compelling. One of this report's findings is that 43 percent of projected openings in the sector will be for middle-skill occupations over the next five years in the region. Moreover, manufacturing workers in manufacturing earn higher wages across all levels of educational attainment compared to the L.A. Basin regional average.

Overall, 150,770 job openings will be created in the industry in the Los Angeles Basin over the next five years.

Manufacturing employment will continue to decline overall

Increased productivity through process compression, automation and offshoring shows no sign of abating in the near future. Employment declines in manufacturing will continue as the potential for achieving additional efficiencies in existing businesses appears to be large.

However, the composition of this employment may be changing. Research, design and engineering functions, traditionally included in the manufacturing sector, are increasingly being outsourced to specialty shops that are measured as part of the service economy.

GROWING COMPONENT INDUSTRIES

- Computer and electronic product manufacturing
- Transportation equipment manufacturing
- Food manufacturing

KEY FINDINGS

Approximately 43 percent of projected openings will be for middle-skill occupations over the next five years.

Manufacturing has a significant share of older workers, with over a quarter of its workforce 55 years and older.

Employees in manufacturing typically earn higher-than-average wages compared to the regional economy, especially in technology intensive manufacturing industries.

Aerospace manufacturing, electronic instrument manufacturing, and semiconductor and electronic component manufacturing are all major employer industries for the identified target middle-skill occupations in manufacturing.

Conclusions & Recommendations

Workforce training is still needed

Because manufacturing processes in both high technology and low technology industries are beco ing more dependent on technical tools (both hardware and software), specific training will continue to be needed. The speed of innovation today demands that industry be involved in developing appropriate training programs and in forming partnerships with learning centers and colleges so that candidates are job-ready for available occupations. This may also involve ensuring that instructors themselves are kept abreast of technological progress occurring in industries for which their students need to be trained.

Not only is such training necessary to prepare job entrants, it is critical to the continual process of creative destruction within industry. As retiring workers take their skills with them, their replacements bring knowledge of and training in newer products and practices to existing manufacturers, accelerating adoption and innovation across industry.

Impending Worker Shortage

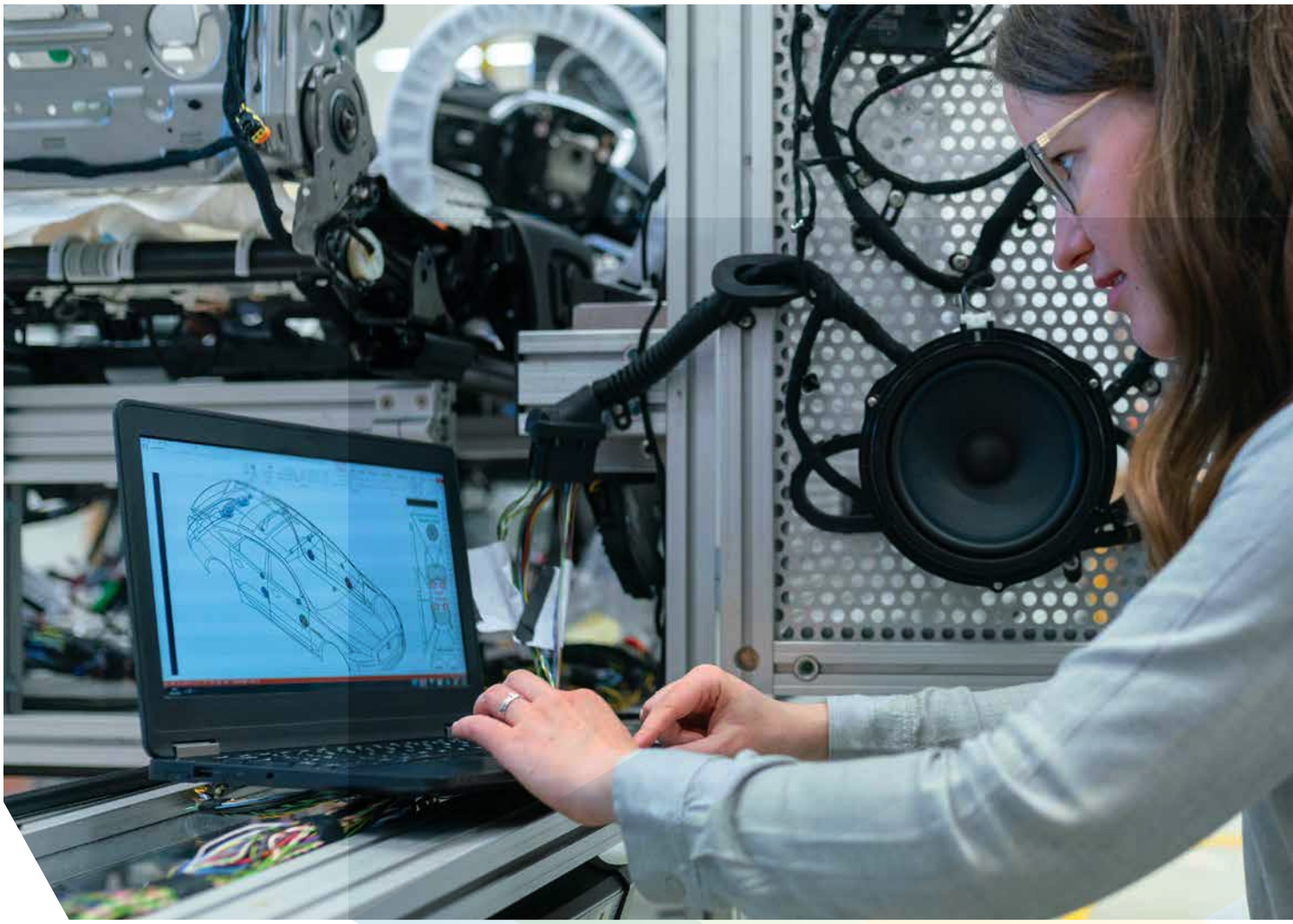
When workforce demand is considered, there is some urgency for the creation and expansion of programs targeting occupations found in the manufacturing sector. When considering only community college program completions, a looming workforce shortage appears to be on the horizon. Based on regional community college completions, there could be an undersupply of just over 1,800 workers each year (over the five-year period examined) to fill job openings in the ten target middle-skill occupations in the Los Angeles Basin across all industries. Close to 2,700 annual openings are projected for target middle-skill occupations in the manufacturing industry, and nearly 3,600 job openings for these same occupations across all industries. Yet, community college completions only totaled 1,764 certificates and associate degrees in the 2017-2018 academic year.

A closer analysis of community college supply reveals programs may need to be calibrated to meet forecasted demand. In some cases, such as the target occupations in the concentration of architecture and engineering, regional programs appear to be graduating more students than there are job openings across all industries. In other cases, such as target occupations grouped together in the concentrations of installation, maintenance and repair and production, there are not enough students to fill projected job openings. The Center recommends the community colleges take a closer look at these programs to determine whether program capacity is sufficient to meet demand.

Challenges and Opportunities

Employers state they are facing constraints in terms of the availability of new qualified technicians to support business growth. There are a number of factors affecting the availability of new talent, such as the high cost of living here in the LA Basin, variation of regulatory and zoning requirements, and traffic which negatively impacts employer access to skilled labor who may reside just outside the Los Angeles Basin. Local colleges have capacity or resource constraints in terms of the availability of qualified instructors, acquisition costs of new technology, and space, which affect the colleges' abilities to respond to industry demand for new workers. These challenges often mean that new jobs will go elsewhere, resulting in a low number of new economic opportunities for employers and creation of new jobs in the region.

The manufacturing industry would benefit from increased apprenticeships, as skilled workers transfer their knowledge and skill in the trade to trainees on-the-job. Apprenticeship programs may present a significant opportunity to cultivate a jobready pipeline of qualified workers in the industry with the requisite skills employers are seeking. It may also help address issues faced by colleges in providing manufacturing-related programs, especially faculty shortages, the high cost of acquisition of new technology, and the lack of space, as employers will provide access to all three.



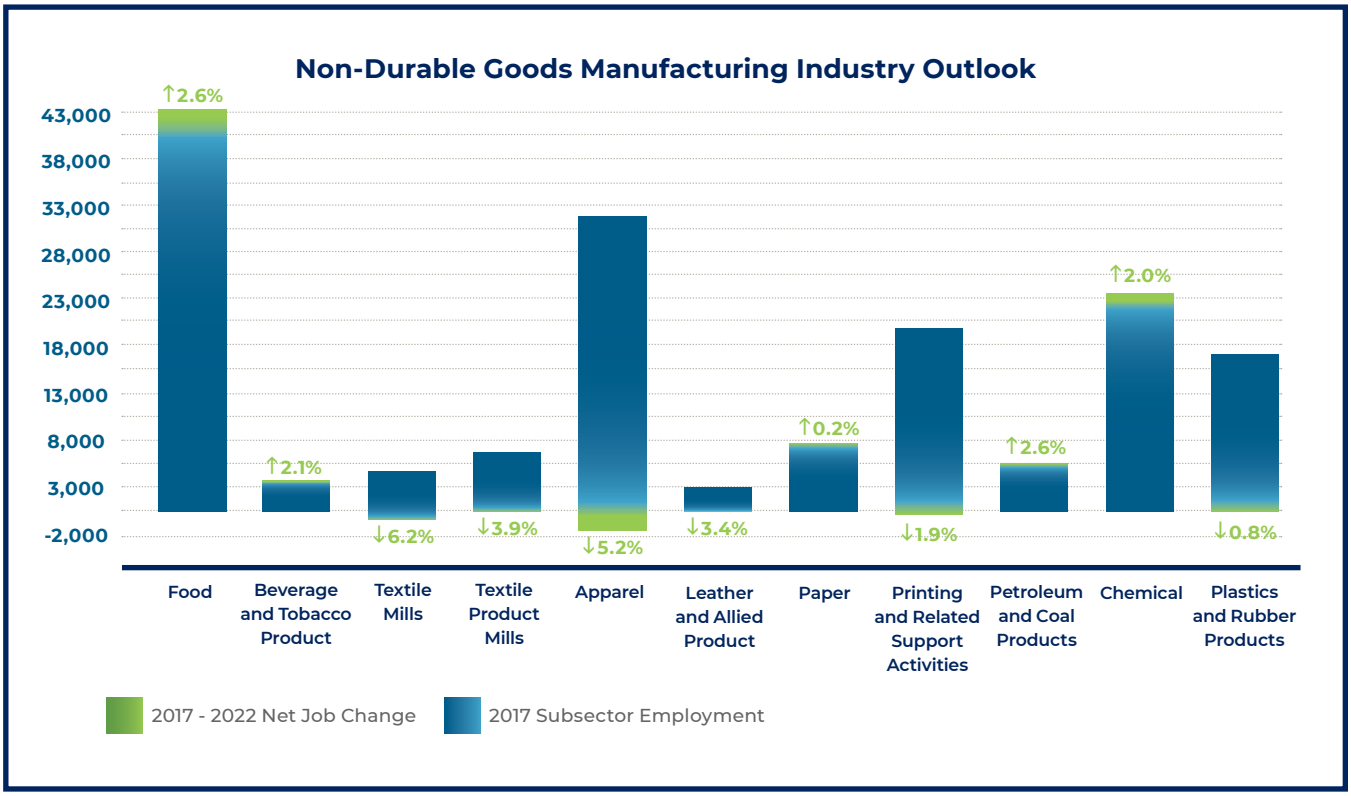
Manufacturing Industry Forecasts

To better understand where the manufacturing industry is headed, its component industries are quantified, and their growth is forecasted over the next five years. These projections are used to extrapolate future workforce needs, i.e., the demand for workers.

Nondurable goods

Nondurable goods are those who have a short life-cycle, typically consumed immediately or in less than three years. Nondurable goods manufacturing industries include:

- Food Manufacturing
- Beverage and Tobacco Product Manufacturing
- Textile Mils
- Textile Product Mills
- Apparel Manufacturing
- Leather and Allied Product Manufacturing
- Paper Manufacturing
- Printing and Related Support Activities
- Petroleum and Coal Products Manufacturing
- Chemical Manufacturing
- Plastics and Rubber Products Manufacturing



311 Food Manufacturing

In 2017, Food Manufacturing employed 42,270 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise 38.1 percent of all jobs in the Food Manufacturing industry by 2022. By 2022, an additional 1,090 jobs are expected to be added to the Food and Manufacturing industry, representing a growth of nearly 2.6 percent.

Characteristics of Workers Hired

The composition of all hires in Food Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 25 percent of workers in this field are under 24 years old. An additional 25 percent of workers are between the ages of 45 and 54.

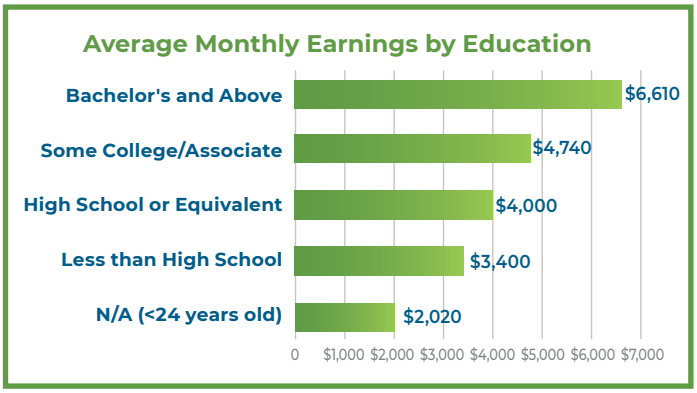
Top Middle-Skill Occupations

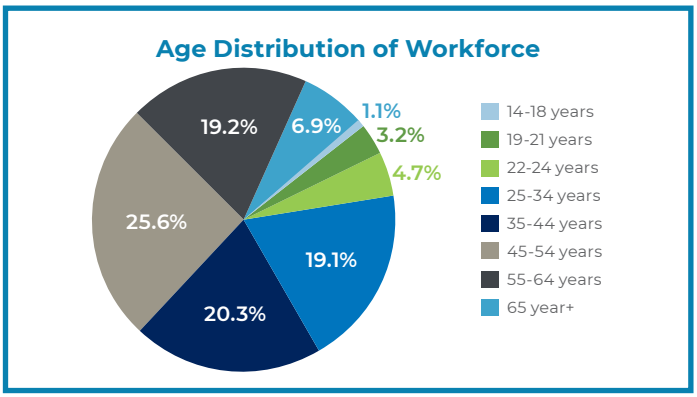
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include industrial machinery mechanics, truck drivers and maintenance and repair workers.

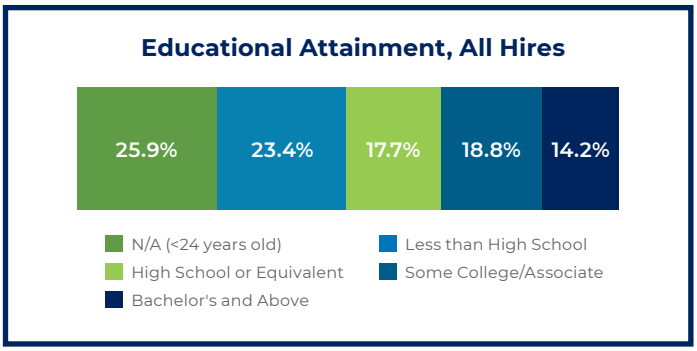
MIDDLE-SKILL OCCUPATIONS

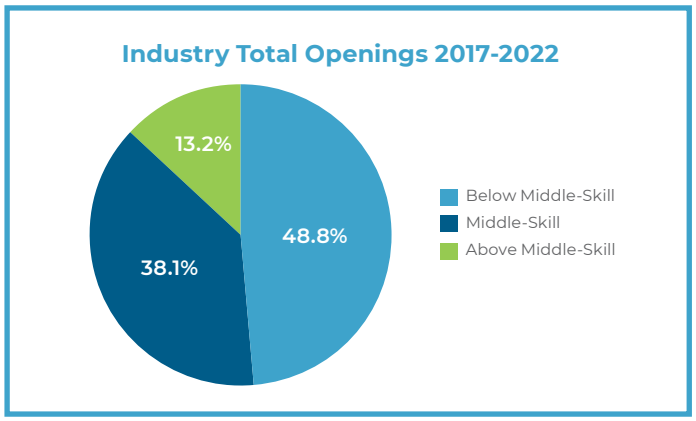
Significant Job Prospects (2022)

Occupational Group	Openings
• Industrial Machinery Mechanics	1,246
• Heavy and Tractor-Trailer Truck Drivers	739
• Maintenance and Repair Workers, General	1,534
• Sales Representatives *(Except Technical & Scientific Products)*	3,804
• Production, Planning, and Expediting Clerks	2,385









312 Beverage and Tobacco Product Manufacturing

In 2017, Beverage and Tobacco product Manufacturing employed 1,610 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise 40.6 percent of all jobs in this industry by 2022. By 2022, an additional 40 jobs are expected to be added to the Beverage and Tobacco Manufacturing industry, representing a growth of 2.1 percent.

Characteristics of Workers Hired

The composition of all hires in Beverage and Tobacco Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 53 percent of workers in this field are between 25 and 44 years old. Nearly 40 percent of workers have some college or a bachelor's degree or higher.

Top Middle-Skill Occupations

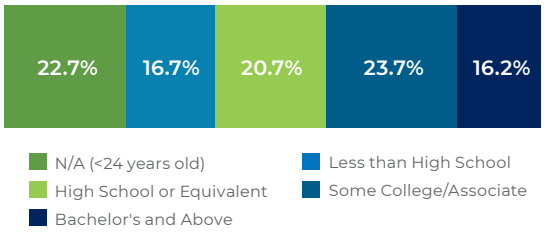
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include bus and truck mechanics, electricians and maintenance and repair workers.

MIDDLE-SKILL OCCUPATIONS

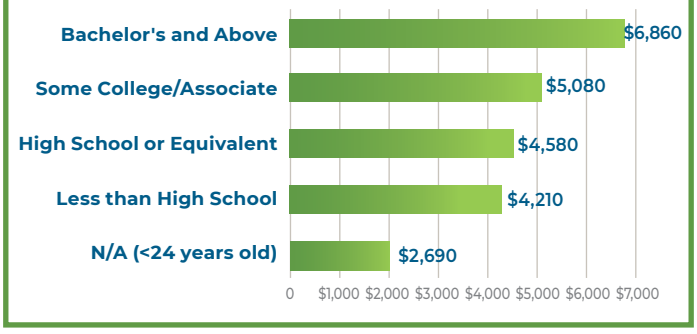
Significant Job Prospects (2022)

Occupational Group	Openings
• Bus and Truck Mechanics and Diesel Engine Specialists	29
• Electricians	197
• Heavy and Tractor- Trailer Truck Drivers	739
• Industrial Machinery Mechanics	1,246
• Maintenance and Repair Workers, General	1,534

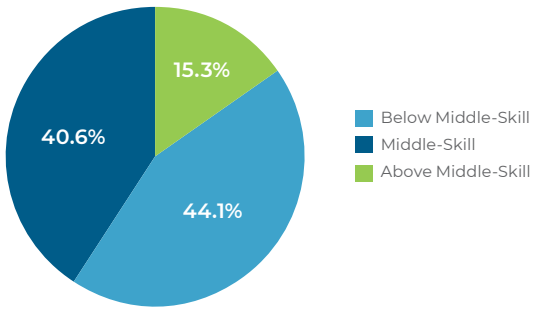
Educational Attainment, All Hires



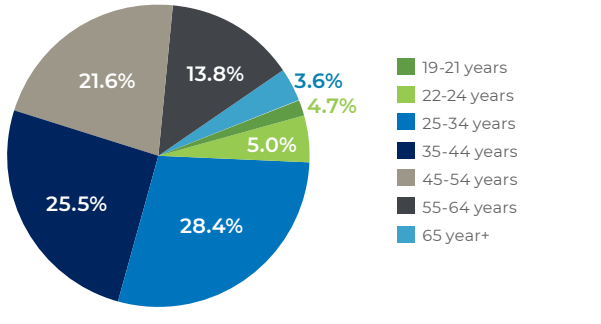
Average Monthly Earnings by Education



Industry Total Openings 2017-2022



Age Distribution of Workforce



313 Textile Mills

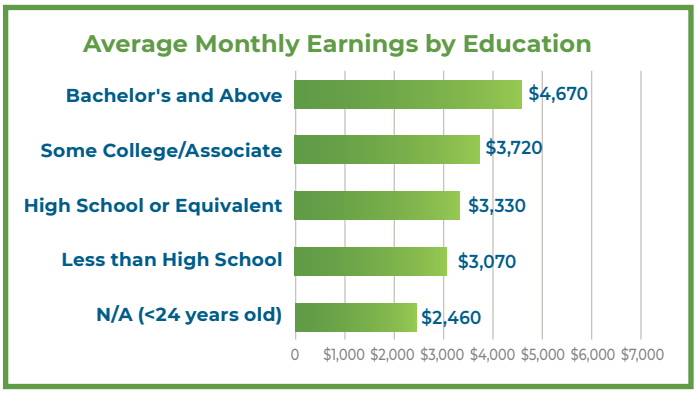
In 2017, Textile Mills employed 4,370 payroll workers in the Los Angeles Basin. Projections indicate that middle skill jobs will comprise over 45 percent of all jobs in the Textile Mills industry by 2022. By 2022, the industry is expected to lose 270 jobs, or 6.2 percent.

