



Advanced Manufacturing

LABOR MARKET ANALYSIS
SAN DIEGO COUNTY

October 2014



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Foreword: Vision for San Diego

I am pleased to share with you the Advanced Manufacturing: Labor Market Analysis report. The report is one in a series of five published this year. We identified five regional high-priority sectors for an in-depth assessment of employer needs: Advanced Manufacturing, Life Sciences, Information and Communication Technologies, Clean Energy and Health Care.

San Diego's robust Advanced Manufacturing sector employs more than 169,000 workers and produces 23 percent of the region's Gross Regional Product. Its projected rapid employment growth and opportunities for on-the-job training, combined with reported current and future skills shortage, placed Advanced Manufacturing on our list of San Diego's top five priority sectors.

Our findings are a result of a collaboration with the San Diego and Imperial Counties Community Colleges Association (SDICCCA). These reports represent the first step in cooperative, sector-based strategies for workforce development in our region. Together, the San Diego Workforce Partnership (SDWP) and SDICCCA conducted online surveys, in-person interviews and focus groups of regional employers from the Advanced Manufacturing sector. We delved deep, asking questions that would give us insight into the jobs that can be filled with an associate degree or short-term training. Our findings and recommendations paint a picture of where we are and where we should be headed in our workforce planning.

With nearly 1.6 million people in the regional workforce, it is important for us to continuously review the state of our industries and identify job potential for our burgeoning workforce. We need to inform the unemployed, the underemployed and the yet-to-be-employed of which careers will provide an upward trajectory and meet the needs of our regional employers. SDWP is committed to funding research and job training programs that will ensure every business in our region has access to a skilled workforce and every job seeker has access to meaningful employment.

Together we will build our region's skilled and prosperous workforce.



A handwritten signature in black ink, appearing to read 'Peter Callstrom', written in a cursive style.

Peter Callstrom, President and CEO
San Diego Workforce Partnership



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EXECUTIVE SUMMARY

The Advanced Manufacturing sector in San Diego County is comprised of many diverse industries, including electronics, aerospace, fabrication metals, biotechnology and more. Manufacturing careers today demand high-tech skills in computers, robotics and information technologies. Advanced Manufacturing is slated to grow by 9,903 jobs (6 percent) from 2013 to 2018, and will continue to add employment to the region due to governmental economic and workforce initiatives.

In May 2014, the federal government designated San Diego (as part of a Southern California consortium) as an official Manufacturing Community in the Investing in Manufacturing Communities Partnership (IMCP). This designation enables the region to access federal funding for workforce development, economic development, capital access, research and innovation, and infrastructure and site development.¹ As the sector and its employment opportunities grow, San Diego's workforce development system will need to develop sector-based strategies to meet the needs of employers. This report is a product of a regional, workforce collaboration to address these labor market issues.

This study documents the growing employment opportunities in the San Diego region for Advanced Manufacturing and features data and analysis of 21,354 online job postings, 241 employer survey responses, 26 executive interviews, employment statistics and focus groups of educational and training providers and employers. This research provides a detailed understanding of job growth, training gaps, hiring challenges and in-demand skills for Advanced Manufacturing firms, and serves to inform resource management and strategic planning for the workforce development system, which includes educational training institutions, Workforce Investment Boards and community workforce development organizations.

Four main occupational clusters of Advanced Manufacturing were analyzed for this report: production, engineering, computer/software, and drafting and technician. Of these clusters, production occupations are expected to have the greatest absolute growth with more than 3,000 jobs added to the region between 2013 and 2018. Drafting and technician occupations are expected to grow at the fastest rate of 19 percent during this period. Engineering occupations will be the most difficult for employers to fill, particularly by smaller employers that require specific skill sets. There is an increasing need for mechatronics—a new interdisciplinary field combining mechanical, electrical, telecommunications, control, and computer engineering. Correspondingly, of the employers that employ electro-mechanical technicians, 83 percent have difficulty in finding qualified workers.

This study also identifies the specific actions employers and educators need to take in order to ensure that San Diego has the skills and knowledge required to maintain and grow this high value-added sector. While education and training institutions in San Diego have the capability to train future workers for this industry sector, the majority of employers reported having difficulty finding qualified workers for each of the occupational clusters. Most employers have difficulty finding qualified candidates for computer numerically controlled machine tool programmers, mechanical engineers and machinists. Some suggested strategies include incorporating Project Based Learning (PBL) methods, internships and apprenticeships into workforce training as well as standardizing certifications and articulation agreements to increase job and training mobility for Advanced Manufacturing workers. The recommendations in this study play a crucial role in the development of a robust manufacturing workforce.

¹ eda.gov/challenges/imcp.

INTRODUCTION

Historically, manufacturing has been an economic driver and pivotal to the creation of a vibrant middle class. While some manufacturers have depended on outsourcing due to foreign competition, others have chosen to prioritize domestic operations, relying on process improvement techniques, incorporation of new technologies and materials, quality management systems and intelligent marketing to remain competitive. This commitment to innovation redefined this industry sector to **Advanced Manufacturing** in recent years. Popular perceptions of manufacturing jobs as dark, dangerous and dirty are largely outdated, as advanced robotics and other “intelligent” systems have dominated the manufacturing process. As manufacturers continue to evolve, so do the requirements placed on their workforce. This sector’s sustainability and potential for growth and well-paying jobs for San Diegans in the years ahead depend on a significant commitment from employers and educators. A commitment to train and develop skills of new and existing workers is required by advances in manufacturing processes and practices.

In order to better understand the labor market landscape and workforce needs of San Diego’s Advanced Manufacturing employers, the San Diego Workforce Partnership (SDWP) collaborated with the California Community Colleges Center of Excellence for Labor Market Research, San Diego-Imperial Region (COE) and the San Diego & Imperial Counties Community Colleges Association (SDICCCA) to conduct this study. Advanced Manufacturing was chosen for in-depth research as one of the five priority sectors that SDWP and SDICCCA share. The research will be used for sector-based workforce development strategies and allocation of resources. This report, commissioned by SDWP with UCSD Extension and the East County Economic Development Council (ECEDC), collected data from surveys of 241 employers and in-person interviews with 26 manufacturing employers that use any of the following processes and technologies in their operations:

- Computer technologies (e.g. Computer-Aided Design/Computer-Aided Manufacturing)
- High-precision technologies
- Robotics, automation, sustainable technologies
- Information technologies
- Nanotechnology
- Lean production processes
- Cutting-edge materials

Advanced Manufacturing Initiatives

The White House has \$135 billion for research and development activities in its 2015 fiscal year budget. For the Advanced Manufacturing sector, this funding promotes “the development and scaling of new advanced manufacturing technologies,” as well as helps “smaller manufacturers adopt new technologies to increase their competitiveness, and accelerate the transfer of new technologies from federal labs to industry.”* Further, President Obama has called for the creation of a manufacturing innovation network—collaboration among private industry, universities and community colleges, and the government—“to co-invest in the development of world-leading manufacturing technologies and capabilities that U.S.-based manufacturers can apply in production” so that the U.S. can compete more effectively in the global market.*

On May 28, 2014, U.S. Secretary of Commerce Penny Pritzker announced that San Diego is part of 12 “Manufacturing Communities.” Through the Investing in Manufacturing Communities Partnership (IMCP) initiative, the federal government provides resources to support these communities that demonstrate best practices in strengthening their Advanced Manufacturing sectors.

With this much investment and resources in Advanced Manufacturing, San Diego County would benefit from targeted, sector-based strategies to grow its future Advanced Manufacturing workforce.

*whitehouse.gov/sites/default/files/omb/budget/fy2015/assets/fact_sheets/investing-in-american-innovation.pdf

The North American Industry Classification System (NAICS) codes² used in this study to define Advanced Manufacturing include traditional manufacturing codes (NAICS 31-33) and codes from the San Diego Association of Governments (SANDAG) industry cluster analysis.³ Occupations that were most commonly employed in the Advanced Manufacturing sector were derived from Standard Occupational Classification (SOC) codes⁴ and grouped into four occupational clusters, which are the focus of this report:

1. Production
 - Installation, maintenance and repair
 - Food processing
 - Inspectors, testers, sorters, samplers and weighers
2. Engineering
 - Computer hardware engineers
 - Electrical engineers
 - Mechanical engineers
3. Computer/software
 - Software developers, applications
 - Software developers, systems software
 - Computer user support specialists
4. Drafting and technician
 - Chemical technicians
 - Engineering technicians, except drafters (all other)
 - Environmental science and protection technicians, including health

This report provides a detailed analysis of Advanced Manufacturing employment in San Diego County and four occupational clusters based on a countywide employer survey conducted by UCSD and ECEDC.⁵ The report features data and analysis from employer survey responses, employment statistics, online job postings and focus groups. The research methodology for this study can be found in Appendix C. The resulting research provides a better understanding of job growth, skills in demand, and hiring challenges for Advanced Manufacturing firms. This report also identifies the specific actions employers and educators need to take in order to ensure that San Diego has employees with skills and knowledge required to maintain and grow this high value-added sector.

INDUSTRY SECTOR OVERVIEW

San Diego County's robust Advanced Manufacturing sector includes diverse industries such as aerospace, maritime, clean technology, biomedical devices and products, pharmaceuticals, sporting goods, beverage and precision manufacturing. The region's Advanced Manufacturing sector had

Traditional Manufacturing versus Advanced Manufacturing NAICS Codes

This report expands the traditional definition of manufacturing NAICS codes 31-33 as defined by the U.S. Bureau of Labor Statistics, and includes data from the telecommunications, biomedical device and clean technology manufacturing industries. However, according to traditional manufacturing NAICS codes 31-33, San Diego County had 2,898 establishments and employed just over 99,000 workers in 2012. Additionally, the GRP was \$12.5 billion in 2007 and increased to \$13.4 billion in 2009 before declining to \$13 billion in 2010. Since then, traditional manufacturing GRP increased to \$15.1 billion in 2012.

² North American Industry Classification System (NAICS) is a coding standard used by federal agencies to collect and disseminate data related to the economy and employment. The full list of NAICS used in this study can be found in Appendix B.

³ SANDAG Info: Traded Industry Clusters in the San Diego Region, 2012. sandiegocitd.org/sites/default/files/Traded_Clusters_Report.pdf.

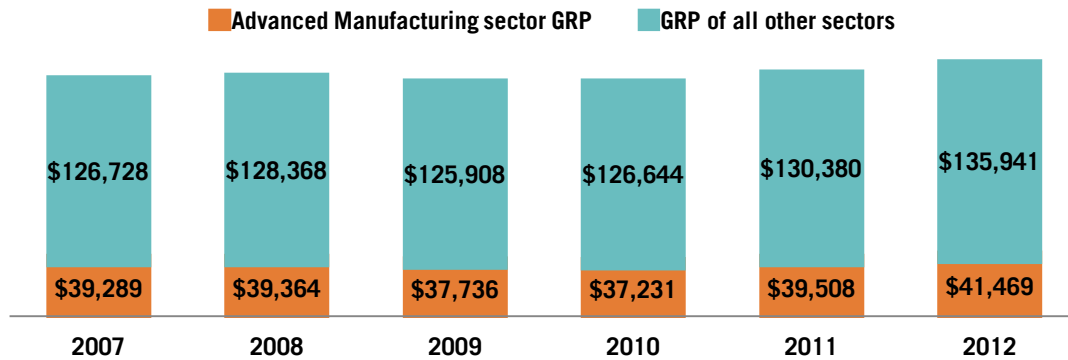
⁴ The Standard Occupational Classification (SOC) is a system used by federal agencies to categorize occupations for data collection and dissemination purposes. For a list of all SOC codes analyzed, view Appendix B.

⁵ For the complete survey, see Appendix J.

7,578 establishments and more than 169,000 workers in 2012.⁶

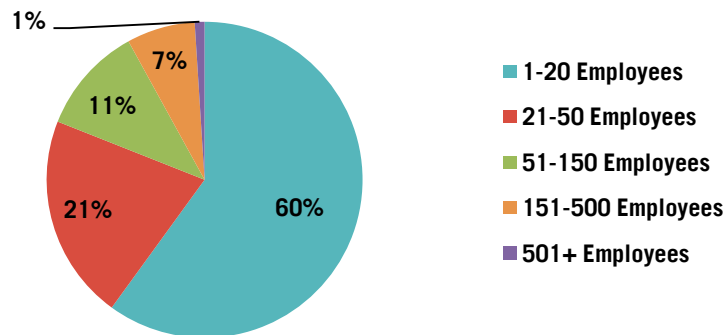
This sector accounted for 10 percent of all establishments, 15 percent of all paid employment and 22 percent (\$13 billion) of annual payroll in San Diego County.⁷ Advanced Manufacturing Gross Regional Product (GRP) consistently made up nearly 23 percent of San Diego County’s GRP from 2007 to 2012 (Figure 1).⁸

Figure 1: San Diego County Gross Regional Product (in millions)



The sector is dominated by small- to medium-sized businesses with the majority of Advanced Manufacturing firms surveyed employing 20 workers or less (60 percent). Only 1 percent of survey respondents employ more than 500 workers (Figure 2).⁹

Figure 2: Employer Size by Number of Employees, Percent of Survey Respondents



San Diego’s Advanced Manufacturing sector includes many diverse industries, and no single industry dominates the Advanced Manufacturing sector (Figure 3).¹⁰ Thirteen percent of survey respondents self-

⁶ For a breakdown of employment and establishments in each industry, view Appendix D.

⁷ censtats.census.gov/cgi-bin/msanaic/msasect.pl.

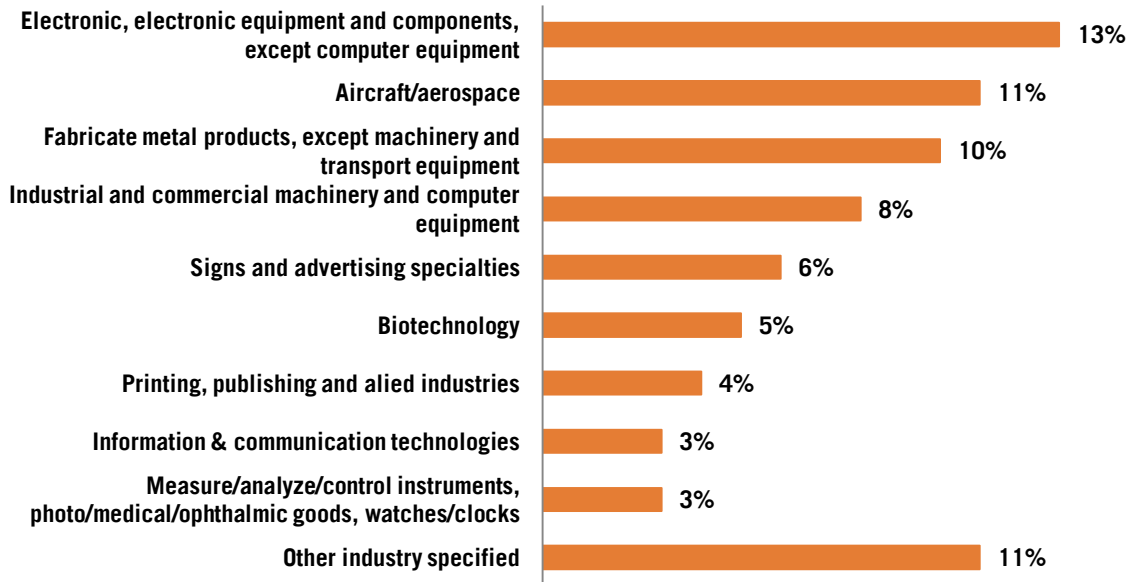
⁸ Gross Regional Product is the value of all goods and services produced in a metropolitan area; Source: U.S. Bureau of Economic Analysis, Regional Data: Gross Regional Product and Personal Income.

⁹ These percentages are based only on **survey respondents** for this study. This chart does not include all Advanced Manufacturing firms in San Diego. Based on U.S. Bureau of Labor Statistics data, the size of all Advanced Manufacturing firms in San Diego by number of employees is broken down as follows: 1-19 employees (82 percent), 20-99 employees (14 percent) and 100+ employees (4 percent).

¹⁰ Figure 3 displays 76 percent of survey respondents that selected industries listed in the survey. The remaining 24 percent of respondents selected a variety of NAICS industry codes, each one totaling 2 percent or less of responses. With the small response rates, the remaining industries were omitted from Figure 3. n = 201. “n” indicates the number of survey respondents.

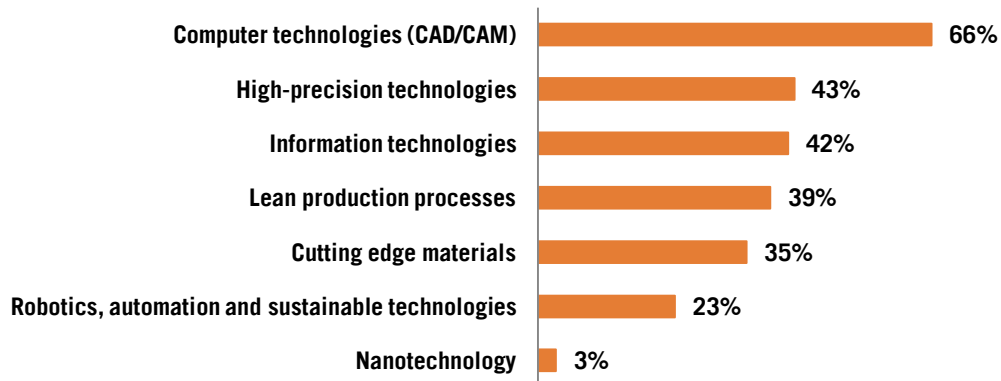
identified their primary business function as "electronic equipment and components." Eleven percent of firms selected "other" and identified their primary business functions as medical equipment, pumps, dental restorations, custom foam inserts, breweries, radio frequency identification, musical instruments and more. Other industries that had a small percentage of respondents were not included.

Figure 3: Top Industry/Business Function of Firms, Percent of Survey Respondents



Employers self-identified as Advanced Manufacturers by indicating that they use at least one advanced process in their operations: 66 percent of respondents use computer technologies (CAD/CAM), 43 percent use high-precision technologies, 42 percent use information technologies and 40 percent employ lean production processes (Figure 4). (Please note that the percentages do not add up to 100 because firms may use multiple advanced processes.)

Figure 4: Advanced Manufacturing Processes Used by Firms, Percent of Survey Respondents



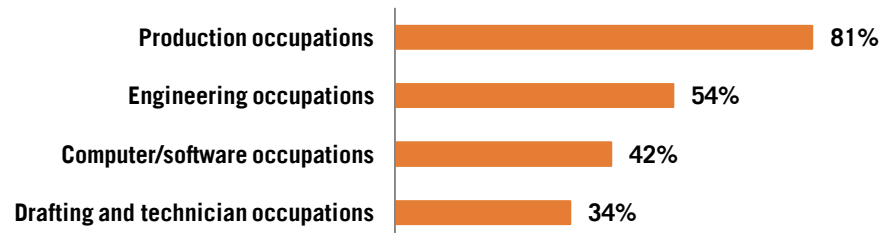
OCCUPATIONAL OVERVIEW

This study highlights four occupational clusters that are most commonly employed by Advanced Manufacturing firms. The top three professions by employment in each cluster are listed below:

1. Production
 - Installation, maintenance and repair
 - Food processing
 - Inspectors, testers, sorters, samplers and weighers
2. Engineering
 - Computer hardware engineers
 - Electrical engineers
 - Mechanical engineers
3. Computer/software
 - Software developers, applications
 - Software developers, systems software
 - Computer user support specialists
4. Drafting and technician
 - Chemical technicians
 - Engineering technicians, except drafters (all other)
 - Environmental science and protection technicians, including health
 - Environmental science and protection technicians, including health

Survey respondents were asked to identify the occupational groups employed within their firms. Most firms employed production occupations, which were followed by engineering, computer/software, and drafting and technician occupations (Figure 5).¹¹ Production occupations dominate the Advanced Manufacturing workforce with 24 to 46 employees in each firm (Table 1).

Figure 5: Percent of Advanced Manufacturing Survey Respondents Employing Occupational Clusters



Technological developments have affected employment patterns in Advanced Manufacturing in recent years. While production occupations (such as machinists and welders) traditionally dominate the Advanced Manufacturing firms, information technology occupations are increasingly significant, with computer and software occupations occupying four to 14 positions in each firm (Table 1).

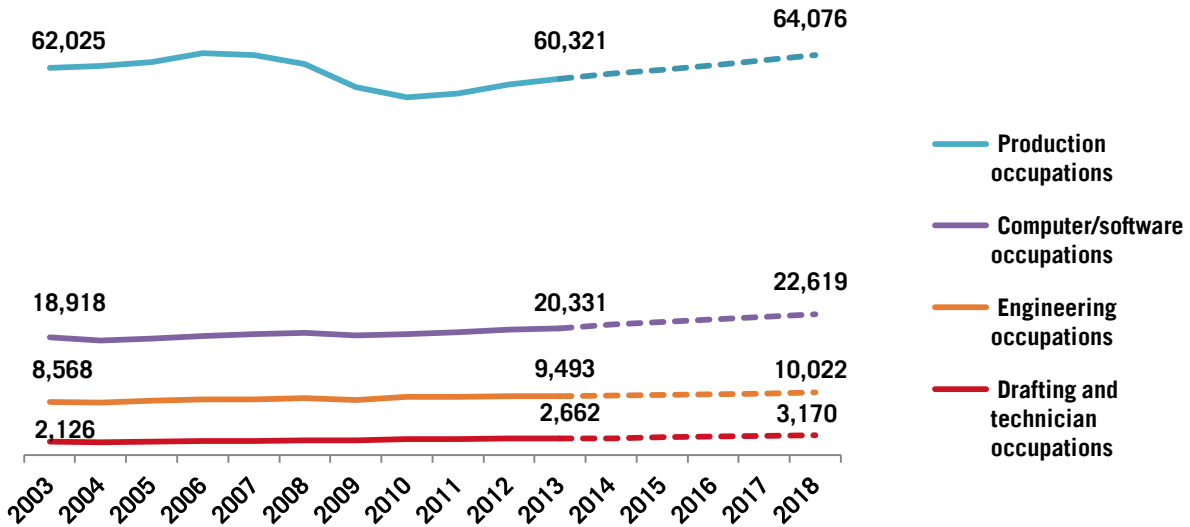
¹¹ Percentages do not add up to 100 because more than one occupational cluster may be employed by each respondent or firm. n = 150. "n" indicates the number of survey respondents.

Table 1: Survey Respondents' Range of Employees by Occupational Cluster

Occupational Cluster	Range of Employment in Each Firm
Computer/software occupations	4-14
Engineering occupations	6-15
Drafting and technician occupations	6-14
Production occupations	24-46

Out of the four occupational clusters analyzed in this study, computer and software occupations are projected to have the second largest employment increase from 2014 to 2018 (Figure 6).¹²

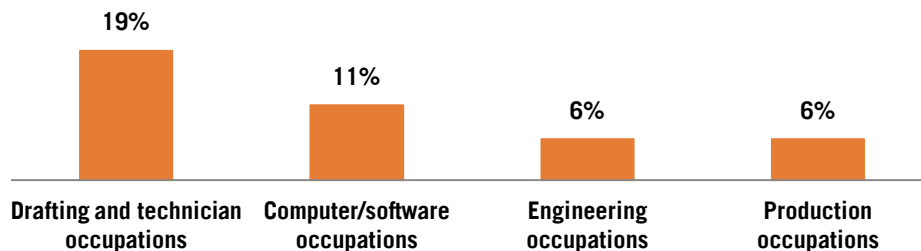
Figure 6: Employment Growth by Occupational Cluster, 2003-2018



Note: Dotted lines indicate projections based on historical data. The projections do not include legislation or external forces that may affect future staffing patterns.

Between 2014 and 2018, production occupations are projected to have the greatest absolute growth of 3,755 jobs added to the region within these five years; however, this occupational cluster lost 1,704 jobs between 2003 and 2013 and was most affected by the recession compared to the other three clusters. Between 2003 and 2013, drafter and technician occupations grew at the fastest rate (25 percent) and are projected to continue growing at the fastest rate (19 percent) between 2014 and 2018 (Figure 7).¹³

Figure 7: Project Employment Growth Rate by Occupational Cluster, 2014-2018



¹² Source: Economic Modeling Specialists International (EMSI), Quarterly Census of Employment and Wages (QCEW) + non-QCEW + self-employment data as of May 2014.

¹³ The 2014-2018 timeframe is projected from the average number of workers that will be added in each of these years after 2013 (or Jan. 1, 2014 to Dec. 31, 2018). The most recent data available for employment is the annual estimate for the year 2013.

As the current Advanced Manufacturing workforce nears retirement age, the need for replacement jobs increases.¹⁴ A talent management study conducted by The Sloan Center on Aging & Work in 2009 indicated that 20 percent of manufacturing companies nationwide had a mean age workplace composition of 55 years or older.¹⁵ San Diego faces a similar issue with a retiring workforce and aging population: By 2018, a significant portion of jobs in each occupational cluster will be replacement jobs (Table 2). Production occupations will have the most replacement needs with 7,698 positions that will open up due to retirement or other attrition.¹⁶

Table 2: Job Growth, Replacement Jobs and Total Openings for Occupational Clusters, 2013-2018

Description	2013 Jobs	2018 Jobs	Change (Job Growth)	Replacement Jobs	Openings ¹⁷ (Job Growth + Replacement Jobs)
Production	86,867	89,823	2,956	10,809	13,765
Engineering	11,580	12,453	873	1,607	2,480
Computer/software	21,797	24,186	2,389	1,616	4,005
Drafting and technician	5,232	6,008	776	674	1,450
Total	125,476	132,470	6,994	14,706	21,700

Between 2014 and 2018, firms are projected to add 6,994 new jobs to these occupational clusters in the region for a total of 132,470 jobs, with over 14,000 replacement jobs also available during this period.

DEMAND, SUPPLY AND GAP ANALYSIS

In assessing which occupations need to be addressed by workforce development, this study compares employment demand against supply of workers and analyzes the difficulty employers have in filling positions in the four occupational clusters. Comparing employer demand versus worker supply helps identify supply gaps that can be filled with workforce investments in education and training. A supply gap is created when the number of workers trained in programs related to the occupation does not match the number of available job openings in a given year. If the San Diego region continues to produce as many workers as it did in 2012—the most recent year available for supply data—it would not be able to keep up with employer demand for production and software workers (Figure 8).¹⁸

¹⁴ Replacement jobs refer to job openings resulting from workers retiring or otherwise permanently leaving an occupation.