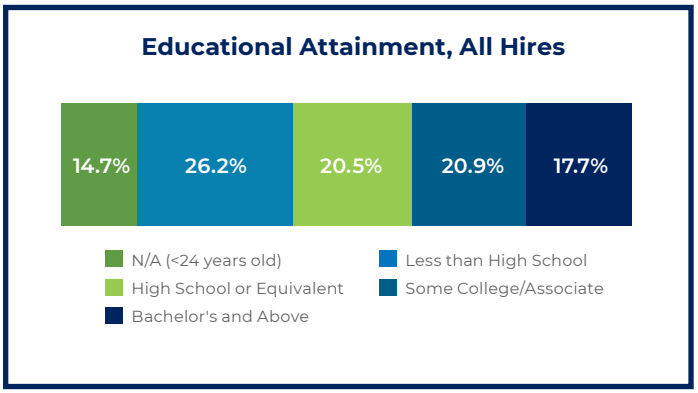
Characteristics of Workers Hired

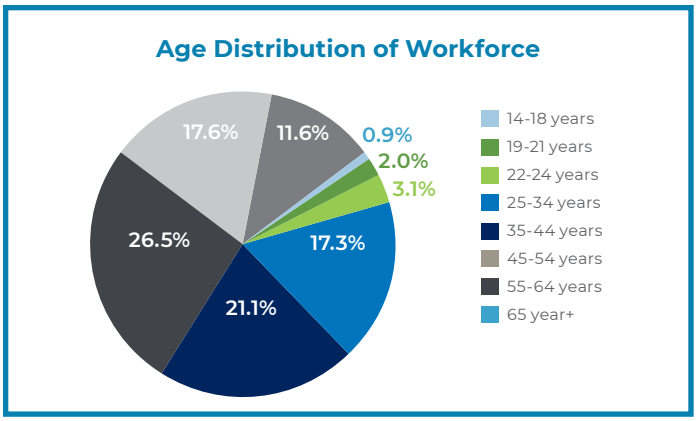
The composition of all hires in Textile Mills in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Nearly 30 percent of workers in textile mills are over 55 years old, and nearly 15 percent are under 24. Workers with a bachelor's degree or higher represent 17.7 percent of the textile mill workforce and earn over $4,600 in average monthly earnings.

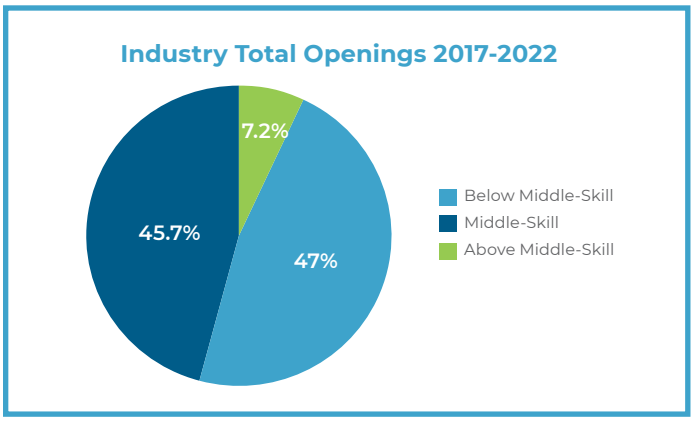
Top Middle-Skill Occupations

Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include sales representatives, first-line supervisors and industrial machinery mechanics.





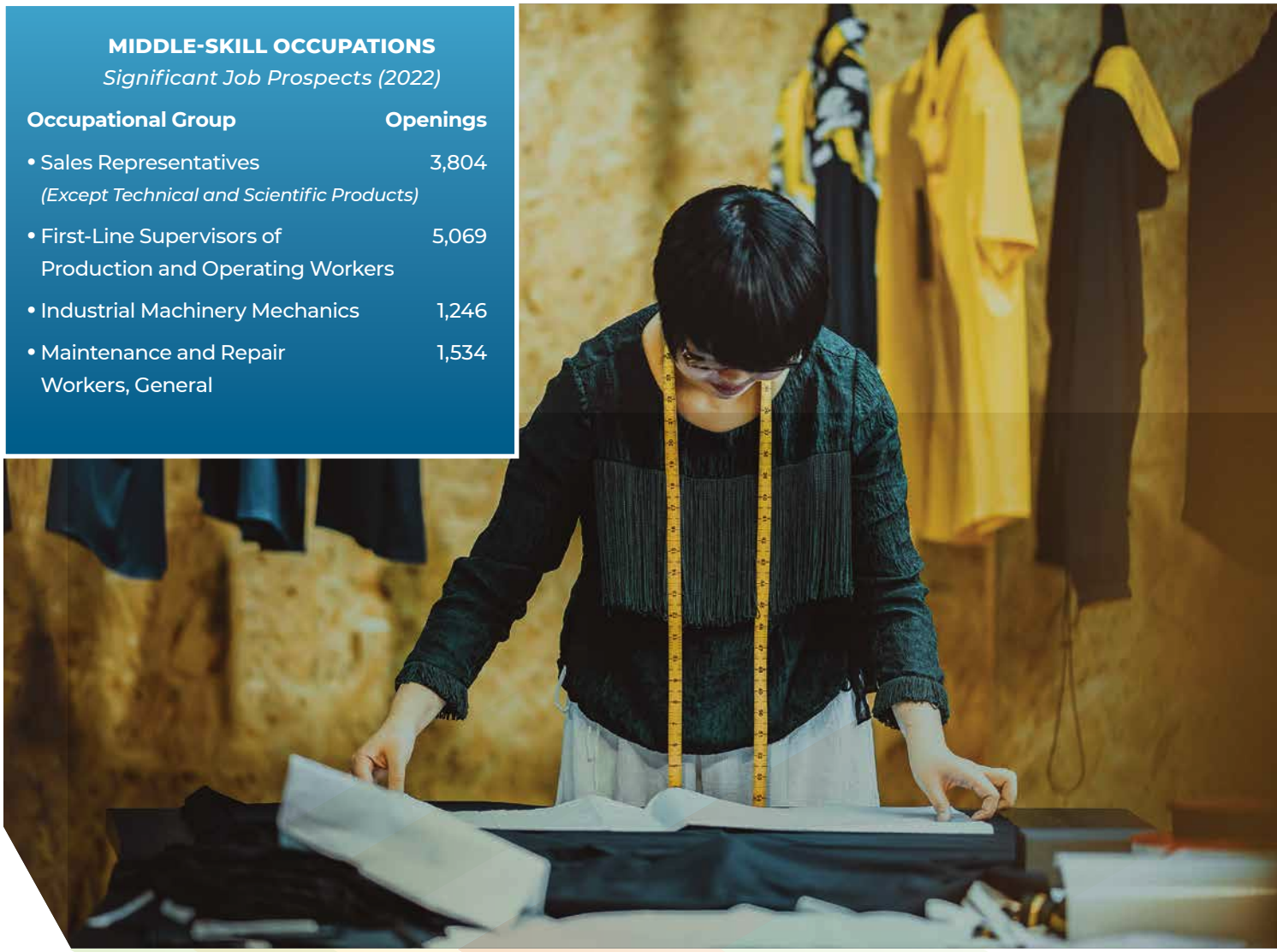




MIDDLE-SKILL OCCUPATIONS

Significant Job Prospects (2022)

Occupational Group	Openings
• Sales Representatives *(Except Technical and Scientific Products)*	3,804
• First-Line Supervisors of Production and Operating Workers	5,069
• Industrial Machinery Mechanics	1,246
• Maintenance and Repair Workers, General	1,534



Manufacturing Industry Forecasts

314 Textile Product Mills

In 2017, Textile Product Mills employed over 4,760 payroll workers in the Los Angeles Basin. By 2022, middle-skill jobs are projected to comprise over 44 percent of all jobs in the Textile Product Mills industry. However, jobs in the industry are expected to decrease by 3.8 percent (185 jobs) by 2022.

Characteristics of Workers Hired

The composition of all hires in Textile Product Mills in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Just over 16 percent of workers have a bachelor's or higher, earning over $6,870 in average monthly wages. About 63 percent of workers have had no college education.

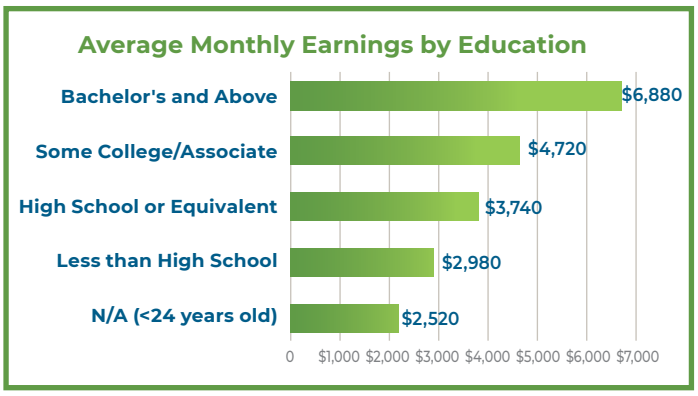
Top Middle-Skill Occupations

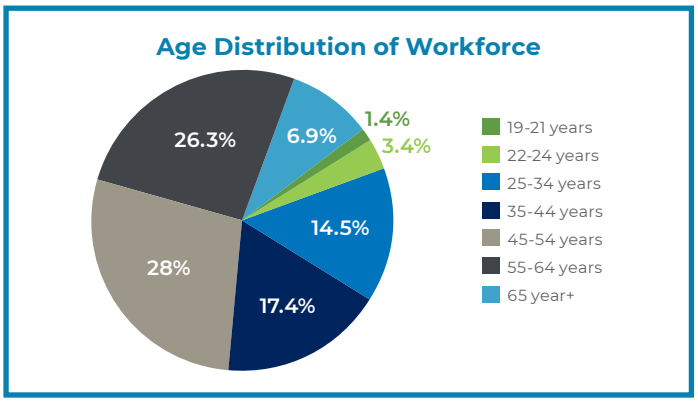
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include sales, customer service and graphic designers.

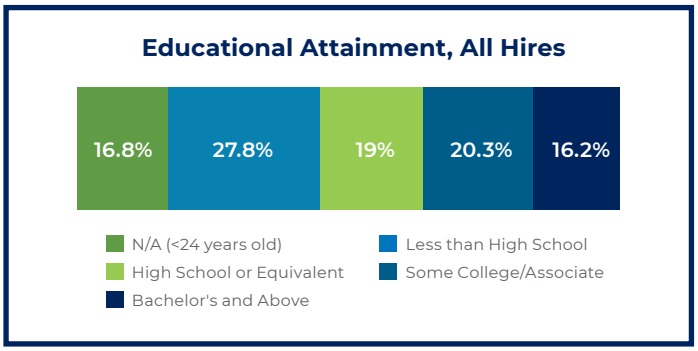
MIDDLE-SKILL OCCUPATIONS

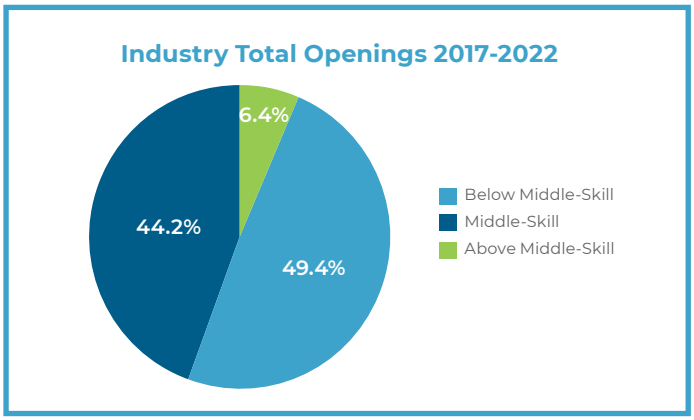
Significant Job Prospects (2022)

Occupational Group	Openings
• Sales Representatives *(Except Technical and Scientific Products)*	3,804
• Customer Service Representatives	3,067
• Graphic Designers	1,006
• Welders, Cutters, Solderers, and Brazers	2,578
• Commercial and Industrial Designers	288









315 Apparel Manufacturing

Employment in 2017 in the Apparel Manufacturing industry comprised of over 32,000 payroll workers in the Los Angeles Basin. Over 38 percent of job openings are projected to be middle-skill level by 2022. Projections also show a decrease of 5.2 percent of jobs in the industry (1,660 jobs).

Characteristics of Workers Hired

The composition of all hires in Apparel Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. About 30 percent of workers are over 55 years old and nearly 40 percent have had some college education or a bachelor's degree or higher.

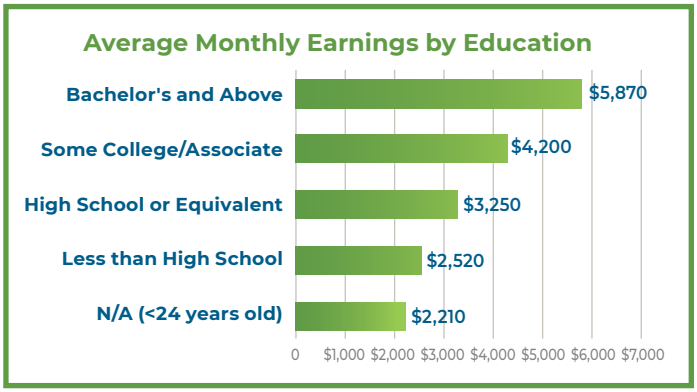
Top Middle-Skill Occupations

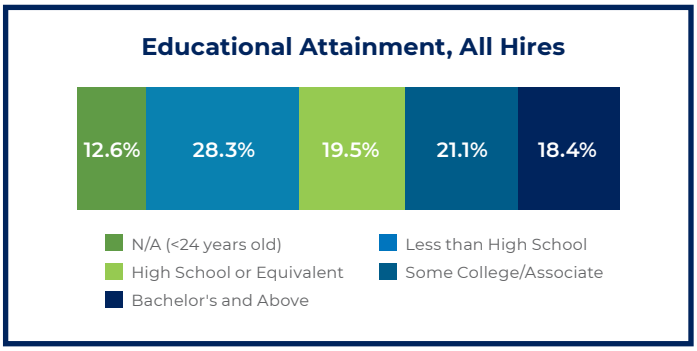
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include production, planning and expediting clerks as well as fashion designers and sales representatives.

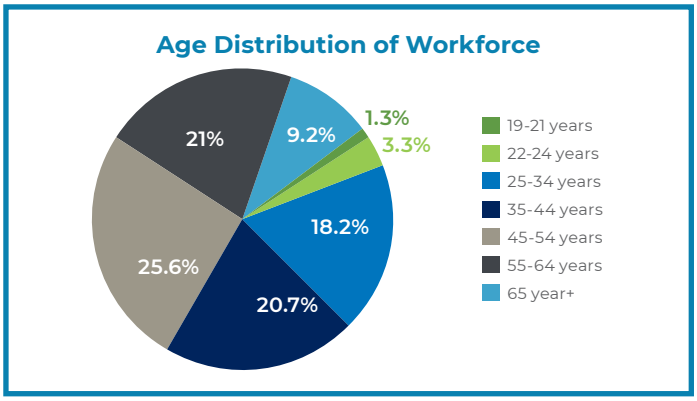
MIDDLE-SKILL OCCUPATIONS

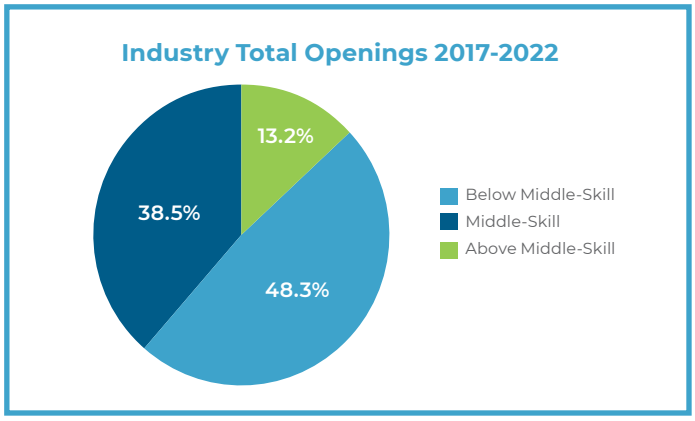
Significant Job Prospects (2022)

Occupational Group	Openings
• Production, Planning, and Expediting Clerks	2,385
• Fashion Designers	449
• Sales Representative *(Except Tech and Scientific Products)*	3,804
• Graphic Designers	1,006
• Customer Service Representatives	3,067









316 Leather and Allied Product Manufacturing

In 2017, Leather and Allied Product Manufacturing employed 1,365 payroll workers in the Los Angeles Basin. Projections indicate that middle skill-jobs will comprise 36.6 percent of all jobs in the Leather Manufacturing industry by 2022. By 2022, the industry is expected to lose 50 jobs.

Characteristics of Workers Hired

The composition of all hires in Leather and Allied Product Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. 29.1 percent of workers are between 45 and 54 years old. 19.5 percent have had some college experience and earn over $4,250 in average monthly wages. Nearly 30 percent of workers have less than a high school diploma.

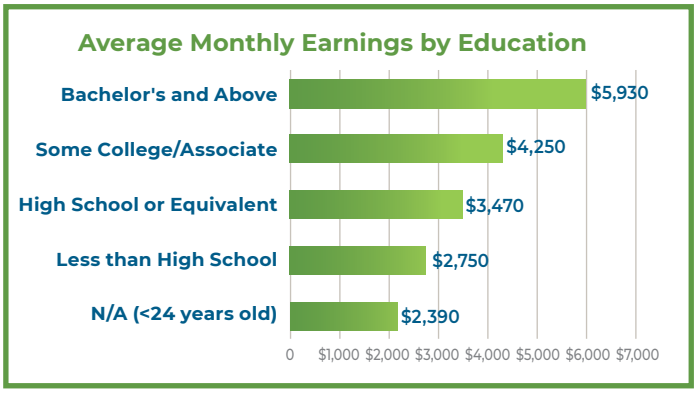
Top Middle-Skill Occupations

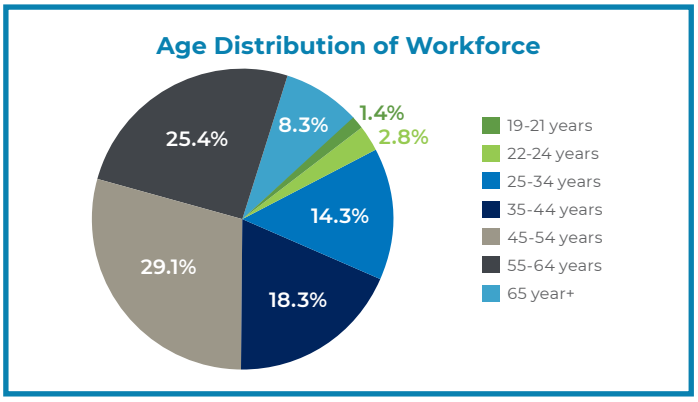
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include sales representatives, fashion designers and customer service representatives.

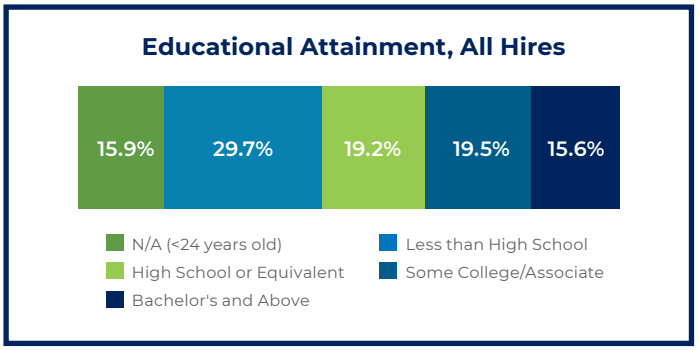
MIDDLE-SKILL OCCUPATIONS

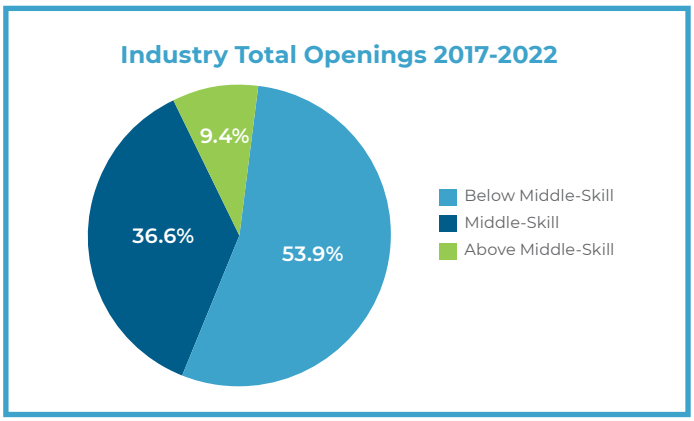
Significant Job Prospects (2022)

Occupational Group	Openings
• Sales Representative *(Except Tech and Scientific Products)*	3,804
• Fashion Designers	449
• Customer Service Representatives	3,067









322 Paper Manufacturing

In 2017, Paper Manufacturing employed 5,874 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise over 46 percent of all jobs in the Paper Manufacturing industry by 2022. Projections show a growth in employment of less than 1 percent from 2017 to 2022 in this industry.

Characteristics of Workers Hired

The composition of all hires in Paper Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. About 29 percent of workers in this field are between 45 and 54 years old. Over 38 percent of workers have some college education or hold a bachelor's degree or higher.

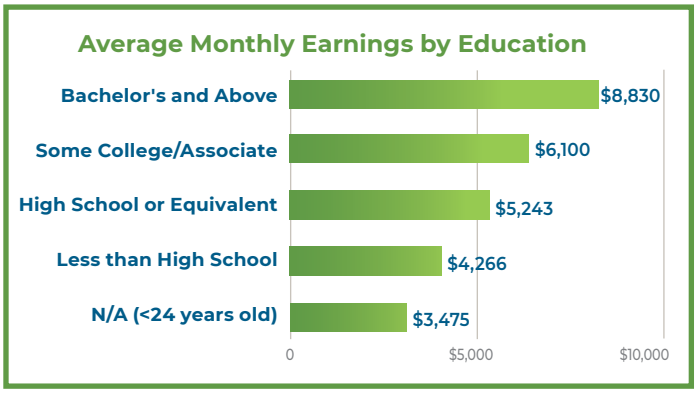
Top Middle-Skill Occupations

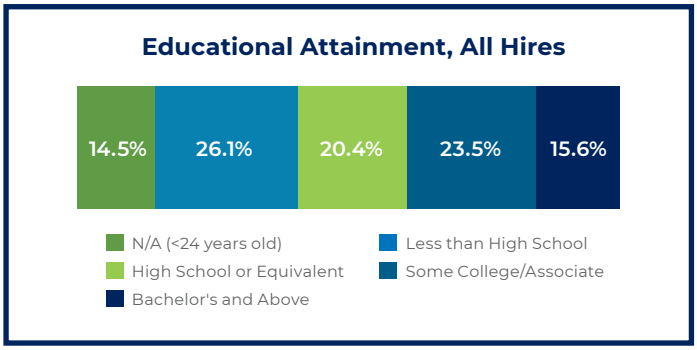
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include sales and customer service representatives as well as maintenance and repair workers.