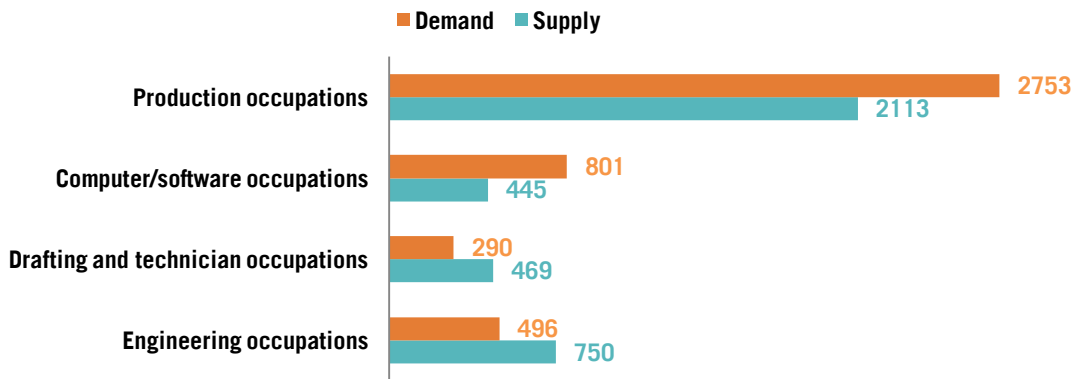
¹⁵ The Sloan Center on Aging & Work at Boston College. nist.gov/mep/upload/aging_workforce.pdf.

¹⁶ For a breakdown of specific occupations in each occupational group by SOC code, view Appendix E.

¹⁷ The openings are the demand for these positions across all sectors and industries, not just within the Advanced Manufacturing sector. Job openings are a result of job growth as well as retirements and other replacement needs. The projection model from the data source (EMSI) is based on historical employment data and does not account for recent legislative policies and other factors that are expected to stimulate higher job growth in these areas.

¹⁸ Average annual openings were used for the measure of demand, and awards by training providers in 2012 were used for the measure of supply. 2012 is the most recent year in which data is available for program awards. Demand data source: EMSI. Dataset includes QCEW, non-QCEW and self-employment. Supply data source: California Community Colleges Chancellors Office (CCCCO) MIS Data Mart for two-year credentials and Integrated Postsecondary Education Data System (IPEDS) from U.S. Department of Education National Center for Education Statistics (NCES) for four-year credentials. For a detailed breakdown of educational institutions and the number of students trained for the year 2012 by occupation, view Appendix F.

Figure 8: Demand and Supply for Occupational Groups, 2012

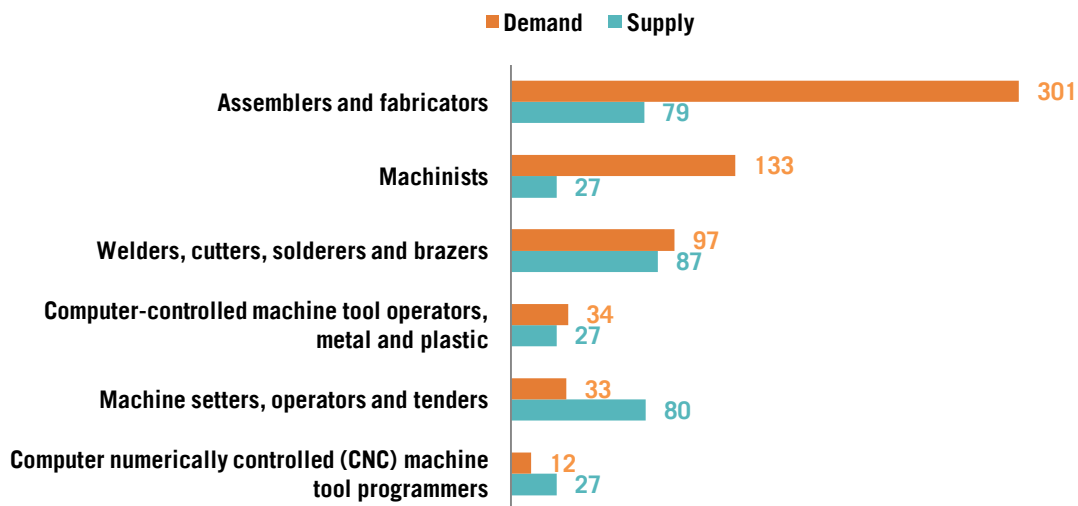


However, analyzing in detail the supply and demand for occupations within each cluster indicates that training gaps are prevalent throughout all occupations, and not simply in the production and computer/software clusters. The following sections are dedicated to the detailed analysis of each occupational cluster. Each section discusses the demand, supply, training gaps, employer hiring difficulties, and skills most frequently sought in each occupation by cluster.

Production Occupations

If San Diego County’s education and training system continues to supply workers at the rate it did in 2012, Advanced Manufacturers would experience a lack of worker supply in assemblers and fabricators; machinists; welders, cutters, solderers and brazers; and computer-controlled machine tool operators, metal and plastic (Figure 9).¹⁹

Figure 9: Demand and Supply for Production Occupations, 2012



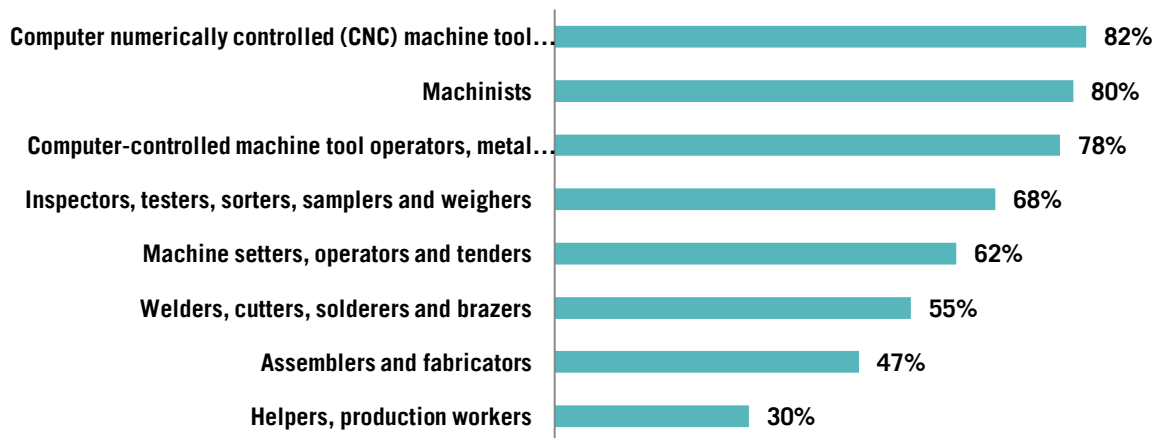
Training programs should not focus only on occupations that have training gaps based on demand and supply data, but also on occupations that employers reported difficult to fill. Another method of determining whether the region is adequately supplying qualified workers is identifying the difficulty employers have in

¹⁹ Demand data source: EMSI. Dataset includes QCEW, non-QCEW and self-employment. Supply data source: CCCC MIS Data Mart for two-year credentials and IPEDS from U.S. Department of Education NCES for four-year credentials.

hiring for specific occupations. Advanced Manufacturing firms were asked to rate the difficulty in finding qualified workers in occupations using a three-point scale: no difficulty, some difficulty and great difficulty. If employers have some to great difficulty in filling certain positions, it indicates that the region is not producing enough workers with the right skill sets for these occupations, or qualified workers are not aware of the opportunities available to them.

The top three production occupations that employers have the most difficulty filling are CNC machine tool programmers, machinists, and computer-controlled machine tool operators (Figure 10).

Figure 10: Percent of Employers with Difficulty in Hiring Production Occupations



Employers have the most difficulty in hiring for computer-related and machining positions. Some of these positions may not have a large demand compared to the other production occupations, but require specialized skills that employers have difficulty finding. For instance, while CNC machine tool programmers do not appear to have a training gap, employers have the most difficulty filling this position (82 percent). Sixty-two percent of employers also have difficulty hiring machine setters, operators, and tenders, but the supply of qualified workers outpaces demand for this occupation. This suggests that programs producing workers in this occupation may not have the skill sets that employers are looking for.

As manufacturing shifts toward more computerized, advanced processes and equipment, employers will require more specialized skills that are difficult to find. To identify some of these specific skill sets, online job postings related to production occupations were analyzed and the skills most frequently associated with each production-related online job posting from Jan. 1 to Dec. 31, 2013 are listed in Table 3.²⁰

Table 3: Top Skills for Production Occupations in Online Job Postings

Occupation	Top Skill Sets
Assembler and fabricators	Hand Tools SAP Oracle Six Sigma Environmental Compliance
Helpers, production workers	Mathematics Physical Demand Inspection Machine Operation Environmental Compliance

²⁰ Source: Burning Glass. Jobs posted for production occupations between Jan. 1 and Dec. 30, 2013.

Machinists	Machining Lathes CNC Machine Tools Mathematics
Inspectors, testers, sorters, samplers and weighers	Inspection Micrometers Calipers Calibration Mathematics
Computer-controlled machine tool operators	CNC Machining Machine Operation Lathes Inspection
Welderers, cutters, solderers and brazers	Soldering Repair Schematic Diagrams Inspection Screwdrivers
Machine setters, operators and tenders	Machine Tools Machining Blueprint CSS CNC Lathes
Computer numerically controlled machine tool programmers	Computer Numerical Control (CNC) Machining 5-axis machining Lathes Inspection

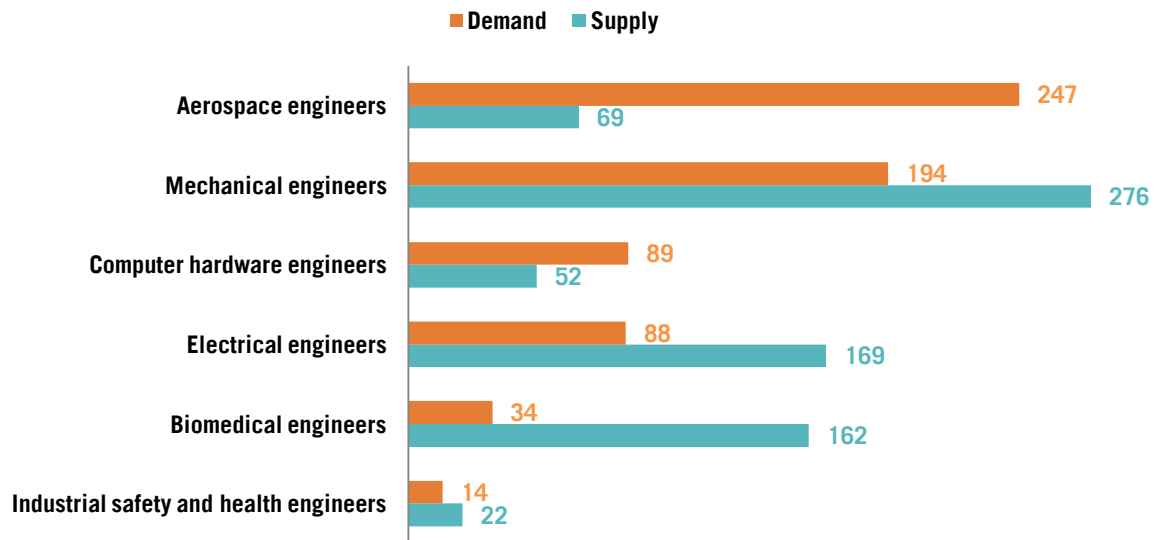
Education and training providers may want to consider including these skills in training and education programs if they are not already incorporated. Additionally, the workforce development system needs to identify whether it wants to develop programs that address occupations that have both training gaps and employer hiring difficulties (such as machinists, computer-controlled machine tool operators, and welders, cutters, solderers and brazers), or whether it wants to develop programs for lower-demand occupations that employers still have difficulty recruiting qualified workers for (such as CNC machine tool programmers and machine setters, operators, and tenders).

Engineering Occupations

Engineering occupations are expected to have a 5 percent growth by 2018. Demand and supply data suggest that the region has a surplus of trained workers, with the exception of aerospace and computer hardware engineer positions (Figure 11).²¹ However, this may be a result of engineering degrees accounting for more than one occupation, which inflates the number of available engineers for each position.

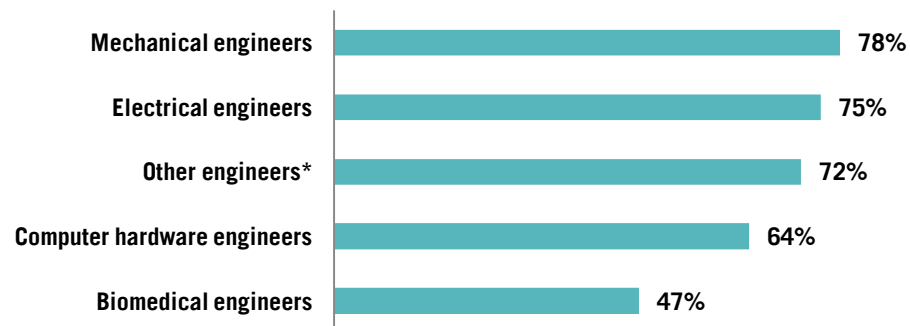
²¹ Demand data source: EMSI. Dataset includes QCEW, non-QCEW and self-employment. Supply data source: CCCCO MIS Data Mart for two-year credentials and IPEDS from U.S. Department of Education NCES for four-year credentials.