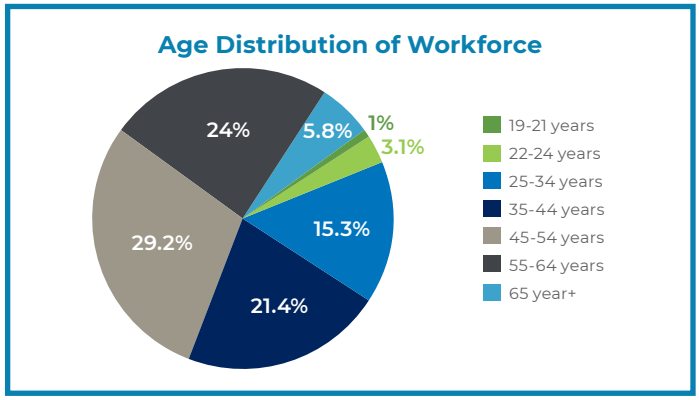
MIDDLE-SKILL OCCUPATIONS

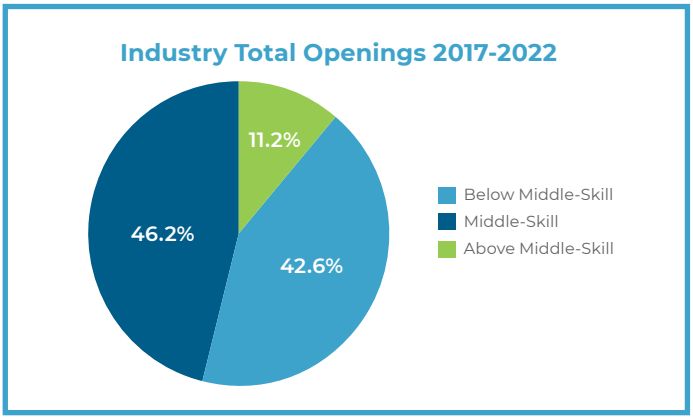
Significant Job Prospects (2022)

Occupational Group	Openings
• Sales Representative *(Except Tech and Scientific Products)*	3,804
• Heavy and Tractor-Trailer Truck Drivers	739
• Customer Service Representatives	3,067
• Maintenance and Repair Workers, General	1,534
• Graphic Designers	1,006









323 Printing and Related Support Activities

In 2017, 19,454 payroll workers were employed in the Printing & Related Activities industry in the Los Angeles Basin. Projections indicate that by 2022, 38.1 percent of these jobs will require middle-skills and total employment will decrease by nearly two percent, or 370 jobs.

Characteristics of Workers Hired

The composition of all hires in Printing and Related Activities in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over a quarter of workers in this field are between 45 and 54 years old. Over 60 percent of workers have a high school diploma or above. Workers with a bachelor's degree or above earn over $6,200 a month on average.

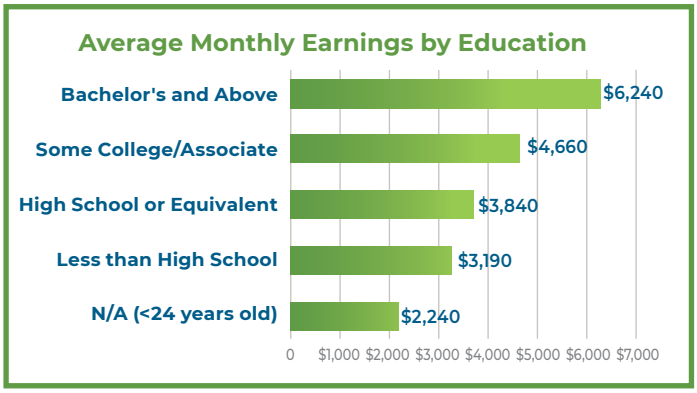
Top Middle-Skill Occupations

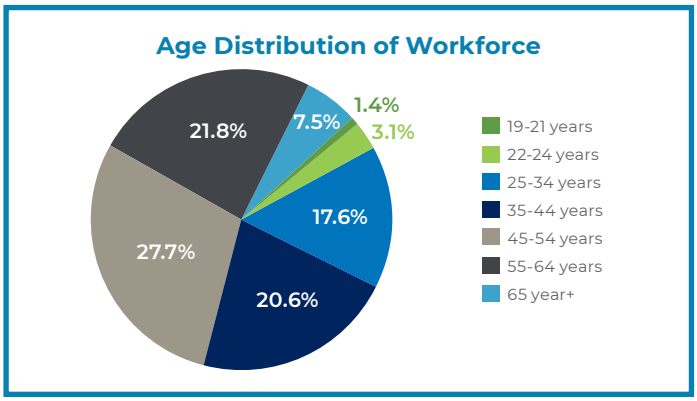
Middle-skill occupations will continue to drive labor demand in this industry. Occupations with the highest growth projections in this industry are sales and customer service representatives.

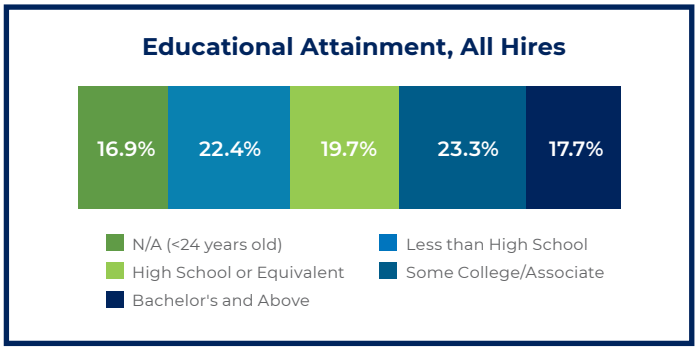
MIDDLE-SKILL OCCUPATIONS

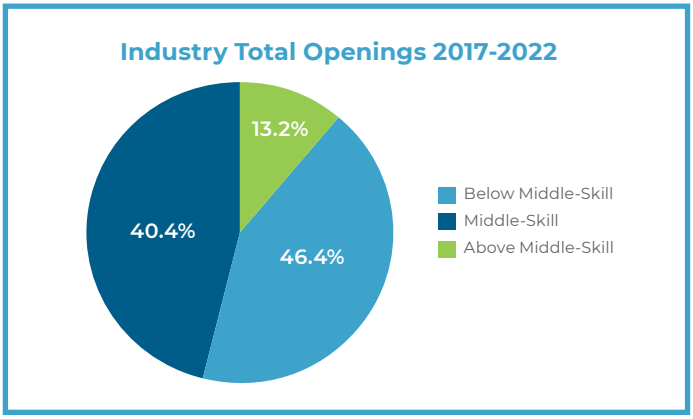
Significant Job Prospects (2022)

Occupational Group	Openings
• Graphic Designers	1,006
• Customer Service Representatives	3,067
• Sales Representatives *(Except Tech and Scientific Products)*	3,804
• Production, Planning, and Expediting Clerks	2,385
	92
• Sales Representatives Services, All Other	3,804









Manufacturing Industry Forecasts

324 Petroleum and Coal Products Manufacturing

Petroleum and Coal Products Manufacturing employed 3,560 payroll workers in the Los Angeles Basin. Projections indicate that by 2022, this industry will experience a 2.5 percent increase in employment. By 2022, 48.5 percent of all jobs in the Petroleum and Coal Products Manufacturing industry are expected to be middle-skill.

Characteristics of Workers Hired

The composition of all hires in this industry in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education, however the majority of workers (over 60 percent) have at least some college education or greater. Over 50 percent of workers in this field are between 45 and 65 years old.

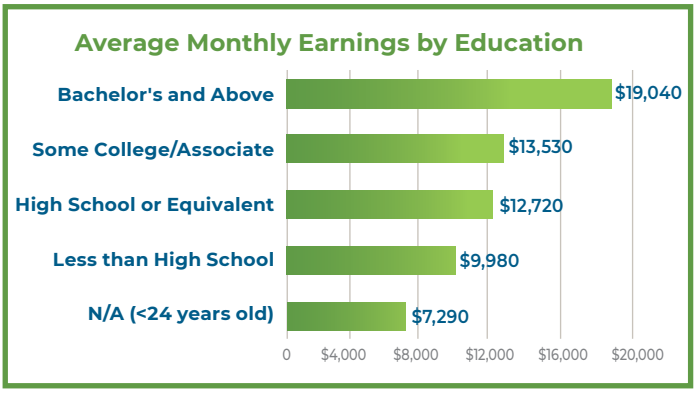
Top Middle-Skill Occupations

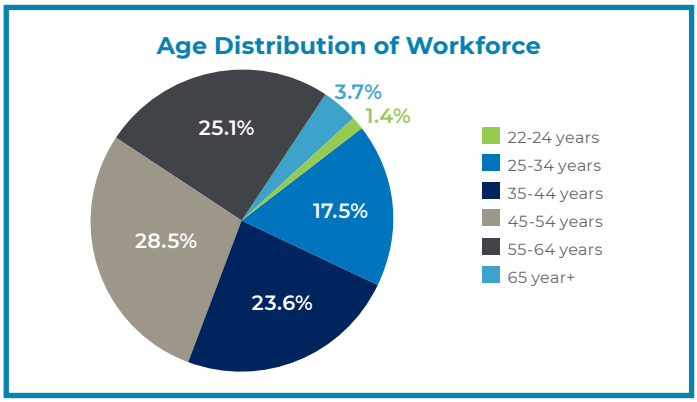
Included in the occupations that require middle-skills are industrial machinery mechanics, logisticians and business operations specialists. Middle-skill occupations will continue to drive labor demand in this industry.

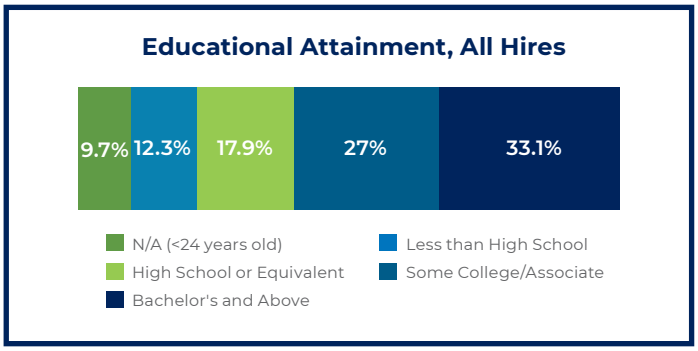
MIDDLE-SKILL OCCUPATIONS

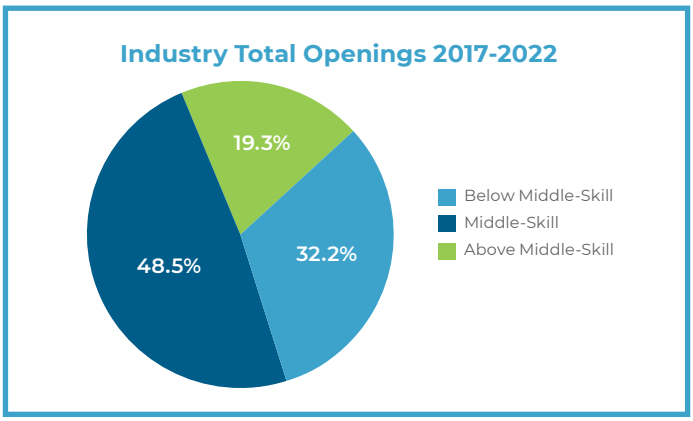
Significant Job Prospects (2022)

Occupational Group	Openings
• First-Line Supervisors of Construction Trades and Extraction	55
• Industrial Machinery Mechanics	1,246
• Business Operations Specialists, All Other	1,108
• Chemical Technicians	331
• Logisticians	666









325 Chemical Manufacturing

In 2017, Chemical Manufacturing employed 23,870 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise 43.3 percent of all jobs in this industry by 2022. Additionally, 485 jobs are projected to be added to the Chemical Manufacturing industry by 2022, representing a growth of over two percent (2%).

Characteristics of Workers Hired

The composition of all hires in Chemical Manufacturing in 2017 varies according to educational attainment and age. Nearly 20 percent of workers have less than a high school education and earn an average of $3,900 a month. Over 23 percent of workers have some college or an associate degree and earn $over $6000 a month on average. Over 25 percent of workers in this field are over 55 years old.

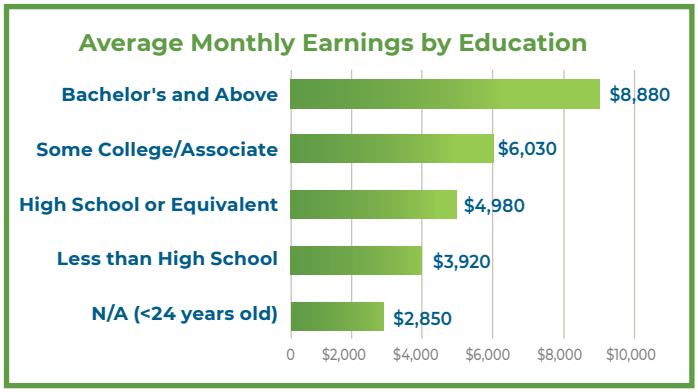
Top Middle-Skill Occupations

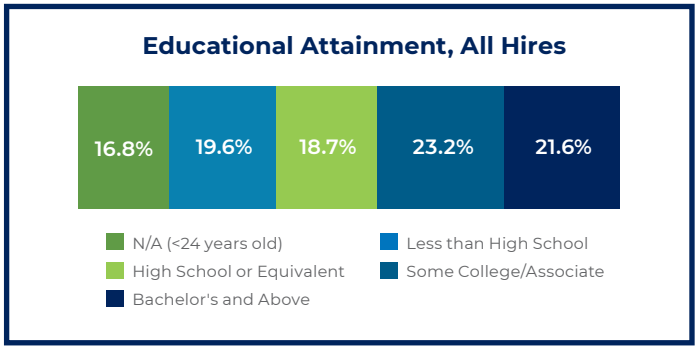
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include maintenance and repair workers, production planning and expediting clerks as well as mechanics.

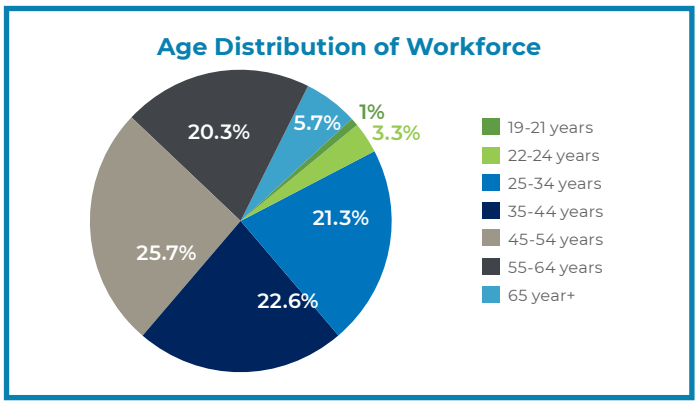
MIDDLE-SKILL OCCUPATIONS

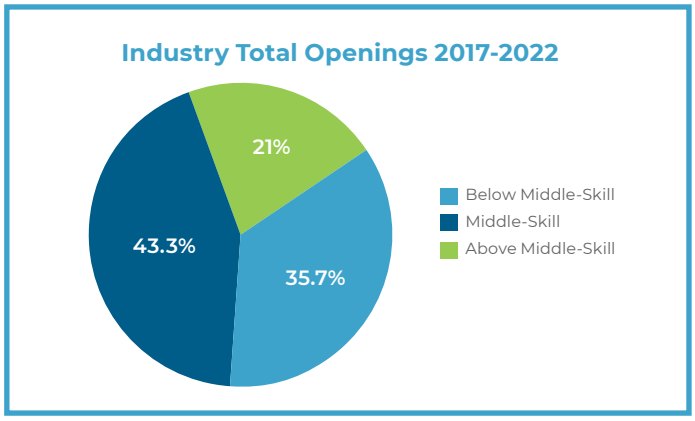
Significant Job Prospects (2022)

Occupational Group	Openings
• Business Operations Specialists, All Other	1,108
• Chemical Technicians	331
• Maintenance and Repair Workers, General	1,534
• Production, Planning, and Expediting Clerks	2,385
• Industrial Machinery Mechanics	1,246









326 Plastics and Rubber Products Manufacturing

In 2017, Plastics and Rubber Products Manufacturing employed 17,840 payroll workers in the Los Angeles Basin. By 2022, this industry is expected to lose under one percent of jobs. 41.2 percent of jobs are expected to require middle-skills by 2022.

Characteristics of Workers Hired

Hires in this industry are comprised of a variety of ages and educational attainments. 18 percent of workers are under 24 years old and 30 percent are over 55. For the 15 percent of workers in this industry with a bachelor's degree or higher, their average monthly earnings are just over $7,000. Workers with some college earn $4,900 on average each month.

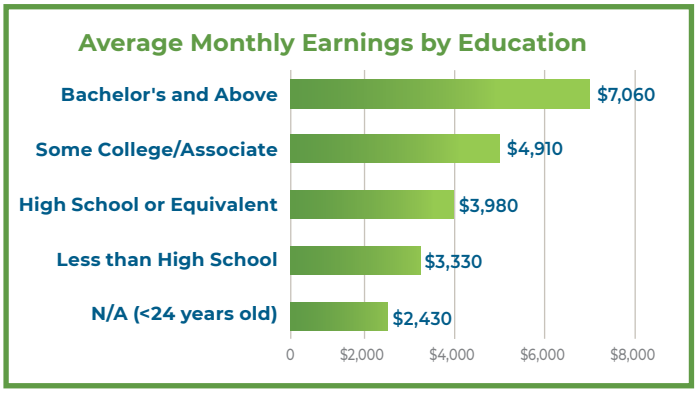
Top Middle-Skill Occupations

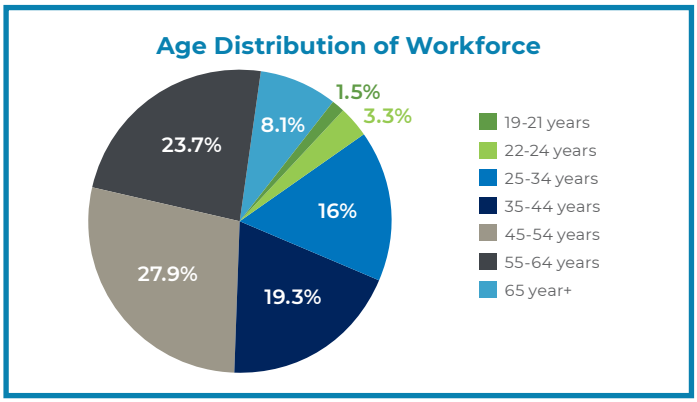
Some occupations growing in demand include sales representatives, mechanics and customer service representatives. Middleskill occupations will continue to drive labor demand in this industry.

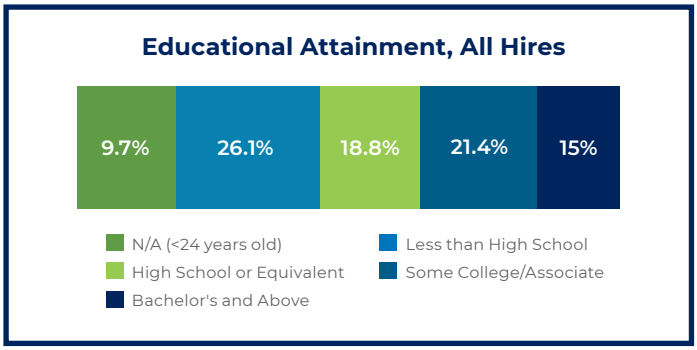
MIDDLE-SKILL OCCUPATIONS

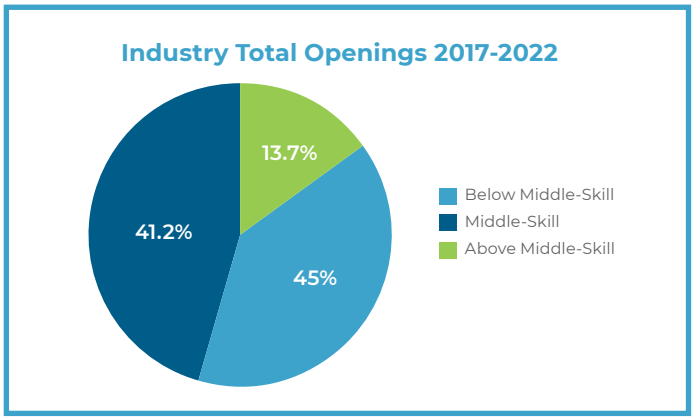
Significant Job Prospects (2022)

Occupational Group	Openings
• Maintenance and Repair Workers, General	1,534
• Industrial Machinery Mechanics	1,246
• Sales Representatives *(Except Tech and Scientific Products)*	*3,804*
• Heavy and Tractor-Trailer Truck Drivers	739
• Customer Service Representatives	3,067





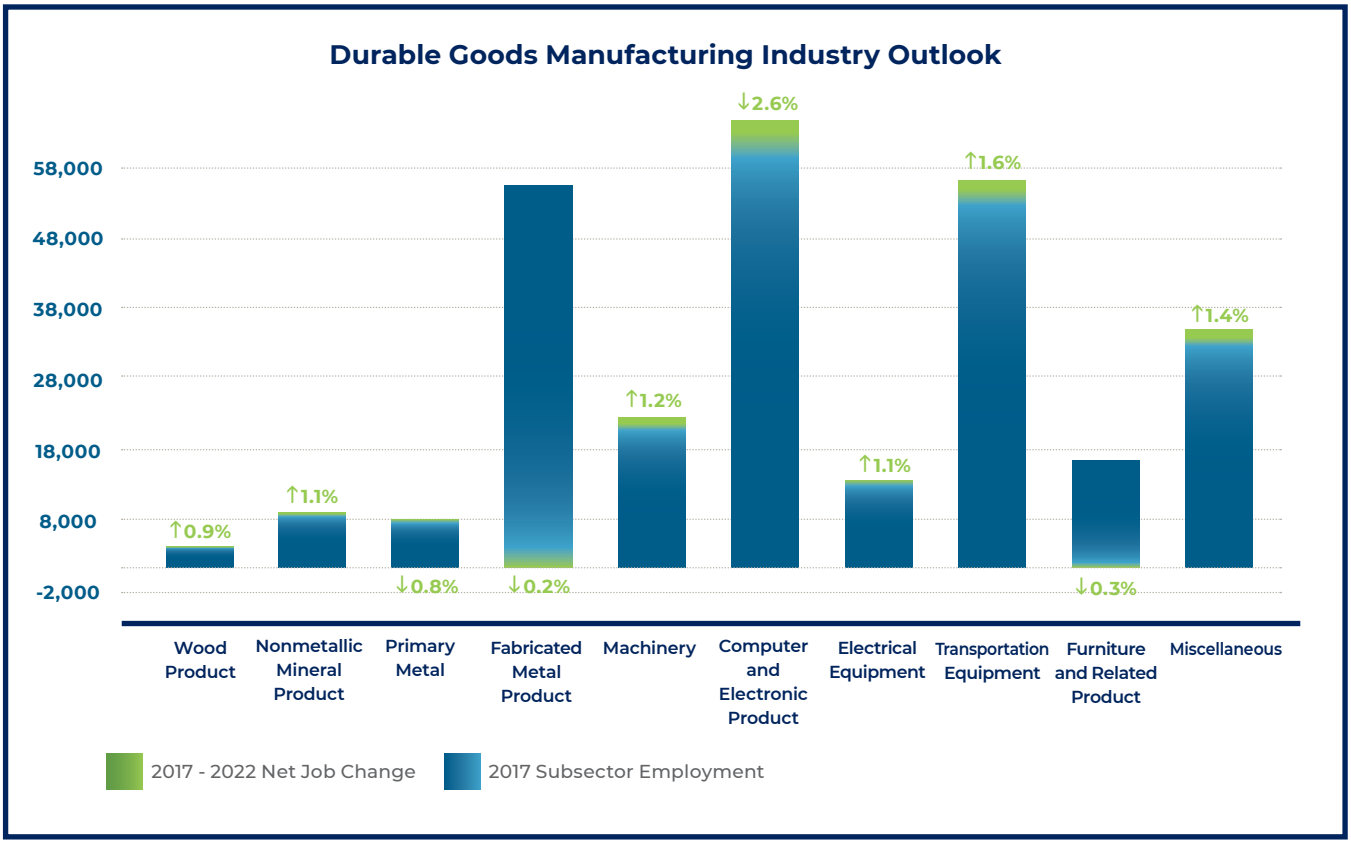




Durable goods.

Durable goods are those that last a long time, typically three years or more.
Durable goods manufacturing industries include

- Wood Product Manufacturing
- Nonmetallic Mineral Product Manufacturing
- Primary Metal Manufacturing
- Fabricated Metal Product Manufacturing
- Machinery Manufacturing
- Computer and Electronic Product Manufacturing
- Electrical Equipment and Appliance Manufacturing
- Transportation Equipment Manufacturing
- Furniture and Related Product Manufacturing
- Miscellaneous Manufacturing



Manufacturing Industry Forecasts

321 Wood Product Manufacturing

In 2017, Wood Product Manufacturing employed over 3,300 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise 46 percent of all jobs in the Wood Product Manufacturing industry by 2022. Projections indicate a stable future for the industry, with an expected growth of 1 percent in the next few years.

Characteristics of Workers Hired

The composition of all hires in Food Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 23 percent of workers in this field have had some college education or hold an associate degree. 22.2 percent of the workforce is between 35 and 44 years old.

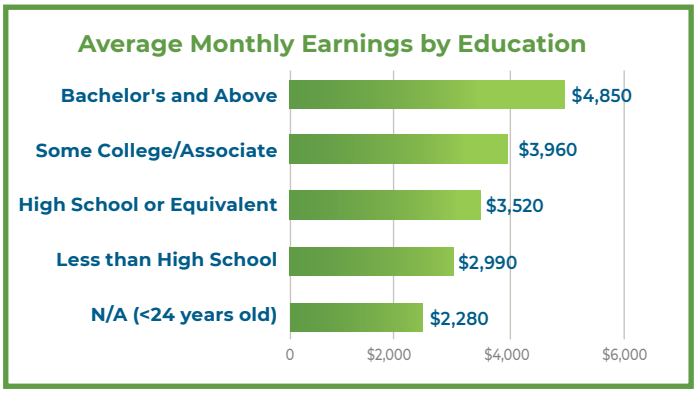
Top Middle-Skill Occupations

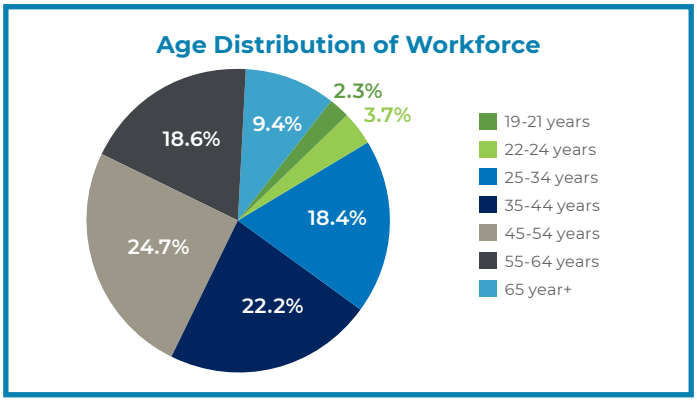
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include carpenters and heavy and tractor-truck drivers, among others.

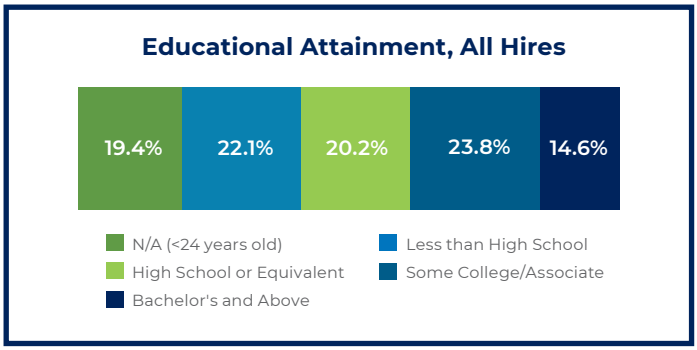
MIDDLE-SKILL OCCUPATIONS

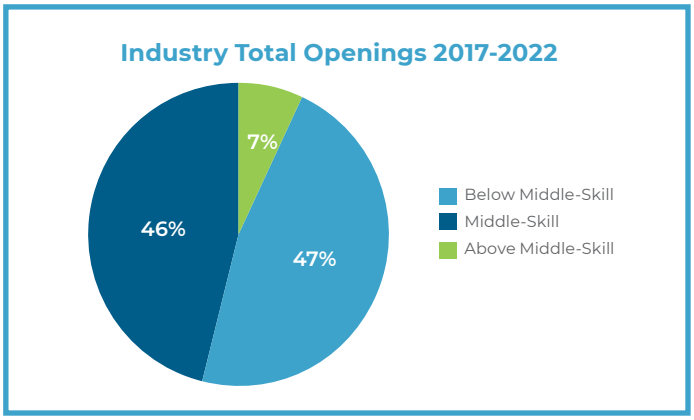
Significant Job Prospects (2022)

Occupational Group	Openings
• Carpenters	509
• Heavy and Tractor-Trailer Truck Drivers	739
• Sales Representative *(Except Tech and Scientific Products)*	3,804
• First-Line Supervisors of Production and Operating Workers	5,069
• Customer Service Representatives	3,067









327 Nonmetallic Mineral Product Manufacturing

In 2017, Nonmetallic Mineral Product Manufacturing employed 6,000 payroll workers in the Los Angeles Basin. Projections indicate a growth of just over one percent in payroll jobs by 2022 and middle-skill jobs will comprise nearly 45 percent of all jobs in this industry.

Characteristics of Workers Hired

The composition of all hires in Nonmetallic mineral product manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Nearly 50 percent of workers in this field are between 35 and 54 years old. For the 23 percent of workers with some college education or an associate degree, they earn an average of over $5,100 per month.

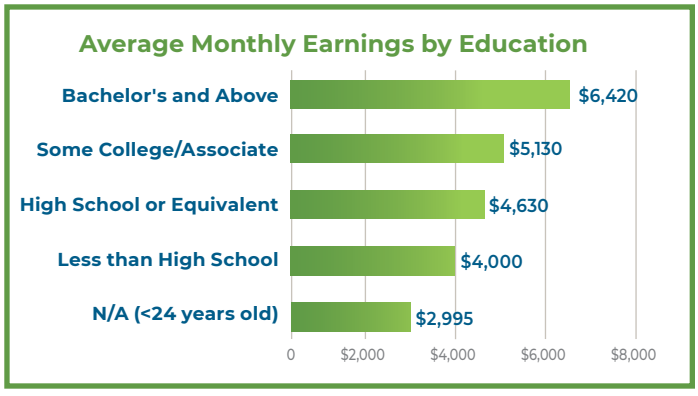
Top Middle-Skill Occupations

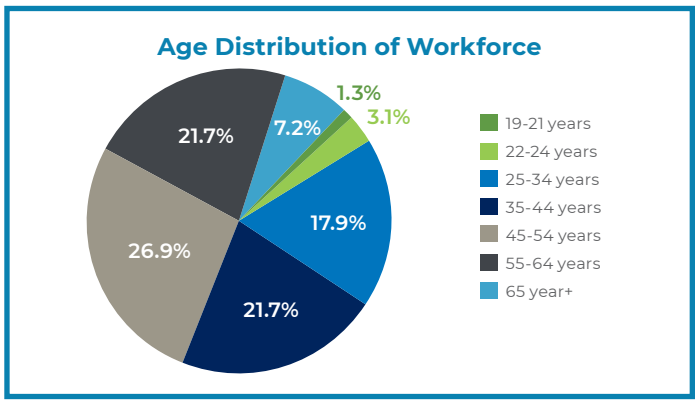
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include customer service and sales jobs as well as truck drivers and electricians.

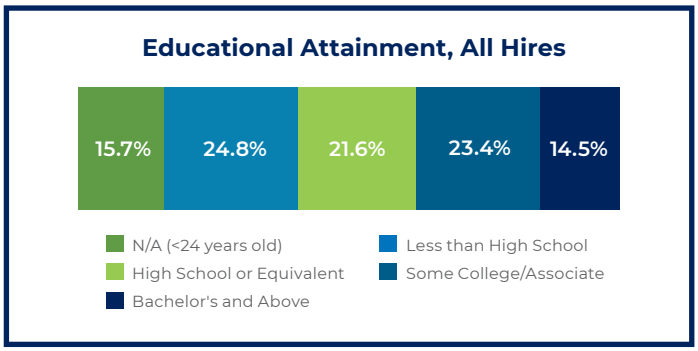
MIDDLE-SKILL OCCUPATIONS

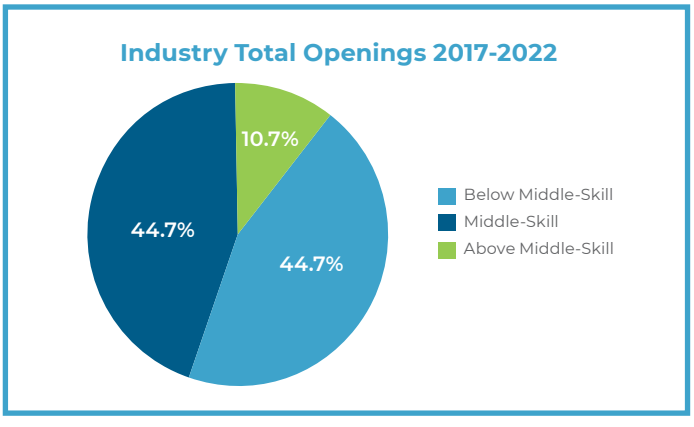
Significant Job Prospects (2022)

Occupational Group	Openings
• Heavy and Tractor-Trailer Truck Drivers	739
• Maintenance and Repair Workers, General	1,534
• Sales Representatives *(Except Tech and Scientific Products)*	3,804
• Electricians	197
• Customer Service Representatives	3,067









331 Primary Metal Manufacturing

In 2017, Primary Metal Manufacturing employed 5,610 payroll workers in the Los Angeles Basin. By 2022, this industry is expected to lose just under one percent of payroll jobs. Projections indicate that middle-skill jobs will comprise about 47 percent of all jobs in this industry by 2022.

Characteristics of Workers Hired

The composition of all hires in Primary Metal Manufacturing in 2017 varies according to educational attainment and age. Over one third of workers have some college education or more. Nearly 20 percent have a high school education or equivalent and earn an average of $4,500 each month. Over 25 percent of workers in this field are between 45 and 54 years old. An additional third of workers are between 25 and 44 years old.

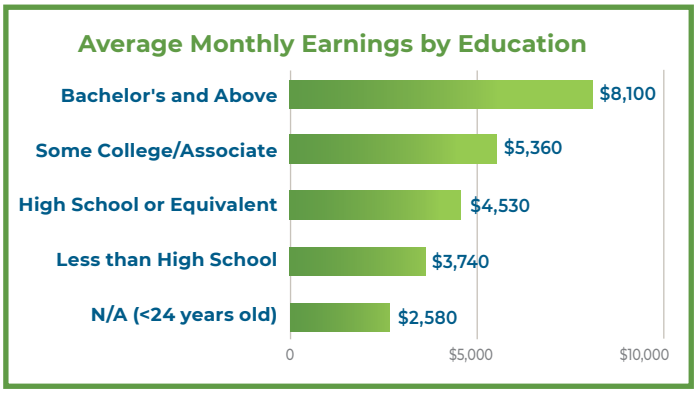
Top Middle-Skill Occupations

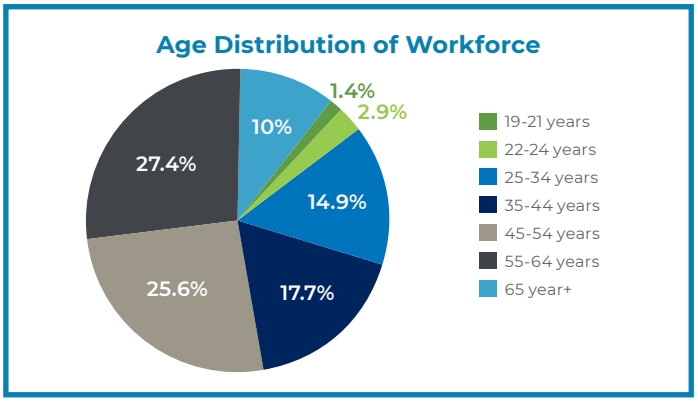
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include welders, cutters, solderers and brazers as well as mechanics and maintenance workers.

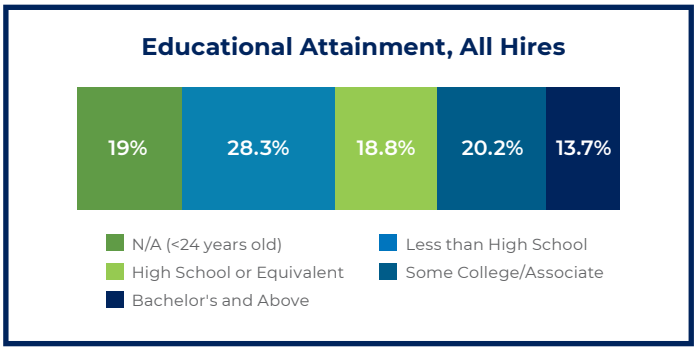
MIDDLE-SKILL OCCUPATIONS

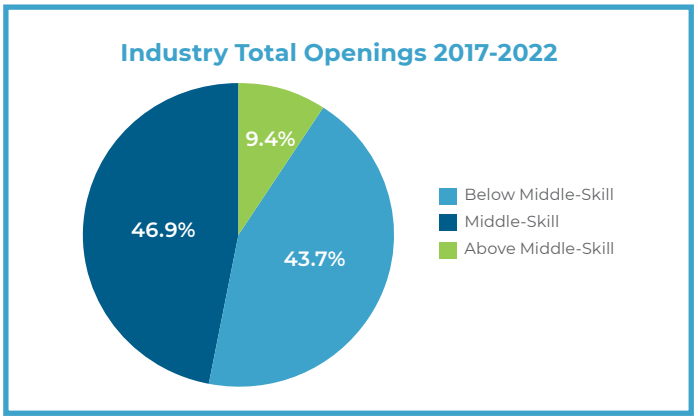
Significant Job Prospects (2022)

Occupational Group	Openings
• Welders, Cutters, Solderers, and Brazers	2,578
• Industrial Machinery Mechanics	1,246
• Maintenance and Repair Workers, General	1,534
• Sales Representatives *(Except Tech and Scientific Products)*	3,804
• Heavy and Tractor-Trailer Truck Drivers	739









332 Fabricated Metal Product Manufacturing

In 2017, Fabricated Metal Production Manufacturing employed 54,480 payroll workers in the Los Angeles Basin. This industry is to remain largely unchanged through 2022. By 2022, projections indicate that middle skill jobs will comprise nearly 45 percent of all jobs.

Characteristics of Workers Hired

The composition of all hires in Fabricated Metal Product Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 37 percent of workers in this field have some college, an associate's, bachelor's degree or higher. Over a third of workers are older than 55 years old.

Top Middle-Skill Occupations

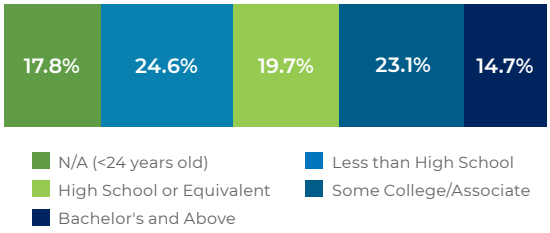
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include machinists and production, planning and expediting clerks.

MIDDLE-SKILL OCCUPATIONS

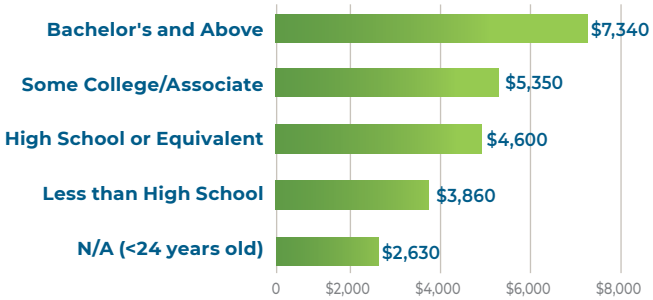
Significant Job Prospects (2022)

Occupational Group	Openings
• Machinists	4,963
• Welders, Cutters Solderers, and Brazers	2,578
• CNC Machine Tool Programmers, Metal and Plastic	4,89
• Production, Planning, and Expediting Clerks	2,385
• Sales Representatives *(Except Tech and Scientific Products)*	3,804

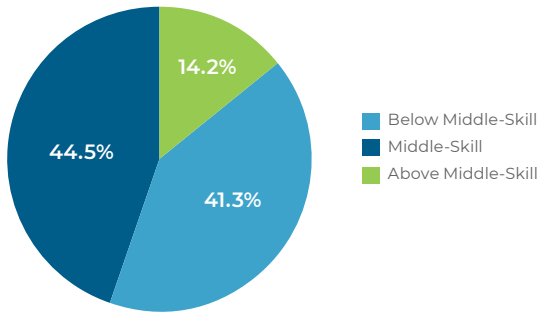
Educational Attainment, All Hires



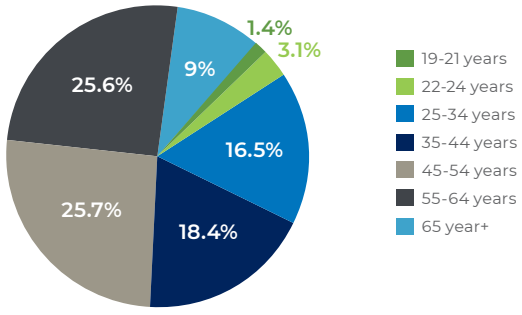
Average Monthly Earnings by Education



Industry Total Openings 2017-2022



Age Distribution of Workforce



333 Machinery Manufacturing

In 2017, Machinery Manufacturing employed 18,930 payroll workers in the Los Angeles Basin. Projections indicate employment in this industry will experience a modest growth of 1.2 percent, or 230 additional jobs by 2022. Of all employment in 2022, middle-skill jobs will comprise nearly 45 percent.

Characteristics of Workers Hired

The composition of all hires in Machinery Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 50 percent of workers in this field are between 45 and 64 years old. 23 percent of workers have some college education and earn average monthly wages of $5,900.

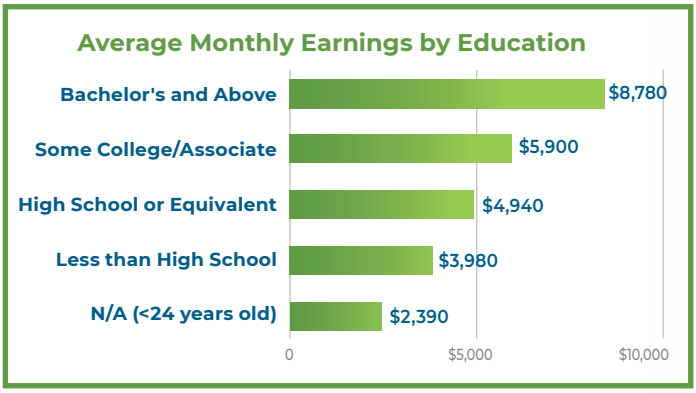
Top Middle-Skill Occupations

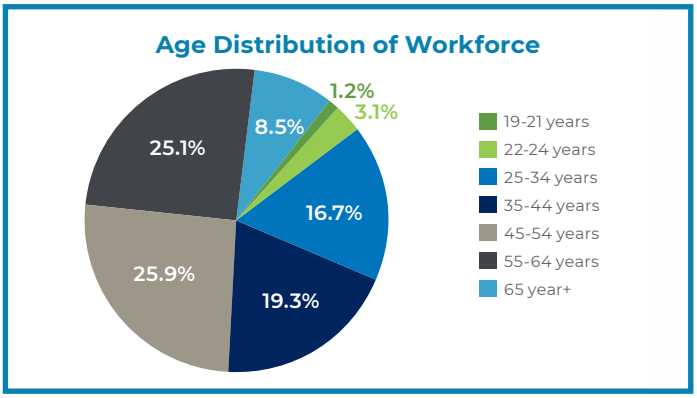
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include machinists, clerks and welders, cutters, solderers and brazers.