Figure 11: Demand and Supply for Engineering Occupations



Employer responses indicate a greater demand for engineering occupations than what is displayed in the projected demand and supply data. Engineering occupations have the highest number of employers citing difficulty hiring qualified workers out of the four occupational clusters. Sixty-four to 86 percent of employers that employ these positions have difficulty finding qualified workers across all engineering disciplines (Figure 12). In executive interviews, small and middle-sized businesses indicated encountering the greatest challenges in recruiting and retaining engineers with mechanical/machining experience. Employers have difficulty competing for qualified workers with their larger counterparts, who tend to have greater salary flexibility and job security.

Figure 12: Percent of Employers with Difficulty in Hiring Engineering Occupations



*Respondents that selected "Other" specified a different engineering discipline, which included manufacturing, design, ME and process, test, systems, software, electronics and sensors, quality, foundry, CAD/CAM, and production engineers. Other engineering occupations had too few respondents to be statistically significant.

This indicates that workforce development cannot rely simply on projected supply versus demand to calculate the job gap for engineers. For this occupational cluster, a disconnect may exist between the skills required by employers and the trainings offered by educational institutions if there are enough engineers produced in the region who do not possess the skills employers desire. However, the surplus of engineers may be a result of data limitations causing the supply of engineers to be counted more than once for each of

the engineering occupations. Table 4 lists skill sets found in job postings for engineers that can be incorporated into engineering curriculum to fill potential skill gaps.²²

Table 4: Top Skills for Engineering Occupations in Online Job Postings

Occupation	Skill Sets
Electrical engineers	Electrical engineering Simulation Circuit design Validation
Mechanical engineers	Mechanical engineering CAD Mechanical design Product development Validation
Computer hardware engineers	Electrical engineering Simulation VHSIC hardware description language (VHDL) Hardware experience Verilog
Biomedical engineers	Mathematics Hydrology Hydraulics Chemistry Geology

In addition to the skill sets identified above, businesses also expressed during executive in-person interviews difficulty in hiring engineers with fabrication experience. Production occupations are not the only positions that require an understanding of machinery in an Advanced Manufacturing facility. Engineers need to understand machine capabilities, metal and other substrate characteristics, and tolerances. Hiring managers expressed the importance of this knowledge:

Engineers without machinery experience often design parts that aren't capable of being built, often due to machine or materials capabilities. Engineers that have machinery experience and education are in very high demand—they can name their price. It has become very competitive to recruit and hire these individuals.

Independent of the engineering degree obtained, candidates with actual hands-on experience are highly sought after by employers and are the types who can work on a part or component with the finished product in mind. It is important for employers that engineers can plan out and connect all components of a product from beginning to end – a quality that comes from experience working with machines.

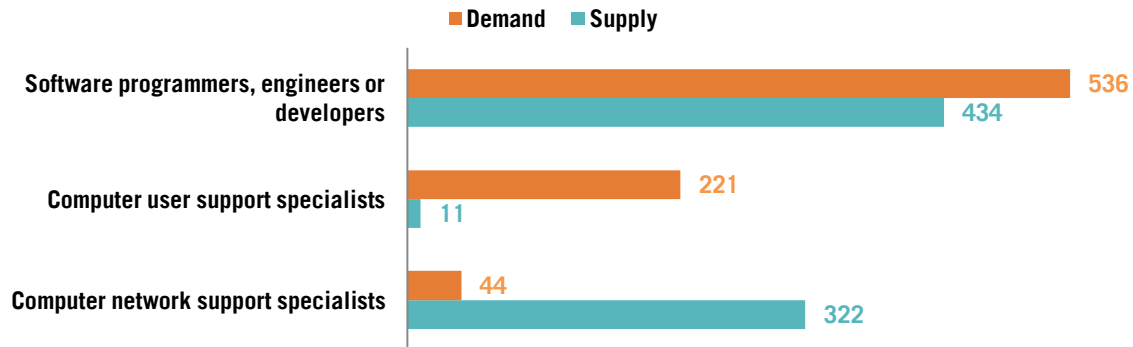
Computer/Software Occupations

As previously mentioned, computer/software occupations have become increasingly important to Advanced Manufacturing firms. Of the four occupational clusters, computer/software occupations are projected to grow at the second fastest rate (11 percent) from now until 2018 in San Diego County. This cluster also has the second largest absolute employment growth with 2,288 additional jobs projected for the region during this period. Within this occupational cluster, computer user support specialists and software developers and programmers are projected to have the greatest job gaps (Figure 13).²³

²² Source: Burning Glass. Jobs posted for production occupations between Jan. 1 and Dec. 30, 2013.

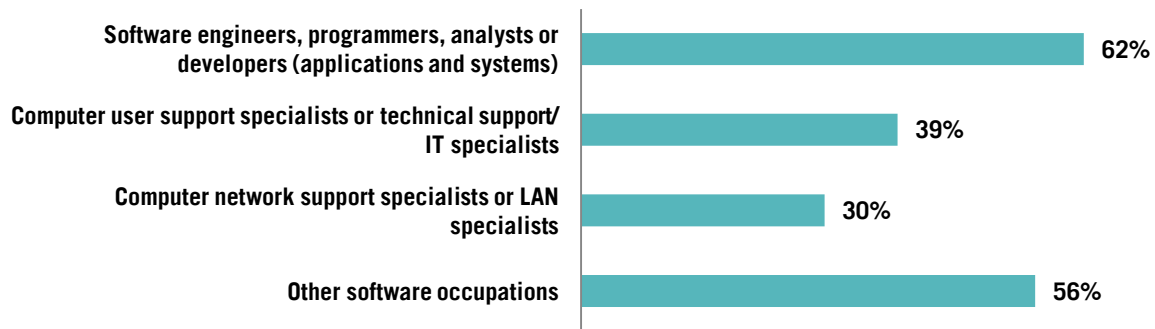
²³ Demand data source: EMSI. Dataset includes QCEW, non-QCEW and self-employment. Supply data source: CCCCO MIS Data Mart for two-year credentials and IPEDS from U.S. Department of Education NCES for four-year credentials.

Figure 13: Demand and Supply of Software Occupations



Software engineers and programmers have become an essential component of manufacturing with 44 percent of survey respondents employing computer/software occupations within their firms. Sixty-two percent of Advanced Manufacturing firms that employ software engineer, programmer analyst and developer positions (for both applications and systems) reported having challenges in recruiting qualified candidates (Figure 14).

Figure 14: Percent of Employers with Difficulty in Hiring Computer/Software Occupations



Advanced Manufacturing firms emphasized that recruiting computer/software workers with the appropriate programming knowledge (which vary by industry) is time consuming—with companies reportedly taking up to three months to find an ideal candidate. Some Advanced Manufacturers are looking for specific software development and programming language knowledge; others are looking for experience with device drivers. In addition, multiple companies reported an emerging need for software engineers with Radio Frequency (RF) and/or wireless technology knowledge.

To identify what specific skill sets employers are looking for, Table 5 lists the top five skills most associated with computer/software occupations in related online job postings.²⁴

Table 5: Top Skills for Computer/Software Occupations in Online Job Postings

Occupation	Skill Sets
Software engineers, programmers, analysts or developers (applications and systems)	Software engineering Systems engineering JAVA

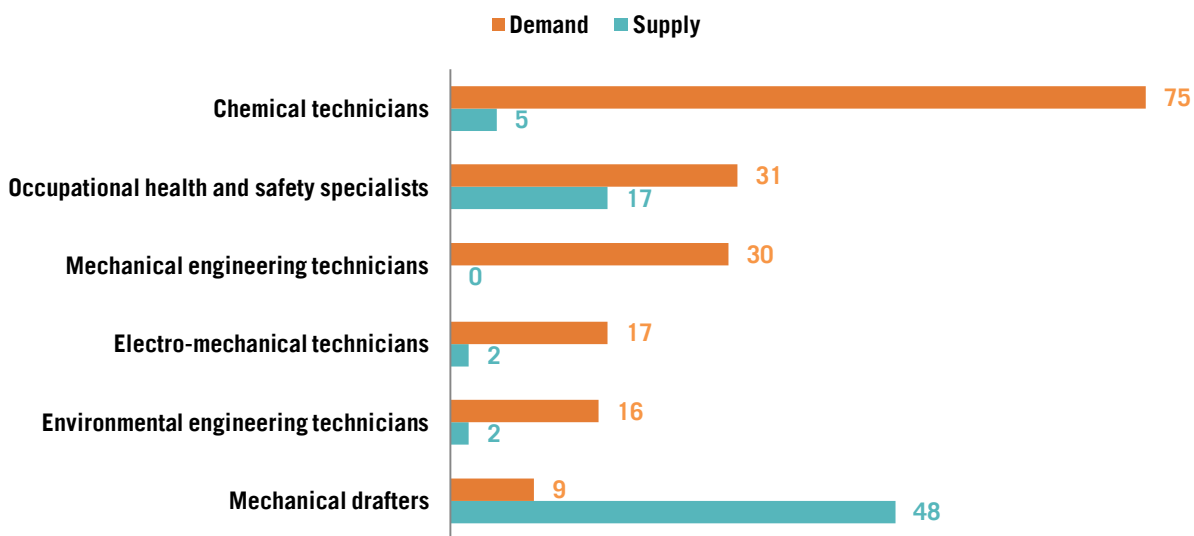
²⁴ Source: Burning Glass. Jobs posted for production occupations between Jan. 1 and Dec. 30, 2013.

	C++ LINUX
Computer user support specialists or technical support/IT specialists	Linux Transmission Control Protocol/Internet Protocol (TCP/IP) Computer networking Microsoft SharePoint Help desk support
Computer network support specialists or LAN specialists	Technical support Repair Help desk support SQL Oracle

Drafting and Technician Occupations

Of the four occupational clusters, the drafting and technician cluster has the largest projected growth rate of 19 percent from 2014 to 2018 in San Diego. According to demand and supply data, technician occupations had a shortfall of trained workers while drafting jobs had an oversupply (Figure 15).²⁵

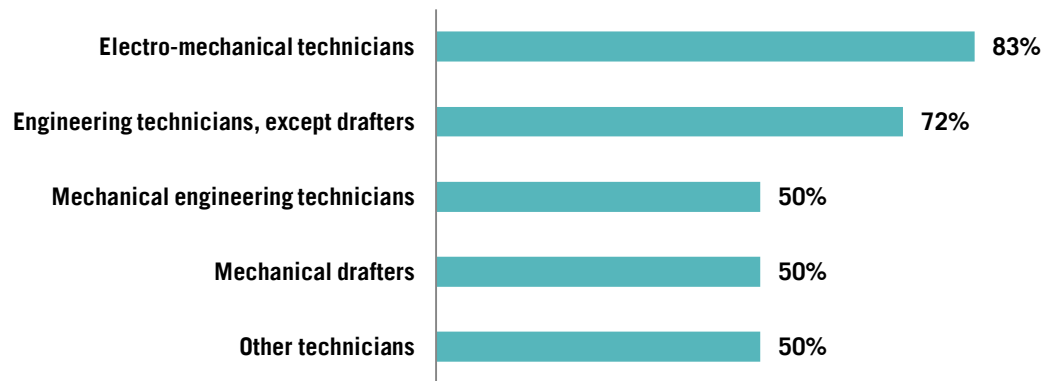
Figure 15: Demand and Supply of Drafting and Technician Occupations



Demand and supply data suggests that San Diego County has a shortage of qualified workers for drafting and technician occupations. Analyzing employer difficulties in hiring for these positions yield a similar outlook: Of the Advanced Manufacturing firms that employ drafting and technician occupations, 50 percent or more of employers reported difficulty recruiting for the occupations in this cluster (Figure 16).

Figure 16: Percent of Employers with Difficulty in Hiring Drafting and Technician Occupations

²⁵ Demand data source: EMSI. Dataset includes QCEW, non-QCEW and self-employment. Supply data source: CCCC MIS Data Mart for two-year credentials and IPEDS from U.S. Department of Education NCES for four-year credentials.



In executive interviews, employers commonly reported a lack of engineering technician skills in cell culturing, machine operation, and knowledge of manufacturing processes. For mechanical drafters, employers had difficulty finding workers with Computer Aided Drafting/Design (CAD) experience. Similarly, employers had difficulty finding qualified mechanical engineering technicians that had schematic diagram and repair knowledge. Table 6 identifies additional skills for drafter and technician occupations that also have the highest frequency in online job postings.