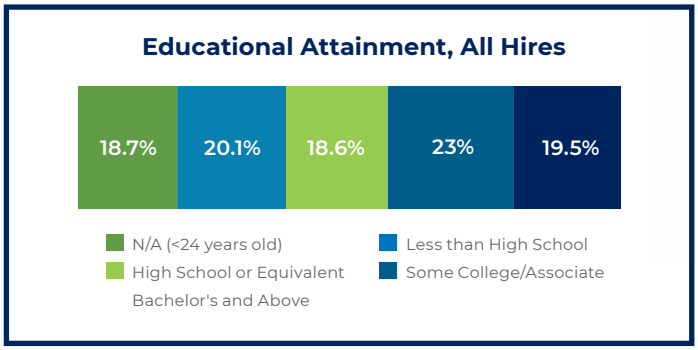
MIDDLE-SKILL OCCUPATIONS

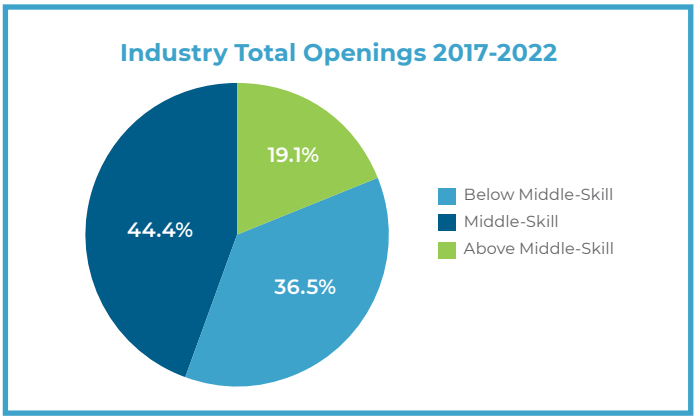
Significant Job Prospects (2022)

Occupational Group	Openings
• Welders, Cutters, Solderers, and Brazers	2,578
• Machinists	4,963
• Production, Planning, and Expediting Clerks	2,385
• CNC Machine Tool Programmers, Metal and Plastic	489









334 Computer and Electronic Product Manufacturing

The Computer and Electronic Product Manufacturing industry employed 61,480 payroll workers in the Los Angeles Basin in 2017. Projections indicate that middle-skill jobs will comprise 46.2 percent of all jobs in this industry by 2022. By 2022, over 1,600 jobs are expected to be added to Computer and Electronic Product Manufacturing industry, representing a growth of over 2.6 percent.

Characteristics of Workers Hired

The composition of all hires in this industry in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 25 percent of workers in this field have a bachelor's degree or above and earn over $14,275 in wages each month. Under 20 percent of workers are under 34 in this industry.

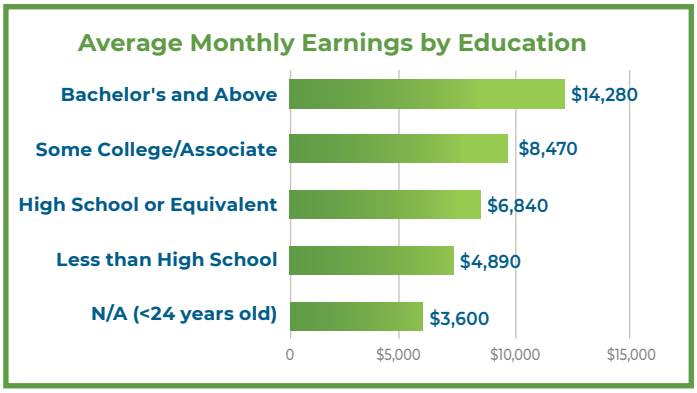
Top Middle-Skill Occupations

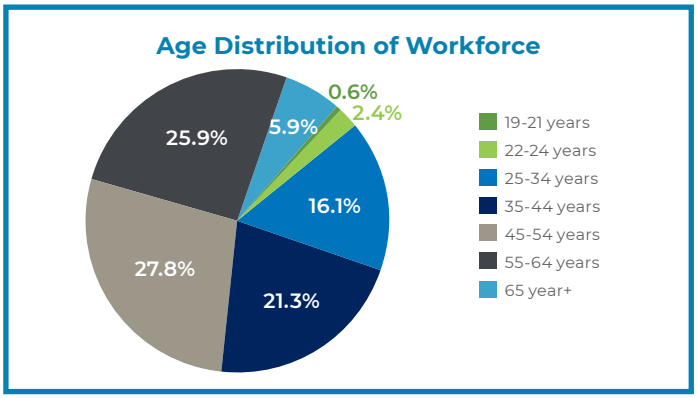
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include engineering technicians, clerks and business operations specialists.

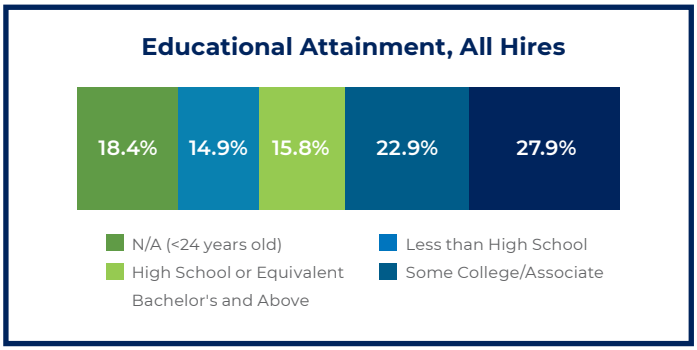
MIDDLE-SKILL OCCUPATIONS

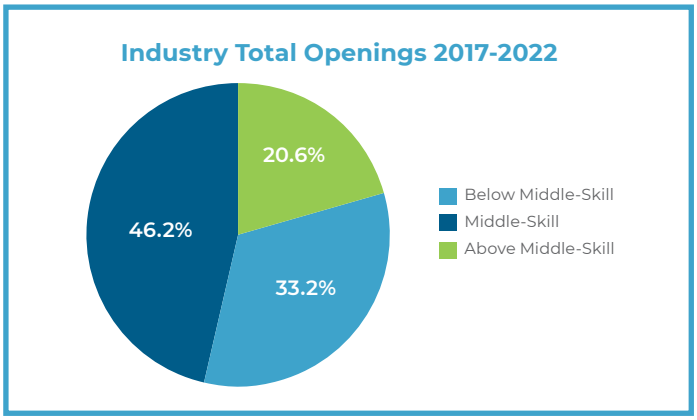
Significant Job Prospects (2022)

Occupational Group	Openings
• Electrical and Electronics Engineering Technicians	1,003
• Business Operations Specialists, All Other	1,108
• Production, Planning, and Expediting Clerks	2,385
• Computer User Support Specialists	463
• Computer Occupations, All Other	194









335 Electrical Equipment, Appliance, and Component Manufacturing

In 2017, Electrical Equipment, Appliance and Component Manufacturing employed over 12,800 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise 44.7 percent of all jobs in this industry by 2022. By 2022, nearly 150 jobs are expected to be added to the industry, representing a growth of just over one percent.

Characteristics of Workers Hired

The composition of all hires in Electrical Equipment, Appliance and Component Manufacturing in 2017 varies according to educational attainment and age. Over 22 percent of workers have an associate degree or some college and earn over $6,100 in average monthly wages. Half of workers in this industry are between 45 and 64.

Top Middle-Skill Occupations

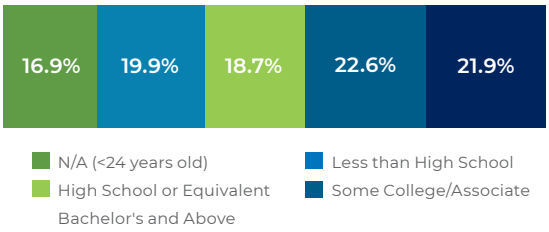
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include sales and customer service representatives, clerks and engineering technicians.

MIDDLE-SKILL OCCUPATIONS

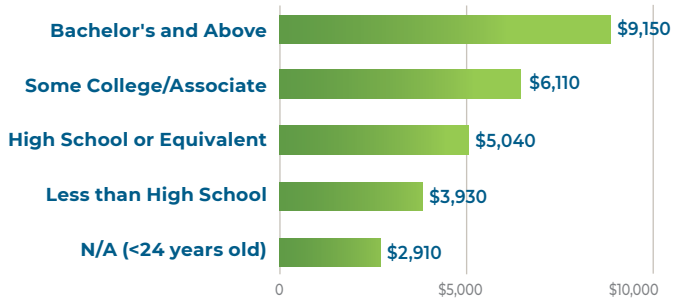
Significant Job Prospects (2022)

Occupational Group	Openings
• Computer User Support Specialists	463
• Sales Representatives *(Except Tech and Scientific Products)*	3,804
• Production, Planning, and Expediting Clerks	2,385
• Electrical and Electronics Engineering Technicians	1,003
• Customer Service Representatives	3,067

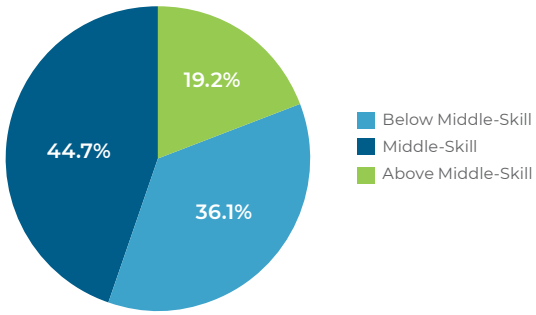
Educational Attainment, All Hires



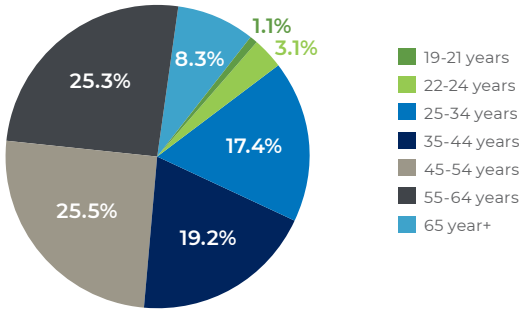
Average Monthly Earnings by Education



Industry Total Openings 2017-2022



Age Distribution of Workforce



336 Transportation Equipment Manufacturing

Transportation Equipment Manufacturing employed 51,880 payroll workers in the Los Angeles Basin in 2017. By 2022, projections indicate that 43.3 percent of all jobs will be middle-skill jobs in this industry. By 2022, an additional 850 jobs are expected to be added to the Transportation Equipment Manufacturing industry, representing a growth of over 1.6 percent.

Characteristics of Workers Hired

The composition of all hires in Transportation Equipment Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 37 percent of workers in this field are between 25 and 44 years old. Just over 18 percent have their high school diploma or equivalent and another 23.6 percent have some college.

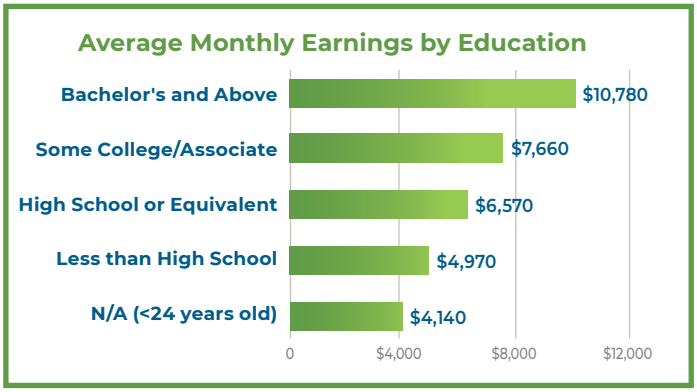
Top Middle-Skill Occupations

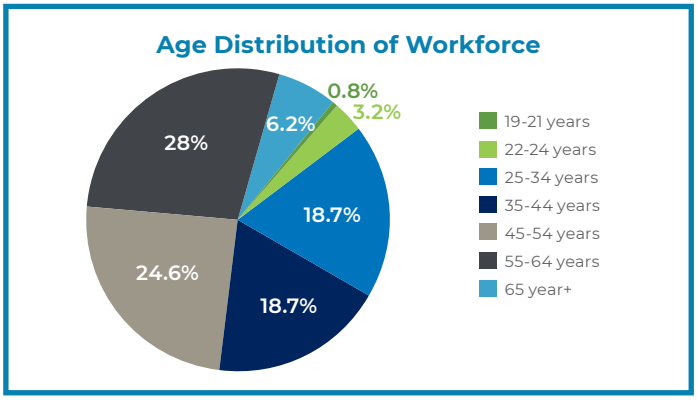
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include welders, cutters, solderers and brazers as well as clerks and business operations specialists.

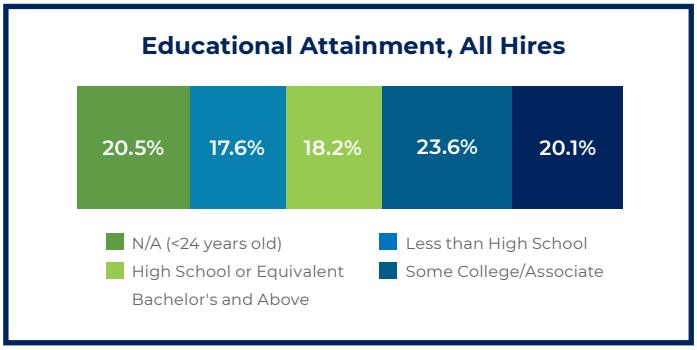
MIDDLE-SKILL OCCUPATIONS

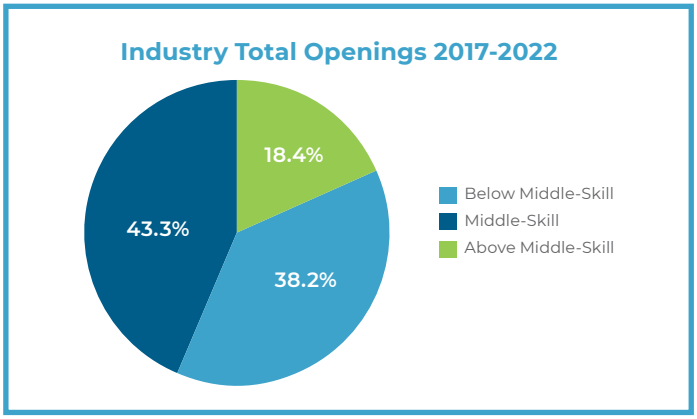
Significant Job Prospects (2022)

Occupational Group	Openings
• Business Operations Specialists, All Other	1,108
• Production, Planning, and Expediting Clerks	2,385
• Welders, Cutters, Solderers, and Brazers	2,578
• Aircraft Mechanics and Service Technicians	300
• Logisticians	666









337 Furniture and Related Product Manufacturing

In 2017, Furniture and Related Product Manufacturing employed over 16,200 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise 43.3 percent of all jobs in this industry by 2022. By 2022, jobs are projected to be largely unchanged, with a loss of under 50 jobs or less than 0.3 percent decline.

Characteristics of Workers Hired

The composition of all hires in Transportation Equipment Manufacturing in 2017 varies according to educational attainment and age. Nearly 20 percent of workers in this field have a high school diploma and earn average monthly wages of over $3,600. An additional 36.8 percent of workers have some college or a bachelor's degree or higher. 47.4 percent of workers are between the ages of 45 and 64 years old.

Top Middle-Skill Occupations

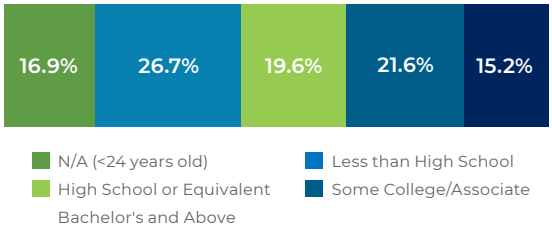
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include repair workers and sales and customer service representatives.

MIDDLE-SKILL OCCUPATIONS

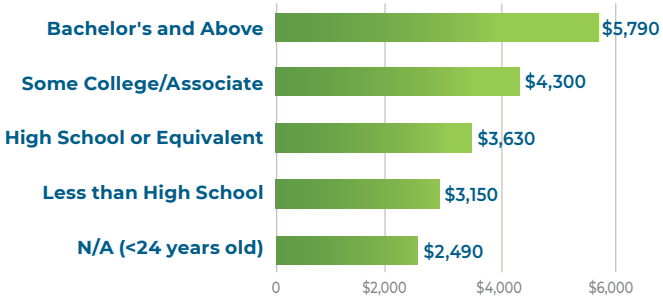
Significant Job Prospects (2022)

Occupational Group	Openings
• Carpenters	509
• Sales Representatives (Except Tech and Scientific Products)	3,804
• Cost Estimators	389
• Maintenance and Repair Workers, General	1,534
• Welders, Cutters, Solderers, and Brazers	2,578
• Customer Service Representatives	3,067

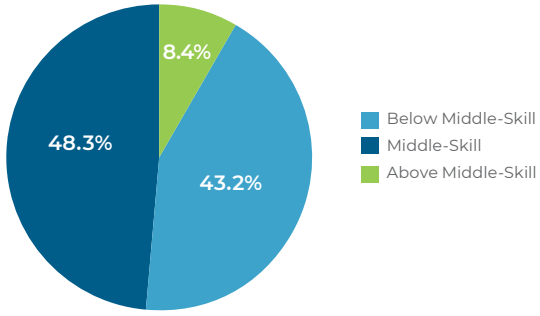
Educational Attainment, All Hires



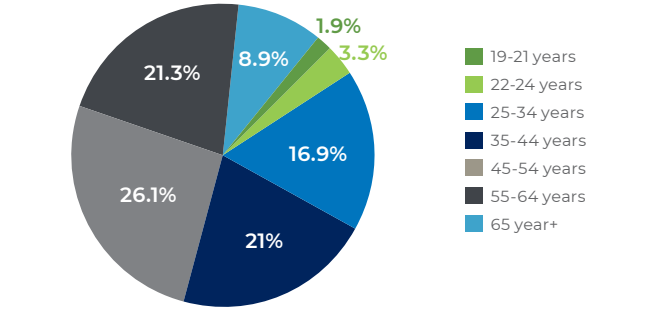
Average Monthly Earnings by Education



Industry Total Openings 2017-2022



Age Distribution of Workforce



339 Miscellaneous Manufacturing

In 2017, Miscellaneous Manufacturing employed over 34,100 payroll workers in the Los Angeles Basin. Projections indicate that middle-skill jobs will comprise just over 40 percent of all jobs in the Food Manufacturing industry by 2022. By 2022, an additional 470 jobs are expected to be added to the Miscellaneous Manufacturing industry, representing a growth of over 1.3 percent.

Characteristics of Workers Hired

The composition of all hires in Miscellaneous Manufacturing in 2017 varies according to educational attainment and age. The industry provides a wide range of jobs to individuals with different levels of education. Over 25 percent of workers in this field are under 34 years old. Additionally, just over 45.6 percent of workers have some college or a bachelor's degree or above.

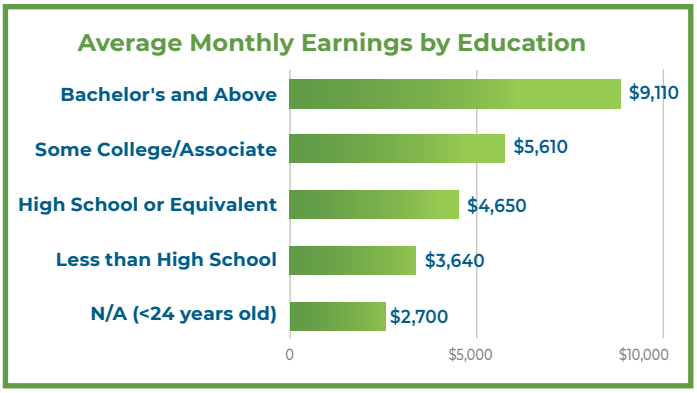
Top Middle-Skill Occupations

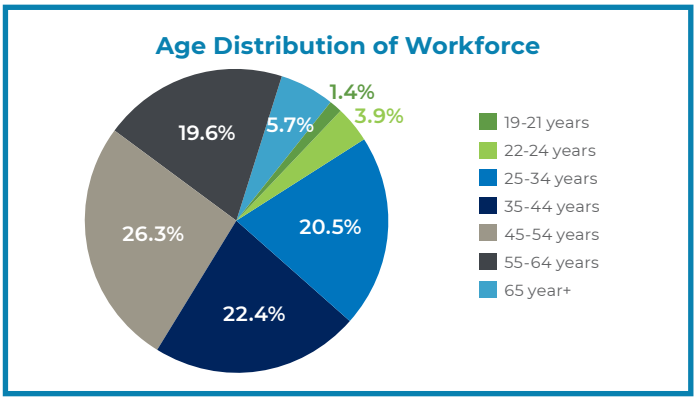
Middle-skill occupations will continue to drive labor demand in this industry. Some occupations growing in demand include welders, cutters, solderers and brazers as well as clerks, customer service representatives and repair workers.