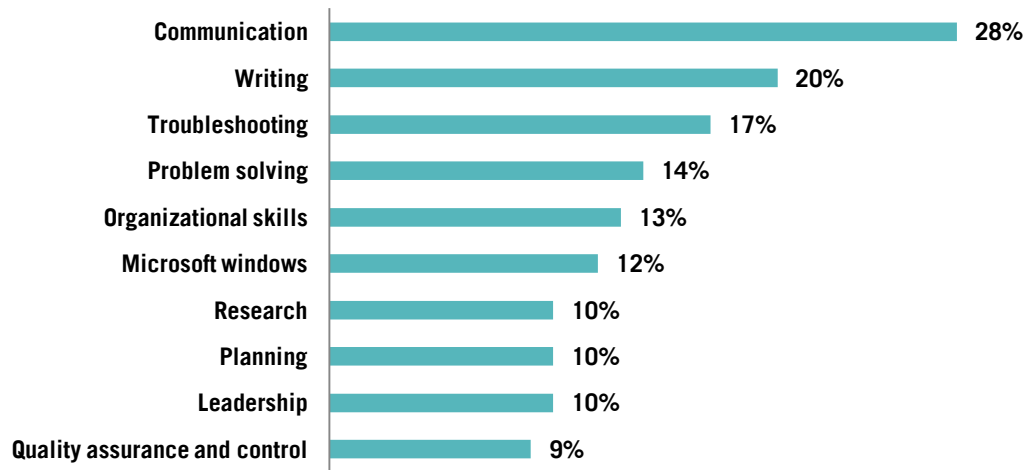
Table 6: Top Skills for Drafting and Technician Occupations in Online Job Postings

Occupation	Skill Sets
Mechanical drafters	CAD AutoCAD Mechanical design Mechanical engineering CAD design
Engineering technicians, except drafters	Software engineering Systems engineering JAVA C++ LINUX
Mechanical engineering technicians	Repair Hand tools Schematic diagrams Soldering Wiring diagrams
Electro-mechanical technicians	Repair Soldering Inspection Schematic diagrams Oscilloscopes

General Skills and Competencies

In addition to specific occupational skill sets, Advanced Manufacturers also reported having difficulty in finding workers with basic competencies. Of the 21,354 online job advertisements posted from January 1 to December 31, 2013 that related to the four occupational clusters, the ten top general skills most sought-after by employers included communication, writing, troubleshooting, and problem solving (Figure 17).

Figure 17: Top Ten General Skills by Percent of Online Job Postings

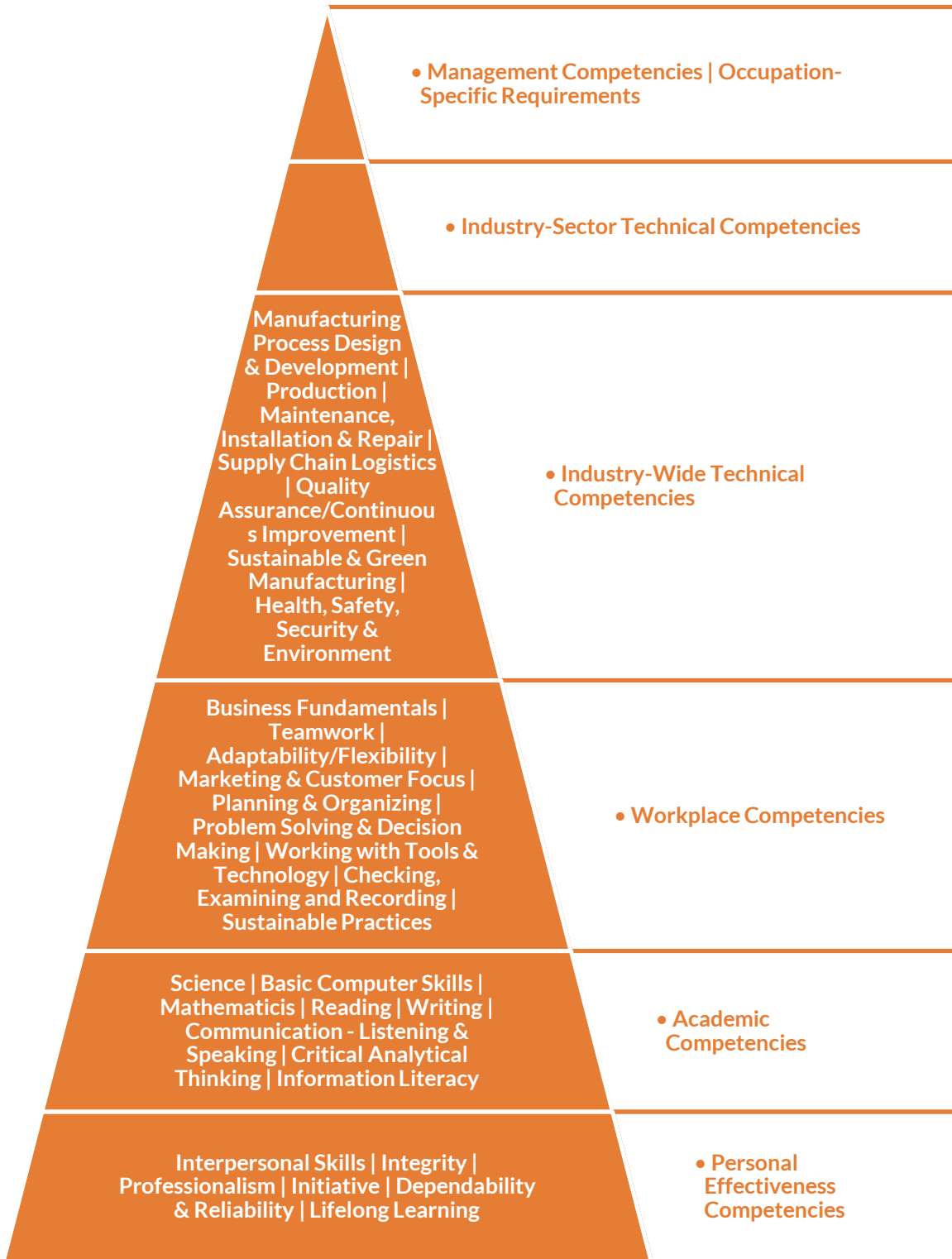


Troubleshooting and problem solving were two skill sets that frequented conversations with employers, many of who expressed a need for workers with initiative and critical thinking.

The U.S. Department of Labor competency model for Advanced Manufacturing illustrates a bottom-up approach in identifying skill sets desired by Advanced Manufacturing firms (Figure 18).²⁶ The foundation for the model relies on personal effectiveness, academic, and workplace competencies—all competencies that are gained through experience and practice in academia and the workplace. Job seekers who want to find employment in the Advanced Manufacturing sector can reference this competency model, which displays employer needs for well-rounded workers.

²⁶ Adapted from Advanced Manufacturing Competency Model. Washington, DC: United States Department of Labor, Employment and Training Administration. careeronestop.org/competencymodel/competency-models/advanced-manufacturing.aspx.

Figure 18: Advanced Manufacturing Competency Model



RECOMMENDATIONS

A robust workforce development strategy depends on expanding the talent pool of skilled workers to meet the critical shortage faced by many Advanced Manufacturing employers. Appendix H contains a comprehensive list of programs that train for careers in the Advanced Manufacturing sector; however, while there are programs available to train workers for the region, 85 percent of survey respondents still reported a moderate to serious shortage of qualified job applicants in at least one occupation. This skilled-labor shortage impedes the industry's ability to achieve its full productive potential, and will become increasingly acute as the already-aging workforce approaches retirement. In order for San Diego County's Advanced Manufacturing firms to remain competitive in the global market, they must have an innovative and highly-skilled technical and productive workforce.

Future strategies for developing the Advanced Manufacturing sector workforce require involvement of both employers and trainers. The following recommendations resulted not only from employer feedback, but also from discussions with education and training providers—a collaboration that should continue if San Diego desires to expand its talented Advanced Manufacturing workforce. Focus should be on expanding the current talent pipeline and aligning education and training with employers' needs.

Shift Public Perception of Traditional Manufacturing to Advanced Manufacturing

Due to technological developments in the sector, manufacturing firms now require highly-skilled workers with technological skills such as robotics or computer programming. However, both educators and employers lamented that the perception of manufacturing has not caught up with advancements in the sector. Employers, educators, workforce development and economic development agencies need to collaborate on improving public understanding of the Advanced Manufacturing sector, focusing especially on the technical, well-paid, and clean nature of today's opportunities. This shift in perspective will help expand the pipeline of skilled workers willing and eager to enter the sector.

Encourage Science, Technology, Engineering and Mathematics (STEM) Education

Fostering STEM education in schools at the K-12 level is foundational for the Advanced Manufacturing sector. STEM programs need to provide industry-relevant math and science preparation for technical education and preparatory courses for university admission. This requires offering more applied learning opportunities and career counseling at the high school level. Such courses could be better tailored to technical careers in a way that current college preparatory math and science courses are not.

Encourage Critical Thinking/Real World Application in Education and Training Programs

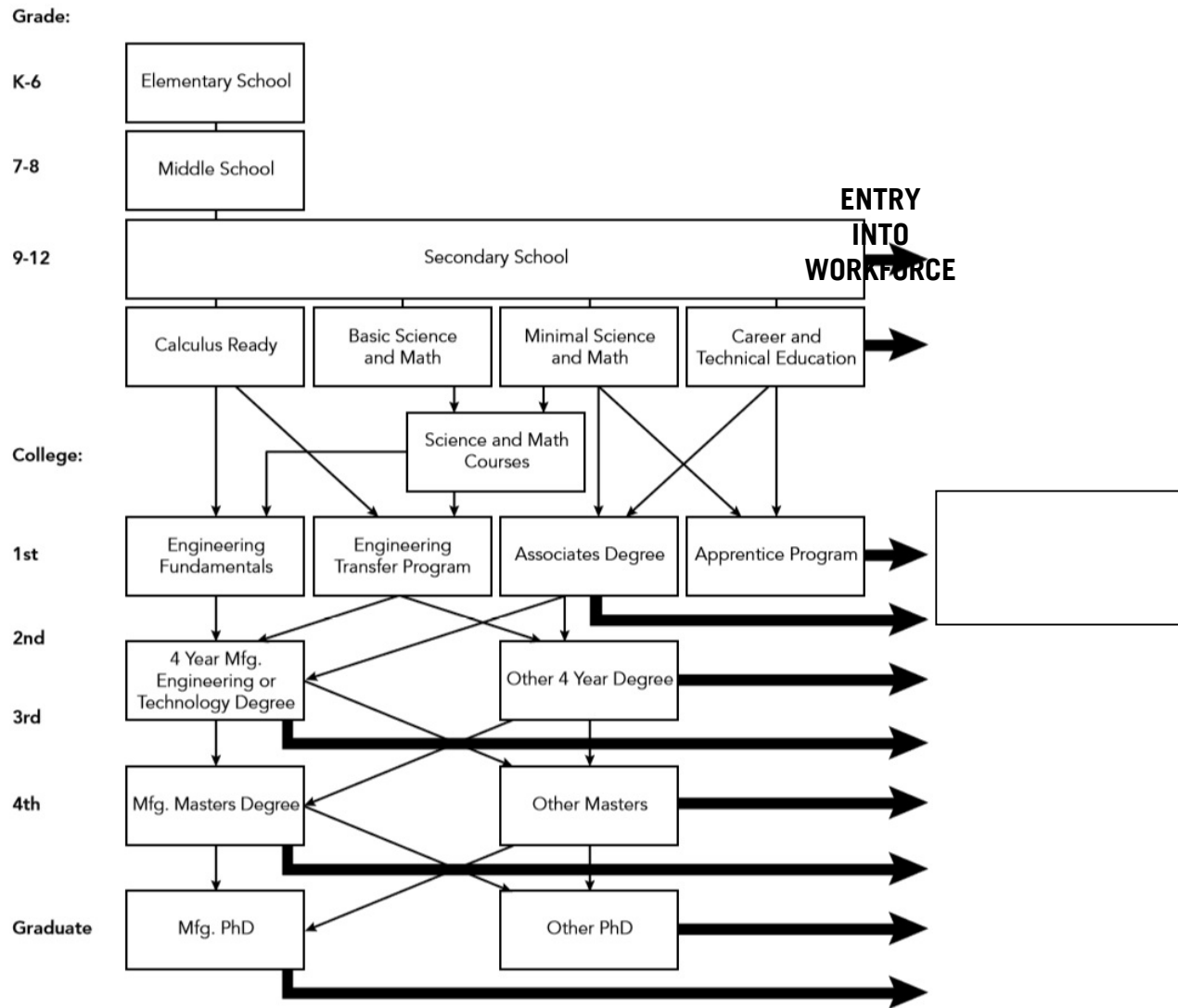
Manufacturers repeatedly emphasized the importance of critical thinking. The lack of problem-solving skills was prominent among job applicants in this sector. Increasing problem-solving skills in education (K-12 and training programs) will instill the approaches and steps required to assess problems, isolate causes, and identify solutions in real world scenarios.

Align the Workforce System with the Advanced Manufacturing Sector

In order to attract younger workers to replace the retiring workforce, awareness of the exciting opportunities in this sector must first be ingrained in the youth. To do so, aligning the entire educational continuum from K-12 to graduate school is key. Figure 19 provides a heuristic process of aligning education with Advanced Manufacturing skills and competences.²⁷ With rapid technological advancement, education providers are regularly adapting curriculum to meet the needs of a constantly-shifting workplace. However, to do so effectively, the workforce development system needs to involve employers and allow them to recommend skills that are most needed and valued in the sectors.

²⁷ Adapted from: Hugh Jack et al. "Curricula 2015: A Four Year Strategic Plan for Manufacturing Education." June 2011.

Figure 19: Institutional Pipeline for Manufacturing Knowledge



Standardize Certifications and Articulation Agreements

While it is difficult to separate the education system into discrete pieces of knowledge attainment and pathways, the importance of being able to designate where entry/exit points exist from school-to-industry is critical. Educational certificates should be transferable from institution to institution (enabling mobility between regions) and from colleges to jobs. Moving towards the standardization of certifications/credentials within this sector will empower the market and enable it to self-regulate. Associations nationwide need to coordinate certification standards in all regions so that they can be combined to create complete training programs in advanced manufacturing. While interchangeability and articulation agreements can be incredibly difficult to achieve, they are becoming increasingly important for the success of the manufacturing sector. Northwestern State University and Northwest Louisiana Technical College recently signed an articulation agreement to facilitate students' abilities to earn industry-based

Certification for Manufacturing, which can then be applied to a bachelor's degree in Industrial Engineering Technology.²⁸ San Diego education and training institutions need to focus on creating these types of region-wide standards and credentials.