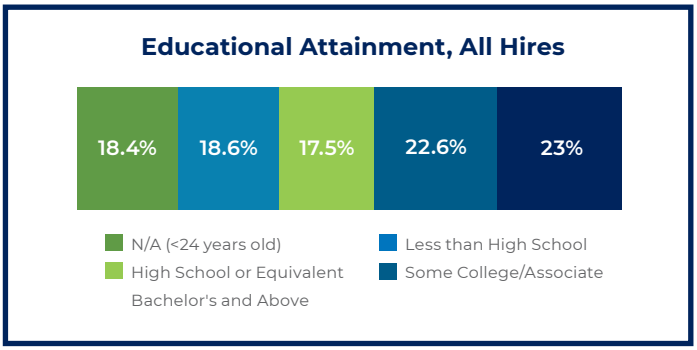
MIDDLE-SKILL OCCUPATIONS

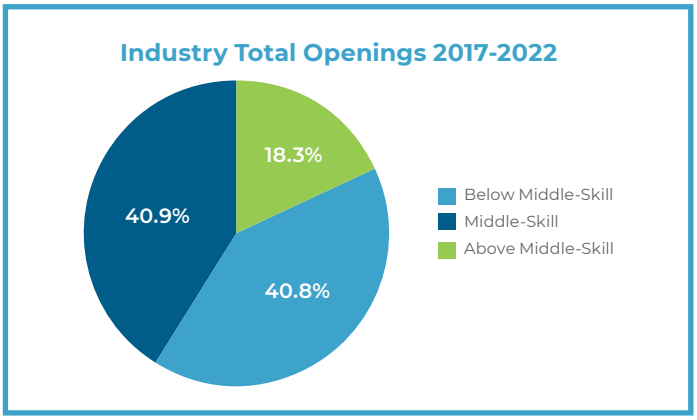
Significant Job Prospects (2022)

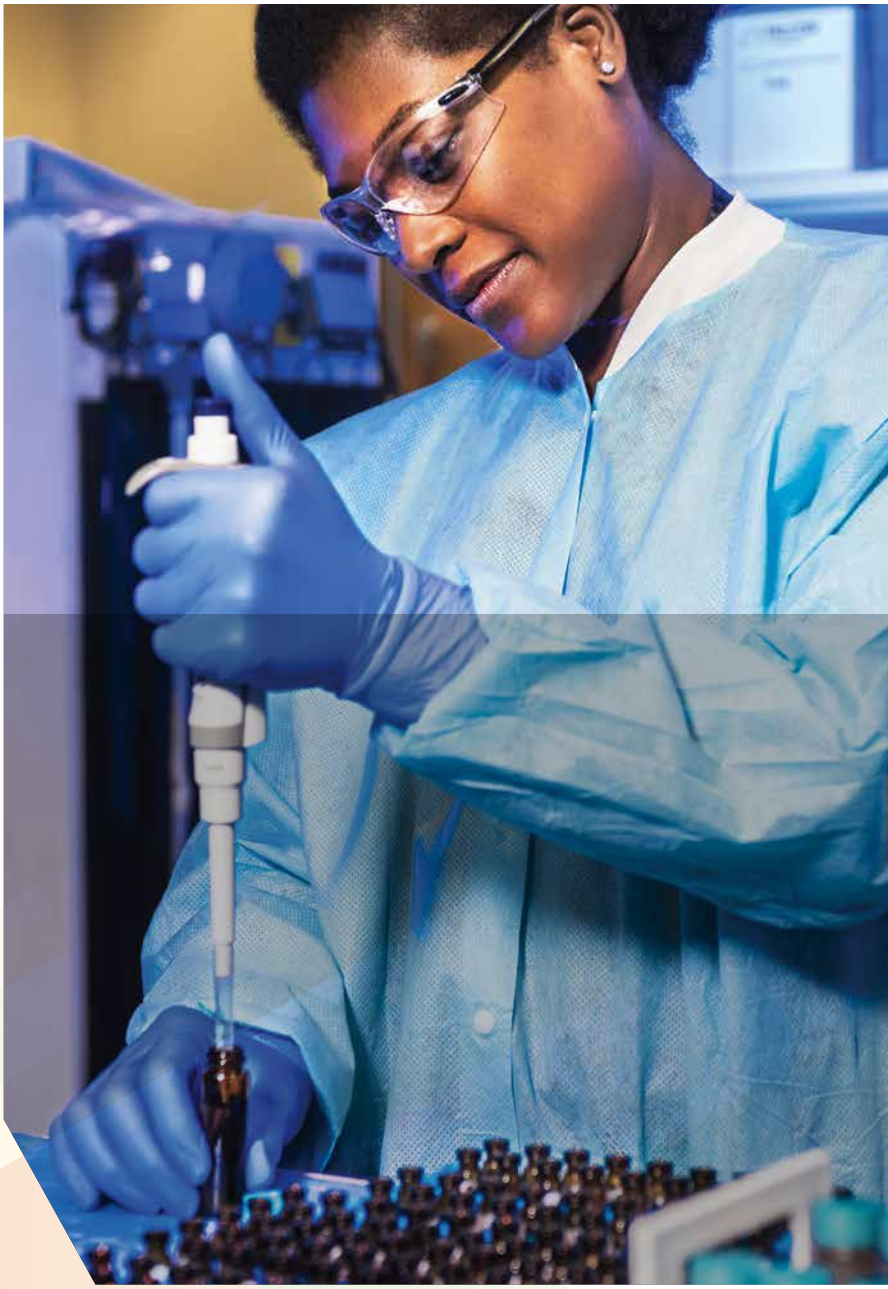
Occupational Group	Openings
• Customer Service Representatives	3,067
• Business Operations Specialists, All Other	1,108
• Production, Planning, and Expediting Clerks	2,385
Maintenance and Repair Workers, General	1,534
Welders, Cutters, Solderers, and Brazers	2,578











Occupational Profiles

Employment numbers and worker characteristics.

Detailed information has been compiled for the top ten middle-skill occupations in the manufacturing sector. Data from 2017, the most recent available, was used to determine wages and worker characteristics for the charts included with the profiles.

The information on top industries employing these occupations, current and projected employment, wages and demographics can be used by community colleges to tailor existing programs and guide outreach to potential students. The occupational analyses that follow may even inspire new program development or new approaches in attracting students to promising career paths.

Each occupational profile contains:

- *Hourly wages paid in 2017 for workers in Los Angeles and Orange counties compared to the living wage;*
- *The distribution of workers across industry sectors in the Los Angeles Basin;*
- *Metrics for the occupation including the number of current jobs and projected openings; and*
- *Worker characteristics, such as educational attainment, age distribution, race and ethnicity, and gender.*

Top 10 Occupations

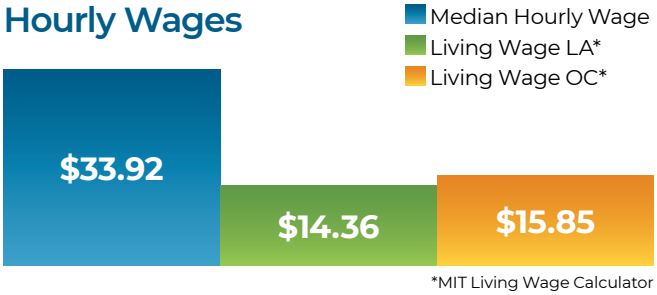
- Aerospace Engineering and Operations Technicians (SOC 17-3021)
- Machinists (SOC 51-4041)
- Welders, Cutters, Solderers and Brazers (SOC 51-4121)
- Computer-Controlled Machine Tool Operators (SOC 51-4011)
- Industrial Machinery Mechanics (SOC 49-9041)
- Electrical and Electronic Engineering Technicians (SOC 17-3023)
- Computer-Controlled Machine Tool Programmers (SOC 51-4012)
- Industrial Engineering Technicians (SOC 17-3026)
- Electrical and Electronics Repairers, Commercial (SOC 49-2094)
- Mechanical Drafters (SOC 17-3013)

Manufacturing Industry Forecasts

Aerospace Engineering and Operations Technicians (SOC 17-3021)

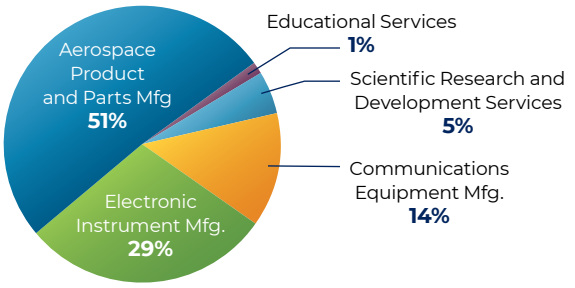
Operate, install, calibrate, and maintain integrated computer/communications systems, consoles, simulators, and other data acquisition, test, and measurement instruments and equipment, which are used to launch, track, position, and evaluate air and space vehicles. May record and interpret test data.

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Over half of all aerospace engineering and operations technicians are employed in aerospace products and parts manufacturing; **220 aerospace engineering and operations technicians** were employed in the electronic instrument manufacturing industry in the region in 2017. They accounted for **29 percent** of employment in this occupation across all industries.

Top industry subsectors employingthis occupation:

- Aerospace Products and Parts Manufacturing
- Electronic Instrument Manufacturing
- Communications Equipment Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

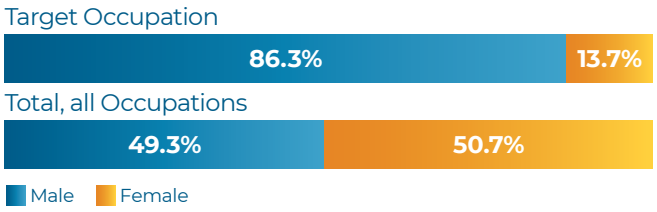
- **220** Total Openings (5-yr)
- **210** Total Mfg. Openings (5-Tr)
- **1.6** Location Quotient

Total Jobs in LA
640
in 2017

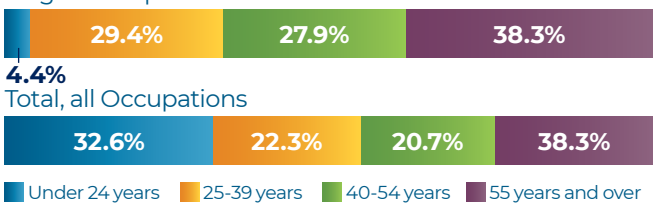
Total Jobs in OC
100
in 2017

Regional Worker Characteristics in LA/OC in 2017

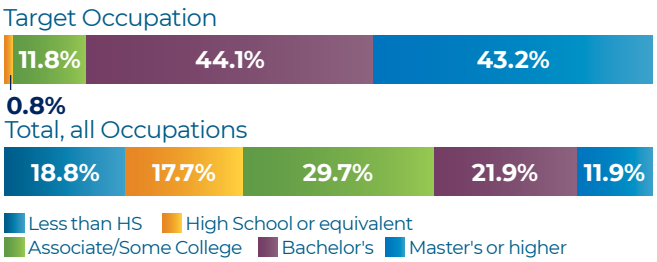
GENDER



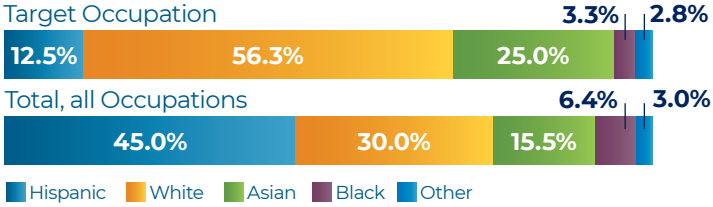
AGE DISTRIBUTION



EDUCATIONAL ATTAINMENT



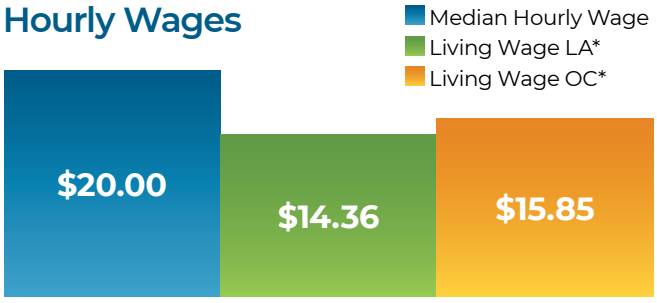
RACE AND ETHNICITY



Machinists (SOC 51-4041)

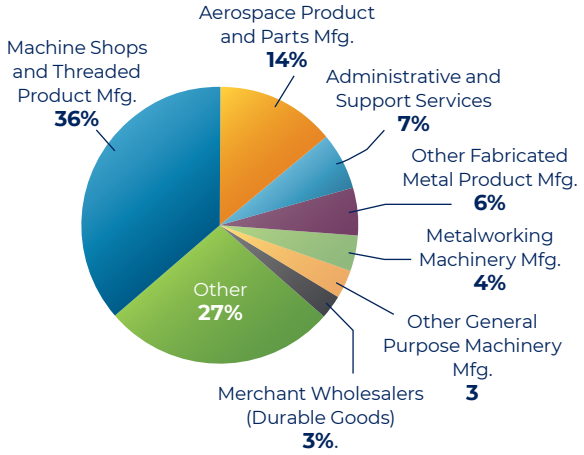
Set up and operate a variety of machine tools to produce precision parts and instruments. Includes precision instrument makers who fabricate, modify, or repair mechanical instruments. May also fabricate and modify parts to make or repair machine tools or maintain industrial machines, applying knowledge of mechanics, mathematics, metal properties, layout, and machining procedures.

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most machinists are employed in machine shops, **2,270 machinists** were employed in the aerospace product and parts manufacturing industry in the region in 2017. They accounted for **14 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Machine Shops and Treaded Product Manufacturing
- Aerospace Product and Parts Manufacturing
- Administrative and Support Services

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

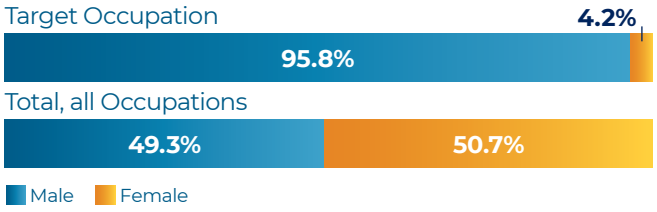
- **5,610** Total Openings (5-yr)
- **4,960** Total Mfg. Openings (5-Tr)
- **1.0** Location Quotient

Total Jobs in LA
10,930
in 2017

Total Jobs in OC
5,360
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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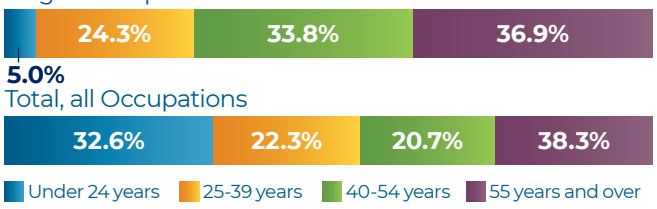
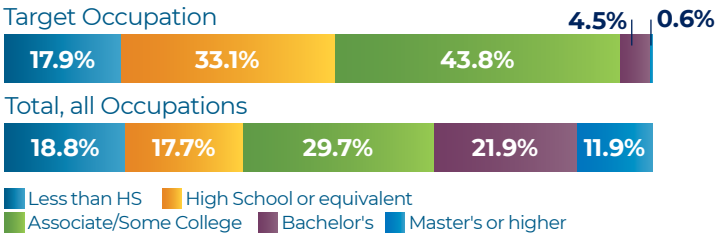
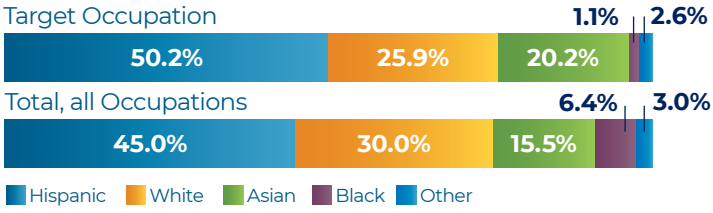


EDUCATIONAL ATTAINMENT



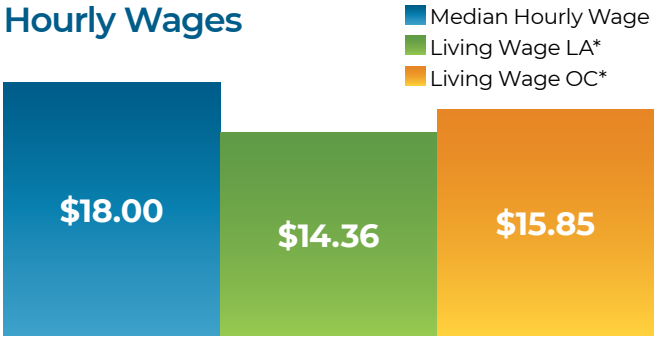
RACE AND ETHNICITY



Welders, Cutters, Solderers and Brazers (SOC 51-4121)

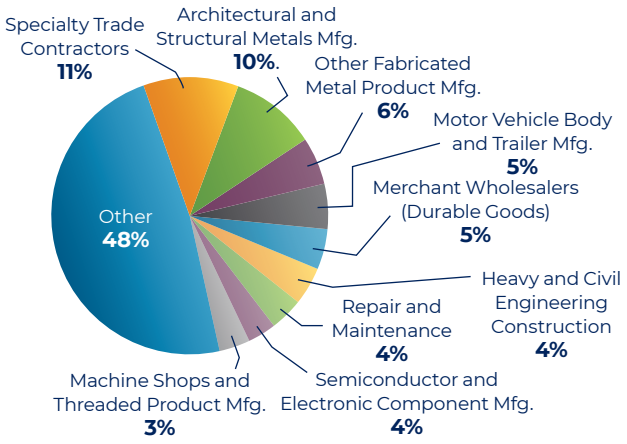
Use hand-welding, flame-cutting, hand soldering, or brazing equipment to weld or join metal components or to fill holes, indentations, or seams of fabricated metal products.

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most welders, cutters, solderers and brazers are employed by specialty trade contractors, **850 welders, cutters, solderers and brazers** were employed in the architectural and structural metals manufacturing industry in the region in 2017. They accounted for **10 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Specialty Trade Contractors
- Architectural and Structural Metals Manufacturing
- Other Fabricated Metal Product Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

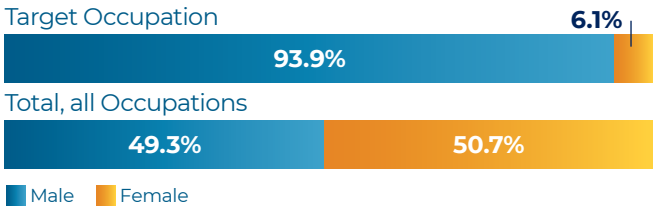
- **3,900** Total Openings (5-yr)
- **2,980** Total Mfg. Openings (5-Tr)
- **0.6** Location Quotient

Total Jobs in LA
5,650
in 2017

Total Jobs in OC
2,980
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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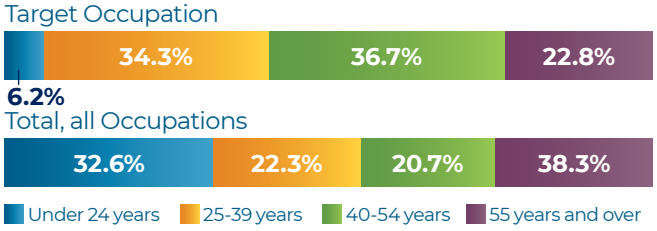
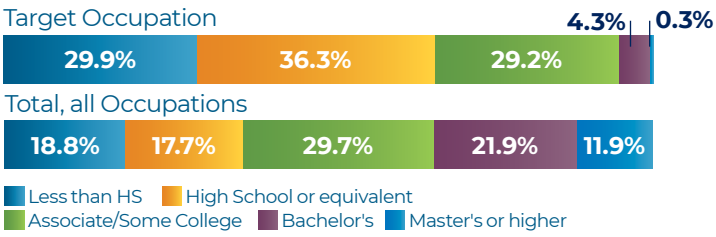
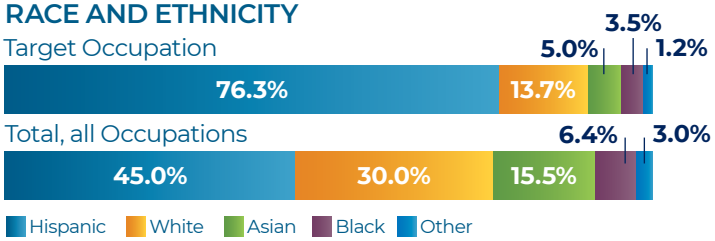


EDUCATIONAL ATTAINMENT



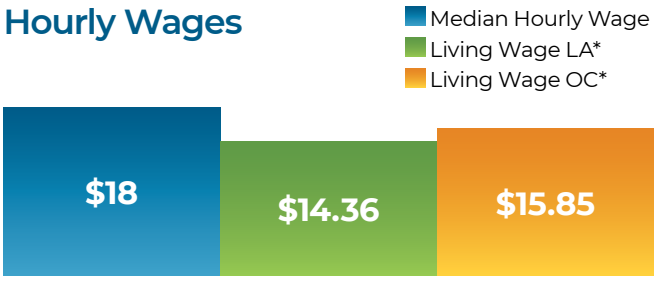
RACE AND ETHNICITY



Computer-Controlled Machine Tool Operators (SOC 51-4011)

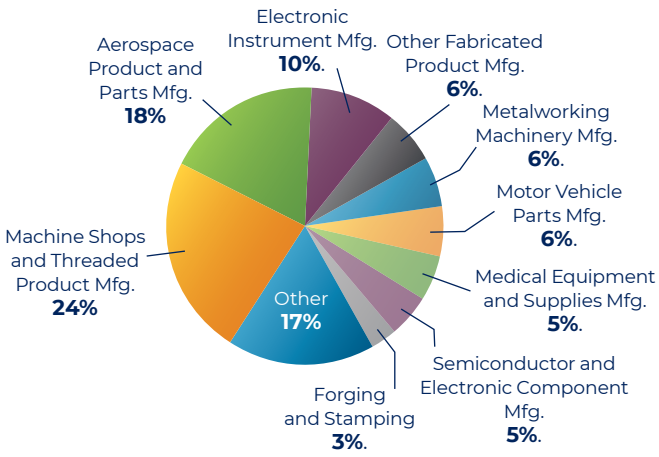
Operate computer-controlled machines or robots to perform one or more machine functions on metal or plastic work pieces.

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most computer-controlled machine tool operators are employed in machine shops, **1,040 computer-controlled machine tool operators** were employed in the aerospace industry in the region in 2017. They accounted for **18 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Machine Shops and Threaded Product Manufacturing
- Aerospace Product and Parts Manufacturing
- Electronic Instrument Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

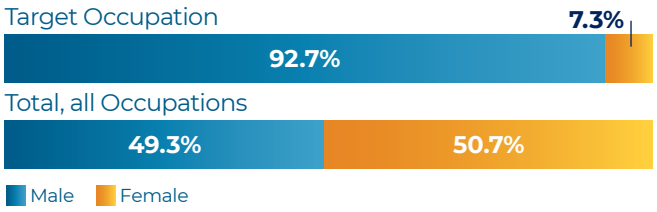
- **2,000** Total Openings (5-yr)
- **1,950** Total Mfg. Openings (5-Tr)
- **1.1** Location Quotient

Total Jobs in LA
3,330
in 2017

Total Jobs in OC
2,430
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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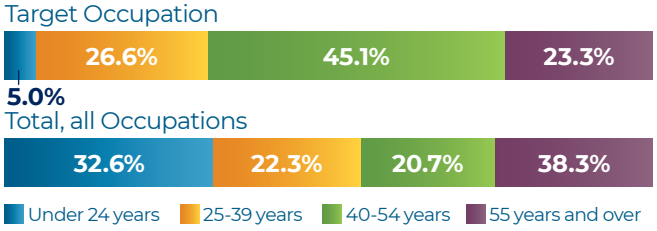
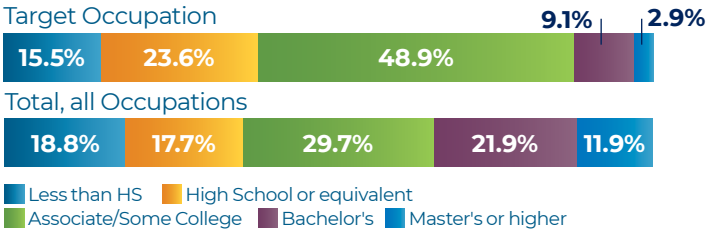
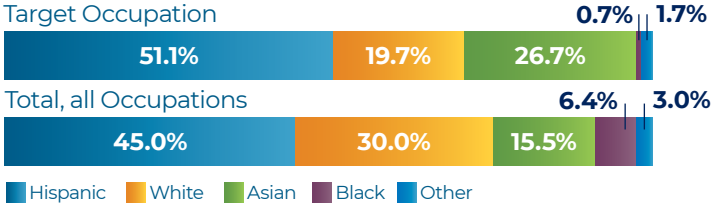


EDUCATIONAL ATTAINMENT



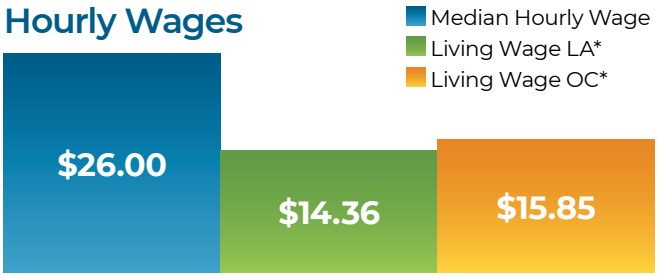
RACE AND ETHNICITY



Industrial Machinery Mechanics (SOC 49-9041)

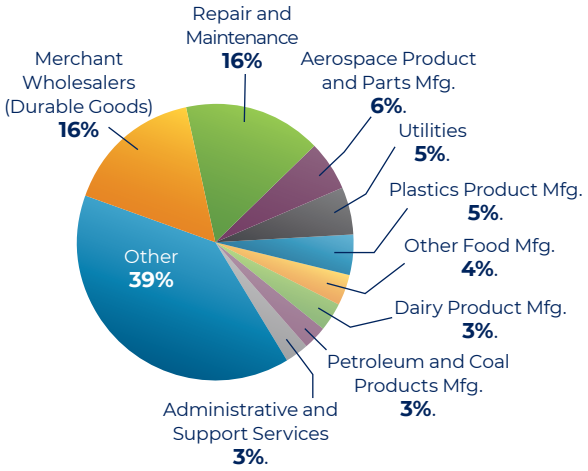
Repair, install, adjust, or maintain industrial production and processing machinery or refinery and pipeline distribution systems. Excludes "Millwrights" (49-9044), "Mobile Heavy Equipment Mechanics, Except Engines" (49-3042), and "Maintenance Workers, Machinery" (49-9043).

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most industrial machinery mechanics are employed by wholesalers of durable goods, **1,290 industrial machinery mechanics** were employed in the repair and maintenance industry in the region in 2017. They accounted for **16 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Merchant Wholesalers (Durable Goods)
- Repair and Maintenance
- Aerospace Products and Parts Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

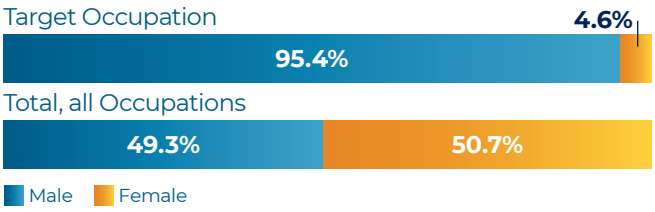
- **2,460** Total Openings (5-yr)
- **1,250** Total Mfg. Openings (5-Tr)
- **0.6** Location Quotient

Total Jobs in LA
5,880
in 2017

Total Jobs in OC
2,130
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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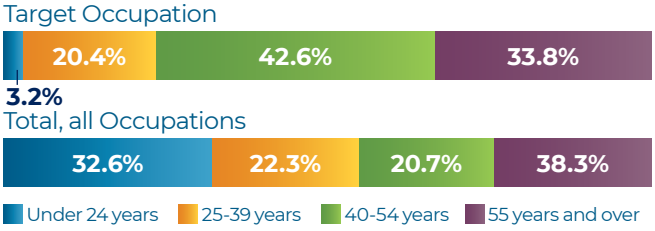
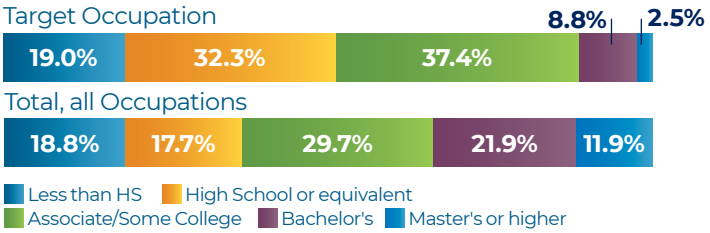
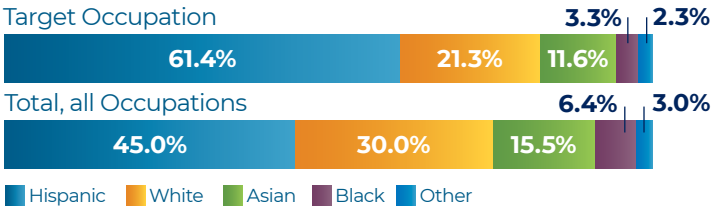


EDUCATIONAL ATTAINMENT



RACE AND ETHNICITY



Manufacturing Industry Forecasts

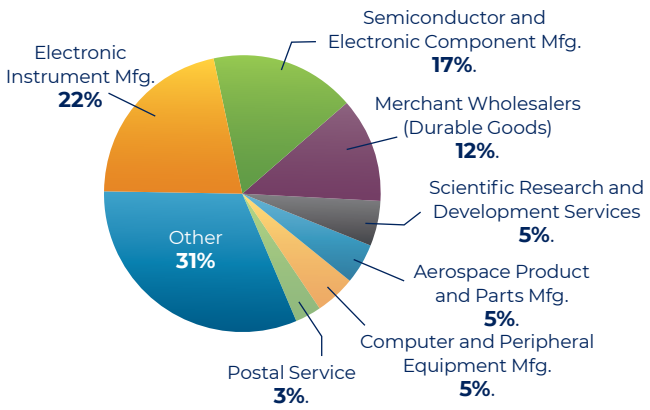
Electrical and Electronics Engineering Technicians (SOC 17-3023)

Apply electrical and electronic theory and related knowledge, usually under the direction of engineering staff, to design, build, repair, calibrate, and modify electrical components, circuitry, controls, and machinery for subsequent evaluation and use by engineering staff in making engineering design decisions. Excludes "Broadcast Technicians" (27-4012).

Hourly Wages

*MIT Living Wage Calculator

Industry Distribution



Most electrical and electronics engineering technicians are employed in electronic instrument manufacturing, **890 electrical and electronics engineering technicians** were employed in the semiconductor and electronic component manufacturing industry in the region in 2017. They accounted for **17 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Electronic Instrument Manufacturing
- Semiconductor and Electronic Component Mfg
- Merchant Wholesalers (Durable Goods)

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

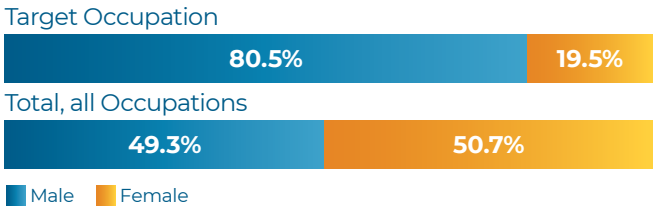
- **1,710** Total Openings (5-yr)
- **1,000** Total Mfg. Openings (5-Tr)
- **1.2** Location Quotient

Total Jobs in LA
3,360
in 2017

Total Jobs in OC
2,330
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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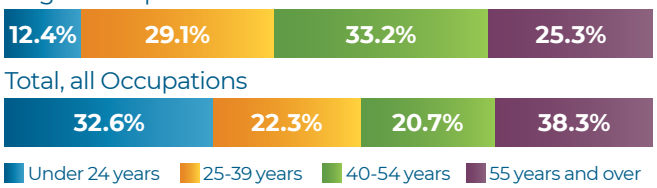
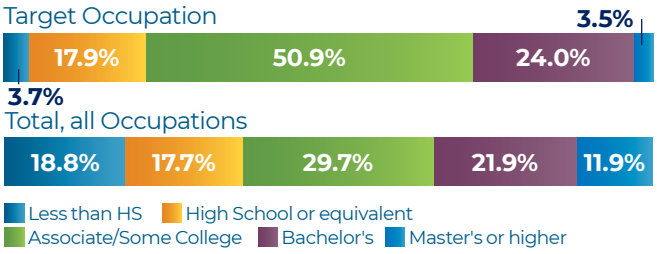
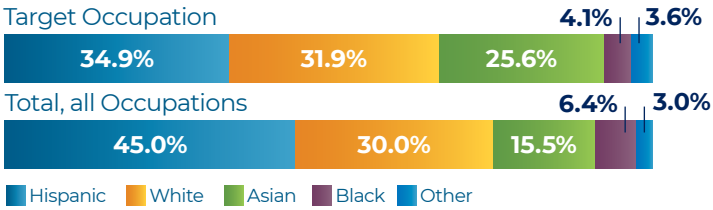


EDUCATIONAL ATTAINMENT



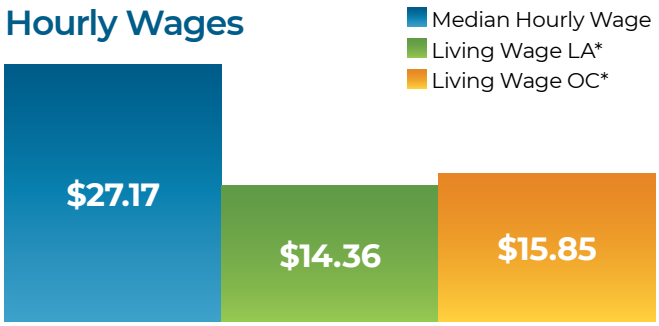
RACE AND ETHNICITY



Computer-Controlled Machine Tool Programmers (SOC 51-4012)

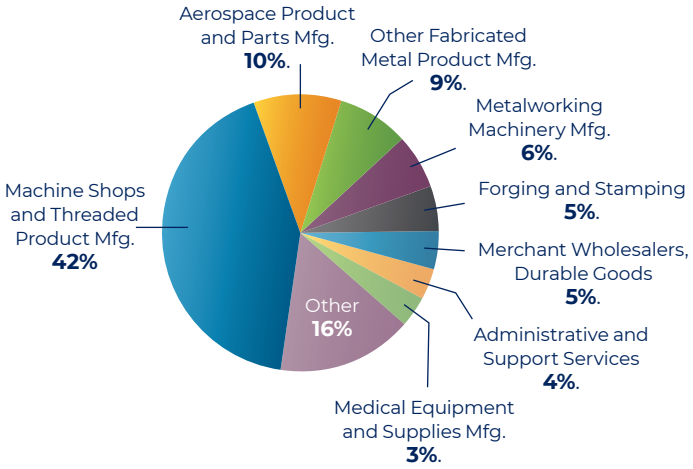
Develop programs to control machining or processing of metal or plastic parts by automatic machine tools, equipment, or systems.

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most computer-controlled machine tool programmers are employed in machine shops, **120 computer-controlled machine tool programmers** were employed in the aerospace industry in the region in 2017. They accounted for **10 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Machine Shops and Threaded Product Manufacturing
- Aerospace Products and Parts Manufacturing
- Other Fabricated Metal Product Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

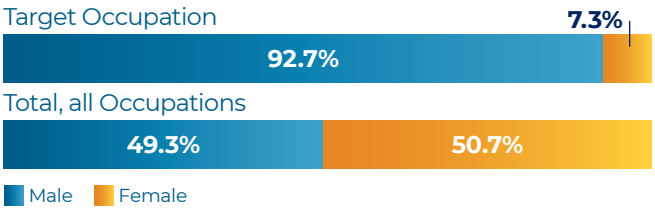
- **530** Total Openings (5-yr)
- **490** Total Mfg. Openings (5-Tr)
- **1.4** Location Quotient

Total Jobs in LA
700
in 2017

Total Jobs in OC
520
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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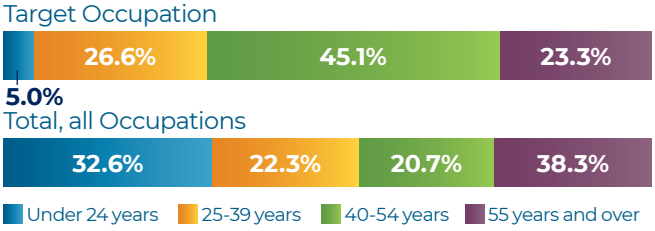
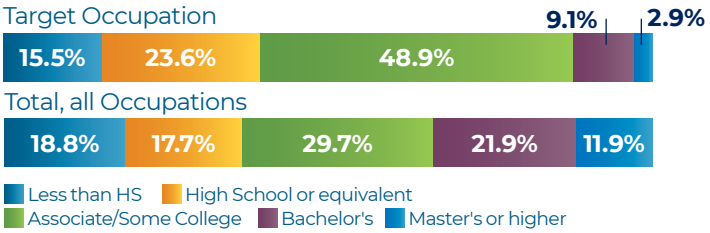
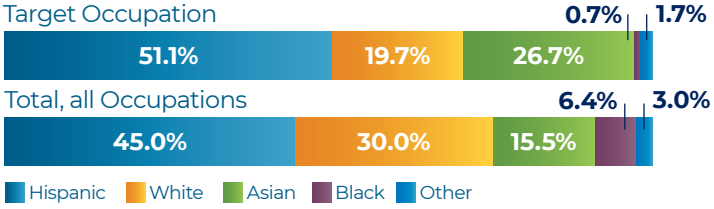


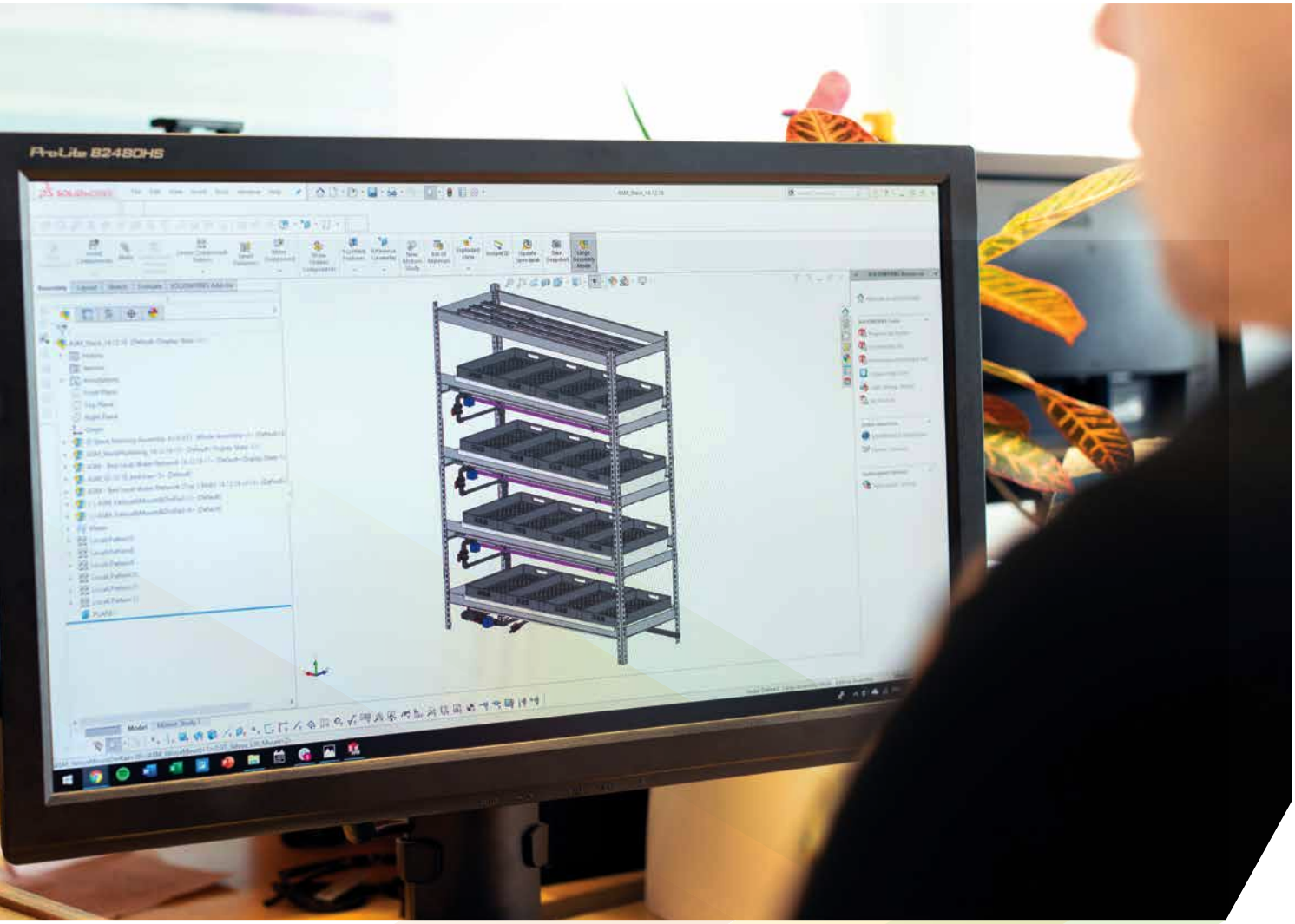
EDUCATIONAL ATTAINMENT



RACE AND ETHNICITY



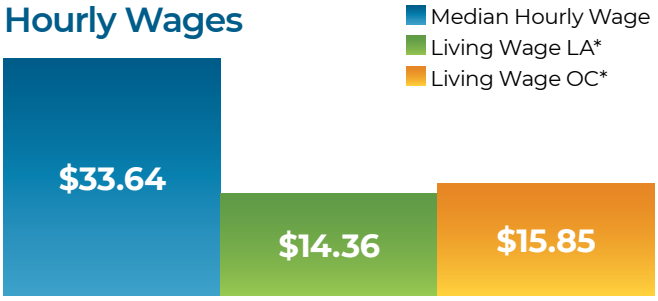
Manufacturing Industry Forecasts



Industrial Engineering Technicians (SOC 17-3026)

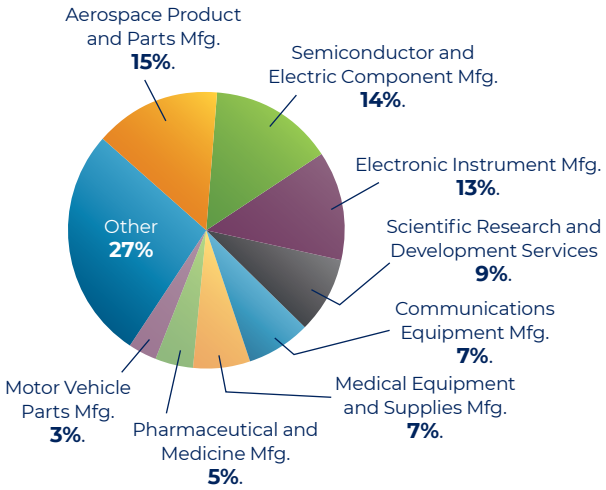
Apply engineering theory and principles to problems of industrial layout or manufacturing production, usually under the direction of engineering staff. May perform time and motion studies on worker operations in a variety of industries for purposes such as establishing standard production rates or improving efficiency.