Add an Internship/Work Experience Requirement to Education and Training Programs

Advanced Manufacturers across industries depend upon “hands on” experience. Creating internships, apprenticeships, or work experience requirements in education and training programs would give students the additional experience manufacturers desire from workers. The majority of manufacturers expressed interest in participating in such hands on programs (with the exception of companies with security restrictions such as the International Traffic in Arms Regulation (ITAR)).

Develop Public-Private Partnerships to Share Resources

Advanced Manufacturing training providers experience challenges expanding the talent pipeline at a rate in line with sector growth. While it is beneficial to the region that jobs in this sector are in demand, training providers do not have enough resources to meet that demand. Advanced Manufacturing equipment is costly, costing up to \$150,000 for a single machine. The number of machines limits the amount of students who can be trained, leading to impacted courses and fewer qualified graduates who can meet employer demand. Substantive public-partnerships between employers and training providers can match employer needs with training curriculum. If companies host a “second shift” where students gain on-the job skills by using equipment during off hours, not only do trainers address the issue of impacted classes, but employers will also have workers trained to use their specialized equipment. Issues may arise with equipment maintenance, but that is a conversation that employers and training providers can have.

Increase Knowledge of Business Assistance Programs

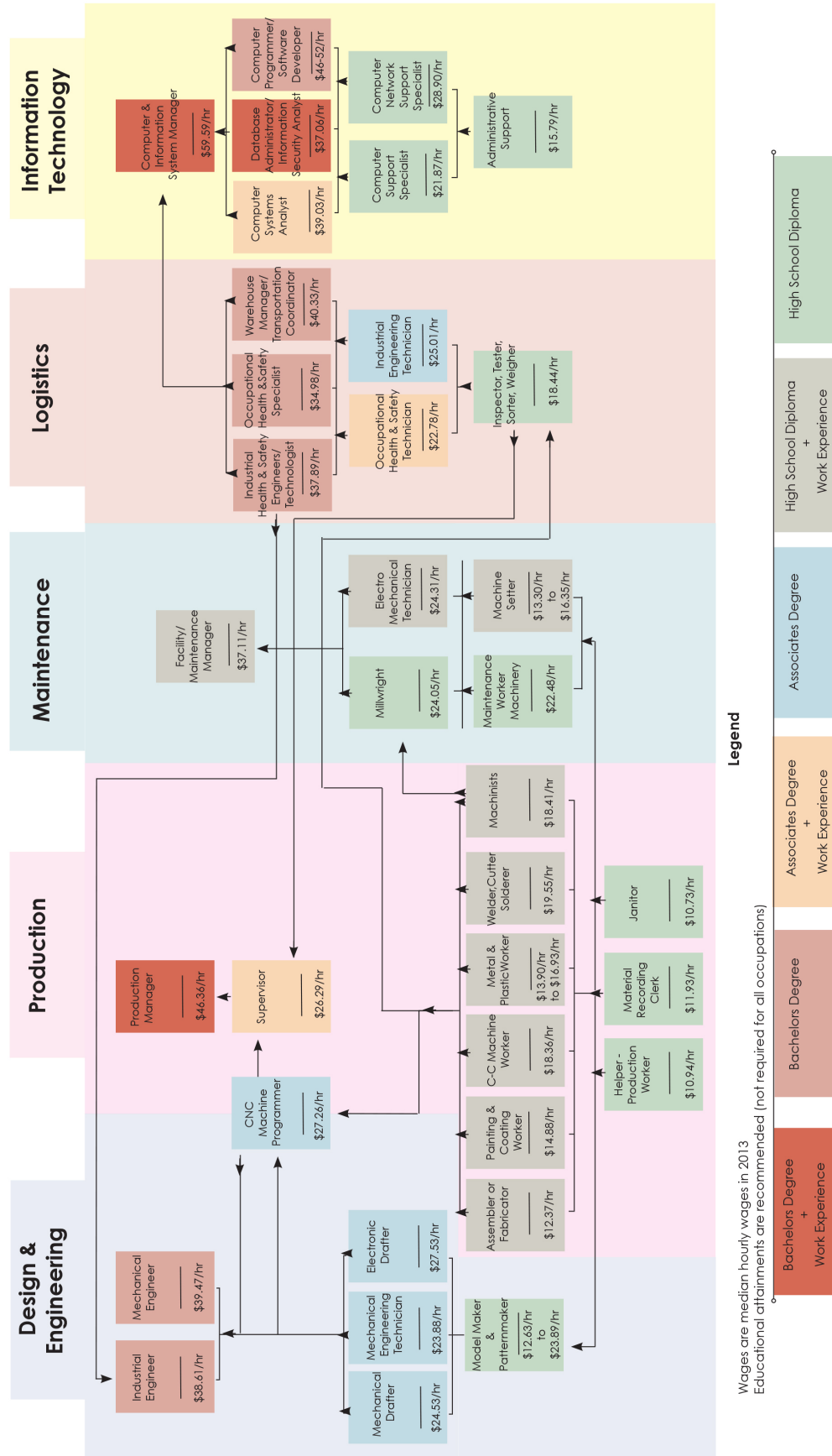
Conversations with Advanced Manufacturers (small or large) revealed that employers have little knowledge of public funds available to help underwrite the costs of their workforce training. Businesses require training for new hires, yet the vast majority are unaware of available training funds such as On-the-Job Training provided by local Workforce Investment Boards. The workforce development system needs a sales force or business outreach group that promotes funding programs and helps employers navigate through training system requirements.

Develop and Expand the Advanced Manufacturing Talent Pipeline

Because Advanced Manufacturers are small, specialized firms, employers invest significant resources in training their workforce and providing personnel opportunities for job growth. A career in this sector can begin at an entry-level position requiring no more than a high school diploma, and move to a management position with formalized training. Figure 20 demonstrates the potential career paths in the Advanced Manufacturing sector. While this does not encompass all possible career progressions, such career lattices help promote sector opportunities to job seekers and may attract skilled workers to this diverse and growing sector.

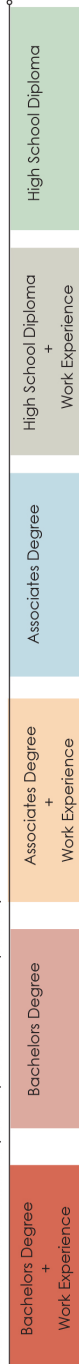
²⁸ news.nsula.edu/home/articulation-paves-way-for-stackable-credentials.

Figure 20: Advanced Manufacturing Career Lattice



Wages are median hourly wages in 2013. Educational attainments are recommended (not required for all occupations)

Legend



CONCLUSIONS

This report has highlighted the extent to which the Advanced Manufacturing sector—the network of production and supply chain companies that continue to “make” things—is alive and well in San Diego, representing more than 20 percent of San Diego County’s GRP. It also underscores the number of immediate challenges facing this high-value cluster, most of which relate to securing a future talent pool needed to design, machine, tool and produce products across a wide array of industries. This research has affirmed the increasing importance of computer/software positions to many production processes, especially computer-aided design and languages. Equally important is the need for “hands-on” experience on the high-tech, sophisticated machinery essential to today’s Advanced Manufacturing sector. Opportunities for technicians, machinists, drafters and welders increasingly require advanced skills and competencies; development of these competencies needs to be addressed more effectively in the San Diego region by both industry and educators.

To grow—even sustain—the important Advanced Manufacturing sector requires collaborative initiatives across education and training institutions. These initiatives need to be employer driven, addressing jobs and skills vital to manufacturing employers.

This report has identified the specific competencies that are in demand among employers, and the barriers to producing the number of workers with the skills required to perform these jobs. The preceding recommendations represent a call to action among education and training institutions as well as employers across San Diego County to ensure the pipeline for manufacturing occupations continues to expand. The current region-wide focus on STEM provides a fascinating example of how major employers, higher education institutions, as well as secondary and community colleges, are working together to ensure that young people have the knowledge and skills required to work in more advanced areas of STEM. Employers need to assume a leadership role in prioritizing workforce development, particularly given the importance for jobseekers in developing skills and competencies through community colleges, and education and training agencies. Employers must commit to internships, apprenticeships and the possibility of offering their in-house equipment for training. Equally important, education providers need to develop more targeted curriculum, ease the way for employers to collaborate in the classroom, and make available greater course selections through which students can acquire the skills and competencies needed.

The challenge for Advanced Manufacturing lies in the sectors’ rapid movement towards specialization, contributing to employment fluctuations across the industry. Collaborative mechanisms to accommodate these shifting demand spikes need to be designed to ensure that education and training organizations receive continuous feedback from employers and are able to respond to employer needs in a timely and effective manner. However, the outlook for Advanced Manufacturing in San Diego remains bright. San Diego has a long tradition of collaboration in its business and innovation clusters. This is the moment to build on this collaborative culture within the Advanced Manufacturing cluster.







APPENDIX A: OCCUPATIONAL PROFILES

Software Developers, Applications

Standard Occupational Code: 15-1132

Other Job Title(s): Software Engineer, Java Software Developer, Applications Engineer, Software Developer

Description: Develop, create and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use with the aim of optimizing operational efficiency. May analyze and design databases within an application area, working individually or coordinating database development as part of a team. May supervise computer programmers.

Fast Facts			
Current Employment (2013)		7,439	
Projected Employment (2018)		8,365	
Growth Rate (2013-2018)		12%	
Average Annual Openings (2013-2018)		289	
Hourly Pay Range		\$36.25 Entry-level	\$46.22 Median
Typical Educational Attainment		Bachelor's degree	

Top Skills and Competencies

Technical	Non-Technical
Software Engineering	Communication
JAVA	Writing
SQL	Problem Solving
LINUX	Troubleshooting
Microsoft C#	Microsoft Windows

Occupational Tasks







- Modify existing software to correct errors, to adapt it to new hardware or to upgrade interfaces and improve performance.
- Develop and direct software system testing and validation procedures, programming and documentation.
- Analyze user needs and software requirements to determine feasibility of design within time and cost constraints.
- Confer with systems analysts, engineers, programmers and others to design system and to obtain information on project limitations and capabilities, performance requirements and interfaces.
- Coordinate software system installation and monitor equipment functioning to ensure specifications are met.

Software Developers, Systems Software

Standard Occupational Code: 15-1133

Other Job Title(s): Senior Systems Engineer, Systems Engineer, Firmware Engineer, Linux Engineer, Software Systems Engineer, Systems Integration Engineer

Description: Research, design, develop and test operating systems-level software, compilers and network distribution software for medical, industrial, military, communications, aerospace, business, scientific and general computing applications. Set operational specifications and formulate and analyze software requirements. May design embedded systems software. Apply principles and techniques of computer science, engineering and mathematical analysis.

Fast Facts			
Current Employment (2013)		7,001	
Projected Employment (2018)		7,754	
Growth Rate (2013-2018)		11%	
Average Annual Openings (2013-2018)		247	
Hourly Pay Range		\$41.31 Entry-level	\$50.38 Median
Typical Educational Attainment		Bachelor's degree	

Top Skills and Competencies

Technical	Non-Technical
Systems Engineering	Communication
LINUX	Writing
C++	Problem Solving
UNIX	Troubleshooting
Electrical Engineering	Microsoft Windows

Occupational Tasks







- Modify existing software to correct errors, to adapt it to new hardware or to upgrade interfaces and improve performance.
- Develop or direct software system testing or validation procedures.
- Direct software programming and development of documentation.
- Consult with customers or other departments on project status, proposals, or technical issues, such as software system design or maintenance.
- Analyze information to determine, recommend and plan installation of a new system or modification of an existing system.
- Consult with engineering staff to evaluate interface between hardware and software, develop specifications and performance requirements or resolve customer problems.
- Design or develop software systems, using scientific analysis and mathematical models to predict and measure outcome and consequences of design.
- Prepare reports or correspondence concerning project specifications, activities or status.

Computer User Support Specialists

Standard Occupational Code: 15-1151

Other Job Title(s): Technical Support Representative, Geek Squad Agent, Technical Support Engineer, Technical Support Specialist, Applications Engineer, Application Analyst, Help Desk Specialist, Help Desk Analyst, Help Desk Support, Desktop Support Specialist, Technical Support Analyst

Description: Provide technical assistance to computer users. Answer questions or resolve computer problems for clients in person or via telephone or electronically. May provide assistance concerning the use of computer hardware and software, including printing, installation, word processing, electronic mail and operating systems.

Fast Facts			
Current Employment (2013)		5,891	
Projected Employment (2018)		6,500	
Growth Rate (2013-2018)		10%	
Average Annual Openings (2013-2018)		221	
Hourly Pay Range		\$18.00 Entry-level	\$21.67 Median
Typical Educational Attainment		Some college, no degree	
		\$27.25 Experienced	

Top Skills and Competencies

Technical	Non-Technical
Technical Support	Troubleshooting
Repair	Communication
Help Desk Support	Customer Service
SQL	Writing
LINUX	Microsoft Windows

Occupational Tasks







- Oversee the daily performance of computer systems.
- Answer user inquiries regarding computer software or hardware operation to resolve problems.
- Enter commands and observe system functioning to verify correct operations and detect errors.
- Set up equipment for employee use, performing or ensuring proper installation of cables, operating systems or appropriate software.
- Install and perform minor repairs to hardware, software, or peripheral equipment, following design or installation specifications.
- Maintain records of daily data communication transactions, problems and remedial actions taken, or installation activities.
- Read technical manuals, confer with users or conduct computer diagnostics to investigate and resolve problems or to provide technical assistance and support.
- Refer major hardware or software problems or defective products to vendors or technicians for service.

Computer Hardware Engineers

Standard Occupational Code: 17-2061

Other Job Title(s): Hardware Engineer, Hardware Design Engineer, Computer Engineer, ASIC Design Engineer, Applications Engineer

Description: Research, design, develop or test computer or computer-related equipment for commercial, industrial, military or scientific use. May supervise the manufacturing and installation of computer or computer-related equipment and components.

Fast Facts			
Current Employment (2013)		3,561	
Projected Employment (2018)		3,592	
Growth Rate (2013-2018)		1%	
Average Annual Openings (2013-2018)		89	
Hourly Pay Range		\$33.32 Entry-level	\$42.33 Median
Typical Educational Attainment		Bachelor's degree	

Top Skills and Competencies

Technical	Non-Technical
Electrical Engineering	Troubleshooting
Computer Engineering	Communication
VHSIC Hardware Description Language (VHDL)	Planning
Test Equipment	Organization
Verilog	Problem Solving

Occupational Tasks







- Update knowledge and skills to keep up with rapid advancements in computer technology.
- Build, test and modify product prototypes using working models or theoretical models constructed with computer simulation.
- Write detailed functional specifications that document the hardware development process and support hardware introduction.
- Specify power supply requirements and configuration, drawing on system performance expectations and design specifications.
- Confer with engineering staff and consult specifications to evaluate interface between hardware and software and operational and performance requirements of overall system.
- Design and develop computer hardware and support peripherals, including central processing units (CPUs), support logic, microprocessors, custom integrated circuits, printers and disk drives.
- Select hardware and material, assuring compliance with specifications and product requirements.
- Monitor functioning of equipment and make necessary modifications to ensure system operates in conformance with specifications.
- Test and verify hardware and support peripherals to ensure that they meet specifications and requirements, by recording and analyzing test data.

Electrical Engineers

Standard Occupational Code: 17-2071

Other Job Title(s): Electrical Engineer, Systems Engineer, Senior Electrical Engineer, Test Engineer, Electrical Design Engineer

Description: Research, design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military or scientific use.

Fast Facts			
Current Employment (2013)		2,387	
Projected Employment (2018)		2,556	
Growth Rate (2013-2018)		7%	
Average Annual Openings (2013-2018)		88	
Hourly Pay Range		\$38.17 Entry-level	\$45.89 Median
Typical Educational Attainment		Bachelor's degree	

Top Skills and Competencies

Technical	Non-Technical
Electrical Engineering	Communication
Simulation	Writing
Systems Engineering	Troubleshooting
Circuit Design	Organization
Schematic Diagrams	Project Management

Occupational Tasks







- Prepare technical drawings, specifications of electrical systems, or topographical maps to ensure that installation and operations conform to standards and customer requirements.
- Operate computer-assisted engineering or design software or equipment to perform engineering tasks.
- Confer with engineers, customers or others to discuss existing or potential engineering projects or products.
- Direct or coordinate manufacturing, construction, installation, maintenance, support, documentation or testing activities to ensure compliance with specifications, codes or customer requirements.
- Design, implement, maintain, or improve electrical instruments, equipment, facilities, components, products or systems for commercial, industrial or domestic purposes.
- Prepare specifications for purchases of materials or equipment.
- Perform detailed calculations to compute and establish manufacturing, construction, or installation standards or specifications.
- Investigate customer or public complaints, determine nature and extent of problem and recommend remedial measures.

Mechanical Engineers

Standard Occupational Code: 17-2141

Other Job Title(s): Mechanical Engineer, Mechanical Design Engineer, Manufacturing Engineer, Design Engineer, Tooling Engineer, Aerospace Engineer

Description: Perform engineering duties in planning and designing tools, engines, machines and other mechanically functioning equipment. Oversee installation, operation, maintenance and repair of equipment such as centralized heat, gas, water and steam systems.

Fast Facts			
Current Employment (2013)		3,546	
Projected Employment (2018)		3,874	
Growth Rate (2013-2018)		9%	
Average Annual Openings (2013-2018)		194	
Hourly Pay Range		\$32.14 Entry-level	\$46.25 Median
Typical Educational Attainment		Bachelor's degree	

Top Skills and Competencies

Technical	Non-Technical
Mechanical Engineering	Communication
Computer Aided Drafting/Design (CAD)	Organization
Mechanical Design	Writing
Product Development	Microsoft Excel
Validation	Problem Solving

Occupational Tasks







- Read and interpret blueprints, technical drawings, schematics or computer-generated reports.
- Assist drafters in developing the structural design of products using drafting tools or computer-assisted design (CAD) or drafting equipment and software.
- Research, design, evaluate, install, operate and maintain mechanical products, equipment, systems and processes to meet requirements, applying knowledge of engineering principles.
- Confer with engineers or other personnel to implement operating procedures, resolve system malfunctions or provide technical information.
- Recommend design modifications to eliminate machine or system malfunctions.
- Conduct research that tests or analyzes the feasibility, design, operation or performance of equipment, components or systems.
- Investigate equipment failures and difficulties to diagnose faulty operation, and to make recommendations to maintenance crew.
- Develop and test models of alternate designs and processing methods to assess feasibility, operating condition effects, possible new applications and necessity of modification.
- Develop, coordinate or monitor all aspects of production, including selection of manufacturing methods, fabrication or operation of product designs.

Engineering Technicians, Except Drafters, All Other

Standard Occupational Code: 17-3029

Other Job Title(s): Manufacturing Technician, Production Technician, Manufacturing Assembler, Production Assembler, Engineering Technician, Manufacturing Specialist

Description: Set up, test and adjust manufacturing machinery or equipment, using any combination of electrical, electronic, mechanical, hydraulic, pneumatic or computer technologies.

Fast Facts			
Current Employment (2013)		1,619	
Projected Employment (2018)		1,707	
Growth Rate (2013-2018)		5%	
Average Annual Openings (2013-2018)		52	
Hourly Pay Range		\$22.72 Entry-level	\$31.41 Median
Typical Educational Attainment		Associate degree	
			\$38.33 Experienced

Top Skills and Competencies

Technical	Non-Technical
Repair	Communication
Installation	Troubleshooting
Calibration	Detail-oriented
Cleaning	Quality Assurance and Control
Manufacturing Processes	Writing

Occupational Tasks







- Recommend corrective or preventive actions to assure or improve product quality or reliability.
- Prepare layouts, drawings or sketches of machinery or equipment, such as shop tooling, scale layouts or new equipment design, using drafting equipment or computer-aided design (CAD) software.
- Identify and implement new manufacturing technologies, processes or equipment.
- Identify opportunities for improvements in quality, cost or efficiency of automation equipment.
- Monitor or measure manufacturing processes to identify ways to reduce losses, decrease time requirements or improve quality.
- Ensure adherence to safety rules and practices.
- Coordinate equipment purchases, installations or transfers.
- Plan, estimate or schedule production work.
- Develop or maintain programs associated with automated production equipment.
- Select material quantities or processing methods needed to achieve efficient production.

Chemical Technicians

Standard Occupational Code: 19-4031

Other Job Title(s): Research Technician, Formulator, Chemical Technician, Research Associate

Description: Conduct chemical and physical laboratory tests to assist scientists in making qualitative and quantitative analyses of solids, liquids, and gaseous materials for research and development of new products or processes, quality control, maintenance of environmental standards and other work involving experimental, theoretical or practical application of chemistry and related sciences.

Fast Facts			
Current Employment (2013)		550	
Projected Employment (2018)		836	
Growth Rate (2013-2018)		52%	
Average Annual Openings (2013-2018)		75	
Hourly Pay Range		\$14.09 Entry-level	\$17.73 Median
Typical Educational Attainment		Associate degree	

Top Skills and Competencies

Technical	Non-Technical
Chemistry	Research
Experiments	Organization
Mathematics	Communication
Inventory Management	Microsoft Excel
Sample Preparation	Computers

Occupational Tasks







- Monitor product quality to ensure compliance with standards and specifications.
- Compile and interpret results of tests and analyses.
- Set up and conduct chemical experiments, tests and analyses using techniques such as chromatography, spectroscopy, physical or chemical separation techniques or microscopy.
- Conduct chemical or physical laboratory tests to assist scientists in making qualitative or quantitative analyses of solids, liquids or gaseous materials.
- Provide and maintain a safe work environment by participating in safety programs, committees or teams and by conducting laboratory or plant safety audits.
- Prepare chemical solutions for products or processes, following standardized formulas or create experimental formulas.
- Maintain, clean or sterilize laboratory instruments or equipment.

Environmental Science & Production Technicians, Including Health

Standard Occupational Code: 19-4091

Other Job Title(s): Solar Site Assessor, Environmental Technician, Water Damage and Mold Remediation Technician

Description: Perform laboratory and field tests to monitor the environment and investigate sources of pollution, including those that affect health, under the direction of an environmental scientist, engineer or other specialist. May collect samples of gases, soil, water and other materials for testing.

Fast Facts			
Current Employment (2013)		493	
Projected Employment (2018)		627	
Growth Rate (2013-2018)		27%	
Average Annual Openings (2013-2018)		49	
Hourly Pay Range		\$17.95 Entry-level	\$21.09 Median
Typical Educational Attainment		Associate degree	

Top Skills and Competencies

Technical	Non-Technical
Environmental Health and Safety	Communication
Repair	Writing
Site Assessments	Leadership
Hazardous Waste	Detail-oriented
Record Keeping	Research

Occupational Tasks







- Collect samples of gases, soils, water, industrial wastewater or asbestos products to conduct tests on pollutant levels or identify sources of pollution.
- Record test data and prepare reports, summaries or charts that interpret test results.
- Develop or implement programs for monitoring of environmental pollution or radiation.
- Discuss test results and analyses with customers.
- Set up equipment or stations to monitor and collect pollutants from sites, such as smoke stacks, manufacturing plants or mechanical equipment.
- Maintain files, such as hazardous waste databases, chemical usage data, personnel exposure information or diagrams showing equipment locations.
- Develop testing procedures or direct activities of workers in laboratory.
- Prepare samples or photomicrographs for testing and analysis.
- Calibrate microscopes or test instruments.
- Examine and analyze material for presence and concentration of contaminants, such as asbestos, using variety of microscopes.

Installation, Maintenance and Repair Technicians

Standard Occupational Code: 49-0000

Other Job Title(s): Maintenance Technician, Mechanic, Auto Technician, Facilities Technician, Maintenance Supervisor, Maintenance Worker, Service Technician

Description: Perform work involving the skills of two or more maintenance or craft occupations to keep machines, mechanical equipment or the structure of an establishment in repair. Duties may involve pipe fitting, boiler making, insulating, welding, machining, carpentry, repairing electrical or mechanical equipment, installing, aligning and balancing new equipment and repairing buildings, floors or stairs.

Fast Facts			
Current Employment (2013)		50,958	
Projected Employment (2018)		53,769	
Growth Rate (2013-2018)		6%	
Average Annual Openings (2013-2018)		1,861	
Hourly Pay Range		\$16.75 Entry-level	\$21.57 Median
Typical Educational Attainment		High School diploma or equivalent to Associate degree	

Top Skills and Competencies

Technical	Non-Technical
Repair	Communication
Schematic Diagrams	Troubleshooting
Plumbing	Customer Service
Inspection	Organization
HVAC	Writing

Occupational Tasks







- Use tools ranging from common hand and power tools, such as hammers, hoists, saws, drills and wrenches, to precision measuring instruments and electrical and electronic testing devices.
- Perform routine preventive maintenance to ensure that machines continue to run smoothly, building systems operate efficiently, or the physical condition of buildings does not deteriorate.
- Inspect, operate, or test machinery or equipment to diagnose machine malfunctions.
- Diagnose mechanical problems and determine how to correct them, checking blueprints, repair manuals or parts catalogs as necessary.
- Assemble, install, or repair wiring, electrical or electronic components, pipe systems, plumbing, machinery or equipment.
- Inspect drives, motors, and belts, check fluid levels, replace filters or perform other maintenance actions, following checklists.
- Clean or lubricate shafts, bearings, gears or other parts of machinery.

Food Processing Workers

Standard Occupational Code: 51-3000

Other Job Title(s): Meat Clerk, Manufacturing Engineer, Manufacturing Technician, Bakery Clerk, Welder, Assembler, CNC Machinist, Machinist, Quality Engineer, Quality Assurance Specialist, Production Manager

Description: Operate or tend cooking equipment, such as steam cooking vats, deep fry cookers, pressure cookers, kettles and boilers, to prepare food products, set up and operate equipment that mixes or blends ingredients used in the manufacturing of food products. Includes candy makers and cheese makers. Operate or tend food or tobacco roasting, baking or drying equipment, including hearth ovens, kiln driers, roasters, char kilns and vacuum drying equipment.