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most industrial engineering technicians are employed in aerospace products and parts manufacturing, **180 industrial engineering technicians** were employed in the semiconductor and electric component manufacturing industry in the region in 2017. They accounted for **14 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Aerospace Product and Parts Manufacturing
- Semiconductor and Electric Component Mfg.
- Electronic Instrument Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

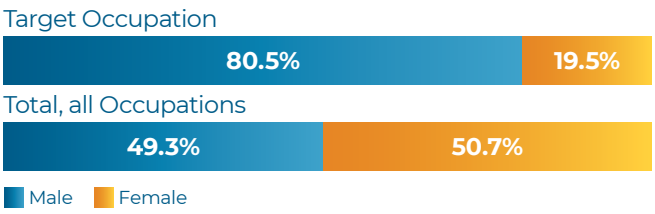
- **410** Total Openings (5-yr)
- **340** Total Mfg. Openings (5-Tr)
- **0.5** Location Quotient

Total Jobs in LA
870
in 2017

Total Jobs in OC
450
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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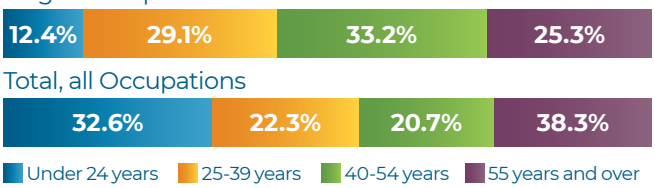
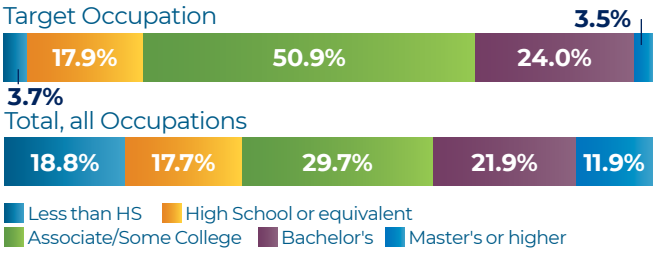
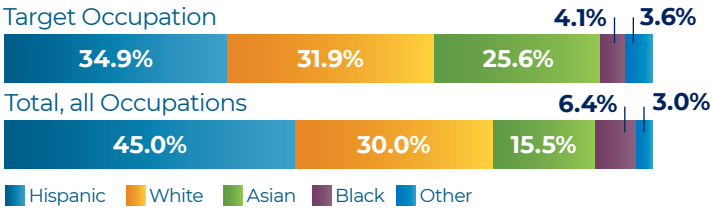


EDUCATIONAL ATTAINMENT



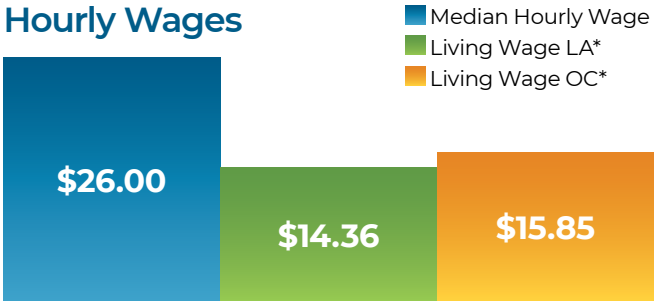
RACE AND ETHNICITY



Electrical & Electronics Repairers, Commercial (SOC 49-2094)

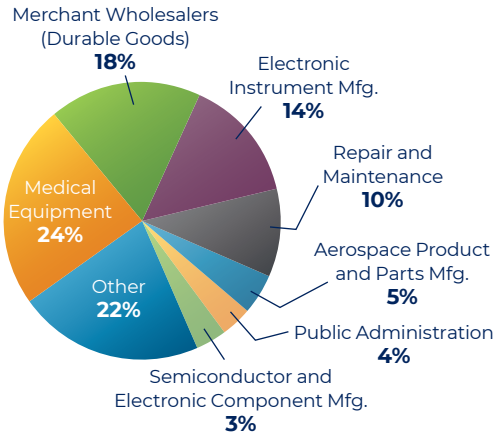
Repair, test, adjust, or install electronic equipment, such as industrial controls, transmitters, and antennas. Excludes "Avionics Technicians" (49-2091), "Electronic Equipment Installers and Repairers, Motor Vehicles" (49-2096), and "Electrical and Electronics Installers and Repairers, Transportation Equipment" (49-2093).

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most electrical and electronics repairers are employed in medical equipment and supplies manufacturing, **380 electrical and electronics repairers** were employed in the wholesale of durable goods industry in the region in 2017. They accounted for **18 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Medical Equipment and Supplies Manufacturing
- Merchant Wholesalers (Durable Goods)
- Electronic Instrument Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

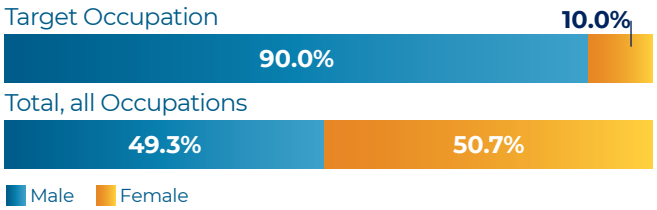
- **630** Total Openings (5-yr)
- **330** Total Mfg. Openings (5-Tr)
- **1.0** Location Quotient

Total Jobs in LA
1,080
in 2017

Total Jobs in OC
1,030
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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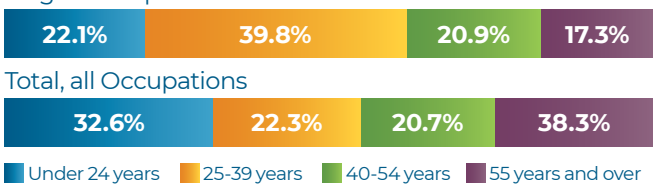
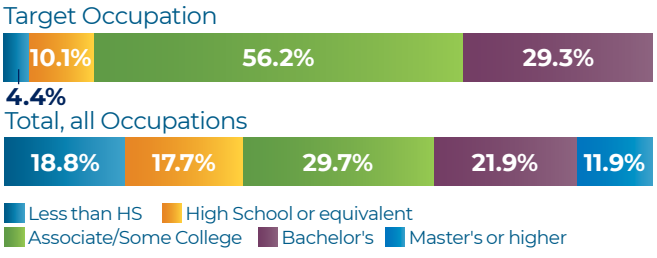
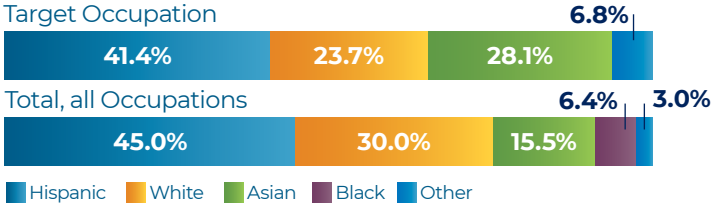


EDUCATIONAL ATTAINMENT



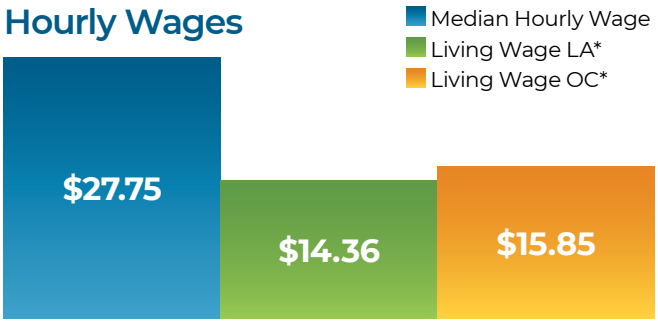
RACE AND ETHNICITY



Mechanical Drafters (SOC 17-3013)

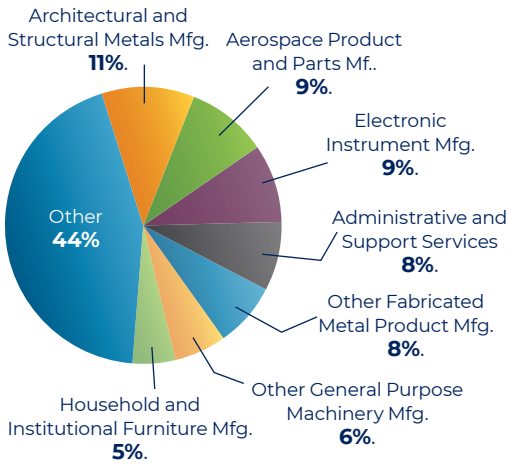
Prepare detailed working diagrams of machinery and mechanical devices, including dimensions, fastening methods, and other engineering information.

Hourly Wages



*MIT Living Wage Calculator

Industry Distribution



Most mechanical drafters are employed in architectural and structural metals manufacturing, **120 mechanical drafters** were employed in the aerospace industry in the region in 2017. They accounted for **9 percent** of employment in this occupation across all industries.

Top three industry subsectors employing this occupation:

- Architectural and Structural Metals Manufacturing
- Aerospace Product and Parts Manufacturing
- Electronic Instrument Manufacturing

Industry Deep Dive

TOTAL PROJECTED OPENINGS 2022:

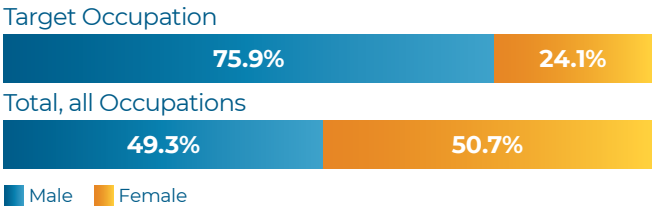
- **440** Total Openings (5-yr)
- **320** Total Mfg. Openings (5-Tr)
- **0.6** Location Quotient

Total Jobs in LA
840
in 2017

Total Jobs in OC
570
in 2017

Regional Worker Characteristics in LA/OC in 2017

GENDER



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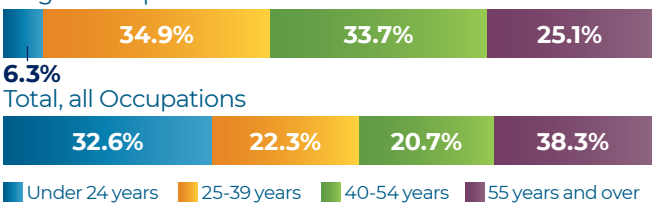
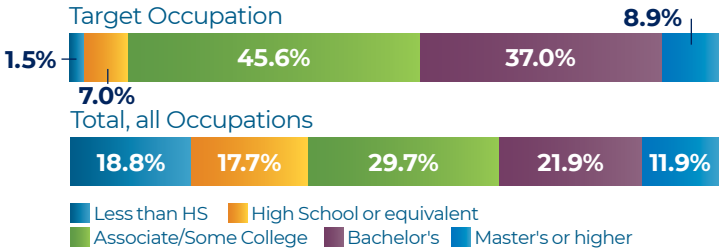
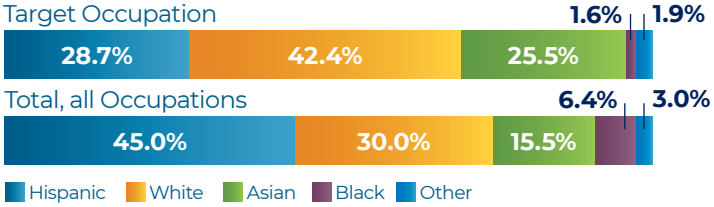


EDUCATIONAL ATTAINMENT



RACE AND ETHNICITY



Appendix

Community College Programs

Appendix A: Regional Community College Completions (certificates and associate degrees) by Program (2017-18)

Aeronautical and Aviation Technology-0950.00 Program has historically trained for aerospace engineering and operations technicians			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Long Beach	1	-	1
Mt San Antonio	8	-	8
Orange Coast	8	28	36
West LA	7	-	7
Total	**24**	**28**	**52**

Computer Electronics-0934.10 Program has historically trained for electrical and electronics engineering technicians; and electrical and electronics repairers, commercial and industrial equipment			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
East LA	-	50	50
El Camino	8	5	13
LA City	1	-	1
LA Trade	5	6	11
LA Valley	-	1	1
Mt San Antonio	-	10	10
Orange Coast	-	7	7
Saddleback	6	12	18
Total	**20**	**91**	**111**

Appendix

Drafting Technology-0953.00 Program has historically trained for mechanical drafters			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Cerritos	12	36	48
Citrus	2	4	6
East LA	2	36	38
El Camino	10	5	15
Fullerton	8	3	11
Golden West	4	14	18
LA Harbor	1	-	1
LA Pierce	4	3	7
LA Valley	-	4	4
Mt San Antonio	6	28	34
Pasadena	1	20	21
Rio Hondo	5	88	93
Saddleback	1	1	2
Santa Ana	6	17	23
Total	**62**	**259**	**321**

Electrical Systems and Power Transmission-0934.40 Program has historically trained for electrical and electronics engineering technicians			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
LA Trade	-	1	1
Santiago Canyon	-	3	3
Total	**-**	**4**	**4**

Electronics and Electric Technology-0934.00 Program has historically trained for electrical and electronics engineering technicians; and electrical and electronics repairers, commercial and industrial equipment			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Coastline	95	-	95
East LA	-	15	15
El Camino	3	8	11
Glendale	3	1	4
Irvine	5	15	20
LA Pierce	3	11	14
LA Southwest	2	-	2
LA Valley	3	12	15
Long Beach	17	29	46
Mt San Antonio	21	33	54
Orange Coast	4	7	11
Pasadena	7	24	31
Saddleback	2	7	9
Santa Ana	2	6	8
Total	**167**	**168**	**335**

Engineering Technology, General (requires Trigonometry)-0924.00 Program has historically trained for electrical and electronics engineering technicians; and industrial engineering technicians			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Cerritos	-	23	23
Glendale	-	17	17
Pasadena	173	-	173
Santa Ana	1	-	1
Total	**174**	**40**	**214**

Appendix

Industrial Electronics-0934.20 Program has historically trained for electrical and electronics engineering technicians; and industrial engineering technicians; and electrical and electronics repairers, commercial and industrial equipment			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
El Camino	-	1	1
Total	**-**	**1**	**1**

Industrial Systems Technology and Maintenance-0945.00 Program has historically trained for electrical and electronics repairers, commercial and industrial equipment; and industrial machinery mechanics			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Fullerton	2	-	2
LA Harbor	1	-	1
LA Trade	3	91	94
Long Beach	1	-	1
Santiago Canyon	6	-	6
Total	**13**	**91**	**104**

Machining and Machine Tools-0956.30 Program has historically trained for computer-controlled machine tool operators, metal and plastic; and machinists			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Cerritos	7	31	38
Compton	1	-	1
El Camino	14	18	32
Fullerton	-	9	9
LA Pierce	7	3	10
LA Trade	6	11	17
LA Valley	-	3	3
Orange Coast	10	82	92
Santa Ana	11	67	78
Total	**56**	**224**	**280**

Manufacturing and Industrial Technology-0956.00 Program has historically trained for industrial engineering technicians; electrical and electronics repairers, commercial and industrial equipment; industrial machinery mechanics; computer-controlled machine tool operators, metal and plastic; computer numerically controlled machine tool programmers, metal and plastic; and machinists			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Cerritos	1	5	6
Compton	1	1	2
El Camino	2	1	3
Fullerton	11	-	11
Irvine	-	1	1
LA Valley	-	2	2
Mt San Antonio	5	4	9
Saddleback	3	6	9
Santa Ana	1	-	1
Total	**24**	**20**	**44**

Appendix

Mechanical Drafting-0953.40 Program has historically trained for mechanical drafters			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
LA Valley	3	5	8
Long Beach	6	-	6
Total	**9**	**5**	**14**
Other Engineering and Related Industrial Technologies-0999.00 Program has historically trained for industrial engineering technicians			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Coastline	8	41	49
LA Trade	7	10	17
Total	**15**	**51**	**66**
Welding Technology-0956.50 Program has historically trained for welders, cutters, solderers, and brazers			
College	**# of Associate Degrees, 2017- 18**	**# of Certificates, 2017-18**	**Total Awards**
Cerritos	16	69	85
Compton	2	3	5
El Camino	10	15	25
Fullerton	-	10	10
LA Trade	9	18	27
Mt San Antonio	5	10	15
Orange Coast	4	3	7
Pasadena	1	1	2
Rio Hondo	18	-	18
Santa Ana	8	16	24
Total	**73**	**145**	**218**

How (and why) we did what we did.

Numerous data sources and methodologies were used to measure the target industry for this industry report.

Industry Forecast

An economic forecast is created to project employment by industry over the next five years using statistical analysis of historical data paired with the most recent qualitative information impacting a set of 151 industries in the Los Angeles Basin. The industries configured for this forecast are defined through the North American Industry Classification System (NAICS) and comprise industries denoted with 2-digit, 3-digit and 4-digit codes through the NAICS hierarchical classification system. A key input for the regional forecast is projected population growth in Los Angeles and Orange counties, provided by the California Department of Finance. State and national trends concerning production methods, consumer behavior, construction and property values that correspond to each industry are a few of the inputs used for the economic forecast model.

Occupations and Projections

Occupations are commonly classified using the Standard Occupational Classification (SOC) system, developed by the Bureau of Labor Statistics. This system classifies workers into 840 detailed occupations that share similar job duties, skills, education and training. These occupations are not industry-specific, but are common to many industries. For example, retail salespersons are employed in a full spectrum of industries, from department and discount stores to computer systems design.

The economic forecast for employment by industry is used to guide a projection of net new jobs for each occupation, calculated by applying the industry occupational composition to the detailed industry employment forecast; occupational forecasts are aggregated across industries.

The United States Census Bureau estimates replacement needs by industry and occupation through detailed surveys of employers and households. These take into account industry changes, the age of the current workforce within each industry and occupation, and the nature of the career path. These estimates are an important component of occupational job openings and workforce development needs, since the retirement and promotion of individuals leave openings for new entrants and those moving up the career ladder.

Total openings are the sum of projected five-year replacement needs and positive net new jobs forecast over the period.

Target Occupations

Target occupations are selected in a two-step process. First, all occupations identified as middle-skill are isolated from each industry. Then, a variety of metrics are used to select target occupations: 2017 employment; projected net job change; replacement rate; number of projected replacement jobs from 2017 to 2022; number of projected total job openings from 2017 to 2022; and annual median wages.

Location Quotient

A common metric to assess a region's competitiveness is employment concentration or location quotients. A location quotient for an industry in a specific region compares the percent of total employment in the industry to the average percent nationwide. For example, if 4 percent of employment in a region is in the aerospace industry compared to 2 percent across the nation, the location quotient for the region's aerospace industry is 2, indicating the region is more specialized in aerospace than the nation.

A location quotient equal to 1.0 indicates the employment concentration in the region is equal to the nation, meaning the region is not highly-specialized in that industry. Higher location quotients imply a competitive advantage. While there can be some variation in this metric, the location quotient threshold of 1.2 usually demonstrates regional specialization and competitiveness.

Supply

Community colleges provide education and training relevant to middle-skill occupations. Comparing occupations with related training programs provides information for supply-and-demand analysis. Community college completion data is provided for the following academic years: 2015-2016, 2016-2017, and 2017-2018, with the latter reflecting the most recent and complete year available.

Appendix

Economic Impact and Contribution Analysis

Economic contribution analysis is used to estimate the portion of a region's economic activity that can be attributed to an existing industry sector, including the expenditure of money for goods and services from regional vendors. These purchases circulate throughout the regional economy.

The health care services industries spend billions of dollars every year on wages and benefits for employees and contingent workers. These workers, as well as the employees of all suppliers, spend a portion of their incomes on groceries, rent, vehicle expenses, health care, entertainment, and so on. This recirculation of household earnings multiplies the initial industry spending through indirect and induced effects.

The extent to which the initial expenditures multiply is estimated using economic models that depict the relationships between industries (such as hospitals and its suppliers) and among different economic agents (such as industries and their employees). These models are built upon data of expenditure patterns reported to the Bureau of Labor Statistics, U.S. Census Bureau and Bureau of Economic Analysis of the U.S. Department of Commerce. Data is regionalized to reflect local conditions such as wage rates, commuting patterns, and resource availability and costs.

The magnitude of the multiplying effect differs from one region to another depending on the extent to which the local region can fill the demand for all rounds of supplying needs. For example, the automobile manufacturing industry has high multipliers in Detroit and Indiana since these regions have deep supplier networks, while the same industry multiplier in Phoenix is quite small. In another example, the jobs multiplier for the construction industry is higher in, say, Arkansas, than in California because a given amount of spending will purchase fewer workers in Los Angeles than in Little Rock.

Multipliers also differ from year to year as relative material and labor costs change and as the production "recipe" of industries change. For example, the IT revolution significantly reduced the job multiplier of many industries (such as manufacturing, accounting and publishing) as computers replaced administrative and production workers.

The metrics used to determine the value of the economic contribution are employment, labor income, value-added and the value of output. Employment includes full-time, part-time, permanent and seasonal employees and the self-employed, and is measured on a job-count basis regardless of the number of hours worked. Labor income includes all income received by both payroll employees and the self-employed, including wages and benefits such as health insurance and pension plan contributions. Value-added is the measure of the contribution to GDP made by the industry, and consists of compensation of employees, taxes on production and gross operating surplus (otherwise known as profit). Output is the value of the goods and services produced. For most industries, this is simply the revenues generated through sales; for others, such as retail, output is the value of the services supplied.

Estimates are developed using software and data from IMPLAN Group, LLC which traces inter-industry transactions resulting from an increase in demand in a given region. The economic region of interest in this document is the Los Angeles

Basin. The activity is reported for 2017, the most recent year for which a complete set of data is available. Estimates for labor income and output are expressed in 2017 dollars to maintain consistency with the reported industry activity.

The total estimated economic contribution includes direct, indirect and induced effects. Direct activity includes materials purchased and employees hired by the industry itself. Indirect effects are those which stem from employment and business revenues resulting

from purchases made by the industry and any of its suppliers. Induced effects are those generated by household spending of employees whose wages are sustained by both direct and indirect spending.

Contribution analysis differs from economic impact analysis in that linkages between the individual component industries are removed, so that indirect activity is not double counted as part of direct activity. For example, firms in the aerospace industry purchase supplies from smaller manufacturers of aerospace parts, which would then be included as both direct revenue of the parts supplier and as an expense of the aerospace industry, resulting in a double counting of overall revenue. Breaking these inter-industry linkages eliminates this double-counting and is a more accurate method of estimating the economic contribution of the industry cluster.

Data Sources

All data was obtained from the Bureau of Labor Statistics and the Census Bureau. Annual employment and payroll data are from the Quarterly Census of Employment and Wages series. Estimates for non-disclosed employment and payroll data were produced using proportional shares of the prior year's data or using midpoint estimates from the Census Bureau's County Business Patterns dataset. Occupational data are from the Occupational Employment Statistics program. Unless noted otherwise, all data is for the 2017 calendar year.

Supply Chain and Output Analysis

Composition of gross output is a metric tracked by the BEA at the state level. It is assumed that the proportion attributable to each component of this metric at the county level is comparable to that at the state level. This seems reasonable given the size of the Los Angeles Basin and its economic activity in the state. Estimates of regional purchases of intermediate goods and services are produced using econometric models by the IMPLAN Group, LLC.

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