Fast Facts			
Current Employment (2013)		4,815	
Projected Employment (2018)		5,320	
Growth Rate (2013-2018)		10%	
Average Annual Openings (2013-2018)		235	
Hourly Pay Range		\$9.59 Entry-level	\$11.40 Median
Typical Educational Attainment		Less than High School diploma to High School diploma or equivalent	

Top Skills and Competencies

Technical	Non-Technical
Physical Demand	Customer Service
Merchandising	Communication
Mathematics	Organization
Cleaning	Lotus Notes
Cooking	Positive Disposition

Occupational Tasks







- Tend or operate and control equipment such as kettles, cookers, vats and tanks and boilers, to cook ingredients or prepare products for further processing.
- Set temperature, pressure and time controls, and start conveyers, machines or pumps.
- Clean, wash and sterilize equipment and cooking area, using water hoses, cleaning or sterilizing solutions or rinses.
- Observe gauges, dials and product characteristics, and adjust controls to maintain appropriate temperature, pressure and flow of ingredients.
- Listen for malfunction alarms and shut down equipment and notify supervisors when necessary.
- Remove cooked material or products from equipment.
- Turn valves or start pumps to add ingredients or drain products from equipment and to transfer products for storage, cooling or further processing.

Inspectors, Testers, Sorters, Samplers and Weighers

Standard Occupational Code: 51-9061

Other Job Title(s): Quality Control Associate, Quality Control Assistant, Quality Control Coordinator, Quality Assurance Analyst, Quality Assurance Auditor, Quality Assurance Specialist, Quality Inspector, Mechanical Inspector

Description: Inspect, test, sort, sample or weigh nonagricultural raw materials or processed, machined, fabricated or assembled parts or products for defects, wear and deviations from specifications. May use precision measuring instruments and complex test equipment.

Fast Facts			
Current Employment (2013)		4,548	
Projected Employment (2018)		4,987	
Growth Rate (2013-2018)		10%	
Average Annual Openings (2013-2018)		194	
Hourly Pay Range		\$14.49 Entry-level	\$18.44 Median
Typical Educational Attainment		High School diploma or equivalent	
		\$23.33 Experienced	

Top Skills and Competencies

Technical	Non-Technical
Inspection	Quality Assurance and Control
Micrometers	Communication
Calipers	Writing
Mathematics	Microsoft Excel
Repair	Organization

Occupational Tasks

- Inspect, test or measure materials, products or work for conformance to specifications.
- Measure dimensions of products to verify conformance to specifications, using measuring instruments such as rulers, calipers, gauges or micrometers.
- Read blueprints, data, manuals or other materials to determine specifications, inspection and testing procedures, adjustment methods, certification processes, formulas or measuring instruments required.
- Record inspection or test data, such as weights, temperatures, grades, or moisture content and quantities inspected or graded.
- Mark items with details such as grade or acceptance-rejection status.
- Discard or reject products, materials, or equipment not meeting specifications.
- Collect or select samples for testing or for use as models.
- Write test or inspection reports describing results, recommendations or needed repairs.

APPENDIX B: DEFINITIONS

North American Industry Classification System (NAICS) Codes for Advanced Manufacturing

NAICS	Description
31-33	Manufacturing
511210	Software Publishers
512110	Motion Picture and Video Production
512191	Teleproduction and Other Postproduction Services
517110	Wired Telecommunications Carriers (except Satellite)
517410	Satellite Telecommunications
517911	Telecommunication Resellers
517919	All Other Telecommunications
541330	Engineering Services
541380	Testing Laboratories
541420	Industrial Design Services
541511	Customer Computer Programming Services
541614	Process, Physical Distribution, and Logistics Consulting Services
541620	Environmental Consulting Services
541690	Other Scientific and Technical Consulting Services
541711	Research and Development in Biotechnology
541712	Research and Development in Physical, Engineering, and Life Sciences (except Biotechnology)
811211	Consumer Electronics Repair and Maintenance
811212	Computer and Office Machine Repair Maintenance
811213	Communication Equipment Repair and Maintenance
811219	Other Electronic and Precision Equipment Repair and Maintenance
822310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic)

Standard Occupational Classification (SOC) Codes for Advanced Manufacturing

SOC	Description
Computer/Software Occupations	
15-1132	Software Developers, Applications
15-1133	Software Developers, Systems Software
15-1151	Computer User Support Specialists
Engineering Occupations	
17-2061	Computer Hardware Engineers
17-2071	Electrical Engineers
17-2141	Mechanical Engineers
Drafter and Technician Occupations	
17-3029	Engineering Technicians, Except Drafters, all Other
19-4031	Chemical Technicians
19-4091	Environmental Science and Protection Technicians, Including Health
Production Occupations	
49-0000	Installation, Maintenance, and Repair Occupations
51-3000	Food Processing Workers
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers

APPENDIX C: METHODOLOGY

The first challenge in conducting this research study was to define what constitutes “Advanced Manufacturing.” After speaking with industry leaders, educators, and economic groups, it quickly became apparent that there is no consensus within industry on the definition of Advanced Manufacturing. Since the sector can cut across virtually any industry, it is difficult to demarcate hard rules for inclusion and exclusion in this group using traditional cluster or sector analysis. Thus, the research team defined the Advanced Manufacturing sector as a group of companies that self-identified as using any of the following processes/technologies in their operations:

- Computer technologies (e.g. Computer-Aided Design/Computer-Aided Manufacturing)
- High-precision technologies
- Robotics, automation, sustainable technologies
- Information technologies
- Nanotechnology
- Lean production processes
- Cutting-edge materials

The research design utilized both qualitative and quantitative approaches to identify and assess the specific skills and knowledge that employers are looking for and to perform a jobs gap assessment and career pathways analysis. The research study relied on a combination of surveys, semi-structured interviews, focus groups and quantitative analyses to elucidate the four major phases of research identified below.

(1) Defining Jobs and Industries that Meet the Sector Definition

In the first phase of the project, UCSD Extension and the East County EDC worked with the experts at SDWP and Centers of Excellence for Labor Market Research (COE) to refine the occupational definitions used in conducting the research. While many of the NAICS and SOC codes are defined in the existing literature, the team found it important to understand the unique economic clusters in San Diego to customize the Advanced Manufacturing report to the region.

(2) Jobs Gap Assessment

UCSD Extension, with the support of CONNECT and the East County EDC, provided an analysis of the supply and demand of the occupations meeting the sector definition identified above. The five elements of this research and corresponding methodologies are described below:

2a. Job demand in the short-term (12 months): The data collection for short-term job demand began with a quantitative analysis of survey responses. UCSD and East County EDC used pre-established relationships with industry to supplement employer outreach and accelerate the outreach and industry collaboration that this grant required.

2b. Job demand in the long run (5 years): Using BLS to forecast demand for sector-specific occupations, the research team was able to estimate future trends based on historical data.

2c. Supply of eligible workers: The research team inventoried and categorized the educational resources and training available to job seekers.

The following educational institutions are tracked by NCES data. The latest year for which these data were available was 2012.

San Diego County California Community College Educational Training Programs in Labor Supply Analysis

University of California, San Diego
 California State University, San Marco
 Grossmont-College Cuyamaca Community College District
 Mira Costa College
 San Diego Community College District

San Diego State University
 Point Loma Nazarene University
 Palomar Community College District
 Southwestern Community College District
 Imperial College

2d. Alignment of job demand with labor supply: To ascertain the alignment of job demand with labor supply, the data from 2b and 3b was analyzed in order to present a full picture of the future job gap (if any). Every two years, the BLS estimates job openings for all SOC codes 10 years in the future. Using this and other sources, Economic Modeling Specialists International (EMSI), estimates the number of annual openings in each occupation. The research team used this analysis as a springboard to pinpoint key drivers and parameters that demonstrate when there's a job gap.

2e. Economic size and scope of the industries with these jobs: A cluster analysis of the economic size and scope was created to portray the Advanced Manufacturing sector within the San Diego County economic ecosystem. The East County EDC's Connectory.com (Connectory), a database that contains detailed capabilities profiles of more than 22,000 industrial and technology companies at every level of the supply chain, contributed to this effort.

(3) Overall Assessment of Employers' Workforce Needs

3a. Surveys: To understand the overall environment and changes in the Advanced Manufacturing space, the research team conducted a representative sample survey of all employers meeting the sector definition. To quantify short-term demand for these occupations and to identify labor and skill drivers in these industries, the research team disseminated an online survey to 2,869 San Diego County companies and received responses from 241 Advanced Manufacturing companies (for the complete survey, see Appendix H). In addition, the team performed a random stratified sampling of the responses and conducted 26 employer interviews to get more detailed information regarding Advanced Manufacturers workforce needs. In addition, the research team used Burning Glass (a job market intelligence data firm) to acquire top in-demand specialized skills for occupations by analyzing 21,354 online job postings for San Diego Advanced Manufacturing positions. The research team was able to utilize East County EDC's Connectory, a database of primary industry businesses in the region, to provide a list of establishments in the Advanced Manufacturing sector. The team was uniquely positioned to conduct this work because of the Connectory's close connection with manufacturing and supply companies and the work the East County EDC did for SDWP's San Diego Regional Manufacturing Report. Building off the Connectory's database as well as the personal relationships with the employers in the region, the team worked with SDWP and COE to design and distribute the survey to collect pertinent data on the future of Advanced Manufacturing in San Diego.

The survey was sent through **Qualtrics** to all sector employers identified above. Each survey had a common core of items relating to a) identifying occupations in the Advanced Manufacturing sector, b) assessment of occupations with challenges finding qualified personnel, c) number as well as type of workers to be hired in the next 12 months, d) training programs or certifications for occupational skills that employer's value. The survey was constructed to collect pertinent company information for data analysis (i.e. size, occupations, necessary skill sets, etc.). Survey questions were collapsed across individual survey items to create a single composite score for each construct, rather than attempting to interpret individual scores from multiple questions. Preliminary data was scored and presented using exploratory data analysis (EDA).

3b. Interviews: A sample of employers across the industry sector was interviewed to probe beyond survey answers. Through these interviews, the research team gained employers' insight into their labor forecasts, an assessment of the skills they prioritize in new hires and feedback regarding the current education and training model and its effectiveness in developing the skillset employers have highlighted. Each interview

was semi-structured, creating a common core of questions, but leaving latitude to explore differences in attitudes, perceptions and challenges.

3c. Focus Groups: In order to capture broader themes across employers, industries, trade associations and educational providers, the evaluation team conducted focus groups. The focus groups included a subset of the employers identified in the data collection phase (n=10) as well as educational trainers and providers charged with developing the manufacturing workforce (n=10). The industry focus group answered questions regarding industry's definition of Advanced Manufacturing and provided guidance on the survey instrument. In addition, a second focus group with educational trainers and providers met to discuss attitudes, perceptions, and challenges and to identify collective themes.

Collectively, the utility of the interviews, surveys, and focus groups enabled a nuanced and sophisticated understanding of employer perceptions, as well as an illustration of their educational/training requirements.

3d. Specific in-demand skill sets: The Centers of Excellence provided the research team with Burning Glass job market intelligence data for each of the occupations listed in this report. Burning Glass data uses technologies to assess multiple online job postings for top specialized skills in demand by region.

(4) Career Pathway Diagrams

Using employer feedback and occupations and skills identified in the previous phases, as well as secondary BLS data and job boards such as Burning Glass, the research team created career pathway diagrams that show occupations, educational level needs, and median salaries. These diagrams serve as a guidepost for those seeking employment in the Advanced Manufacturing sector and identify clear channels to specific occupations.

APPENDIX D: BUSINESS PATTERNS DATA

Payroll and Establishments by Industry²⁹

NAICS code	NAICS description	Paid employees	Annual payroll (in \$1,000s)	Total establishments
311	Food Manufacturing	3,970	\$124,373	188
312	Beverage and Tobacco Product Manufacturing	1,030	\$46,351	42
313	Textile Mills			13
314	Textile Product Mills	492	\$15,734	62
315	Apparel Manufacturing	753	\$18,308	80
316	Leather and Allied Product Manufacturing	375	\$8,110	19
321	Wood Product Manufacturing	435	\$19,426	43
322	Paper Manufacturing	589	\$28,818	25
323	Printing and Related Support Activities	3,374	\$148,536	294
324	Petroleum and Coal Products Manufacturing	138	\$10,270	12
325	Chemical Manufacturing	8,123	\$795,102	162
326	Plastic and Rubber Products Manufacturing	4,424	\$233,646	106
327	Nonmetallic Mineral Product Manufacturing	1,528	\$60,415	85
331	Primary Metal Manufacturing	311	\$18,068	21
332	Fabricated Metal Product Manufacturing	8,178	\$386,838	434
333	Machinery Manufacturing	8,721	\$640,368	183
334	Computer and Electronic Product Manufacturing	18,653	\$1,521,260	344
335	Electrical Equipment, Appliance, and Component Manufacturing	2,656	\$226,406	73
336	Transportation Equipment Manufacturing	22,268	\$1,371,874	134
337	Furniture and Related Product Manufacturing	1,334	\$50,273	155
339	Miscellaneous Manufacturing	11,832	\$814,487	423
511210	Software Publishers	8,614	\$1,020,665	157
512110	Motion Picture and Video Production	325	\$17,324	118
512191	Teleproduction and Other Postproduction Services	N/A	N/A	18
517110	Wired Telecommunications Carriers	6,308	\$518,162	223

²⁹ Source: United States Census Bureau, 2012 County Business Patterns

517210	Wireless Telecommunications Carriers (Except Satellite)	N/A	N/A	122
517410	Satellite Telecommunications	N/A	N/A	4
517911	Telecommunications Resellers	N/A	\$16,058	25
517919	All Other Telecommunications	169	\$11,592	32
541330	Engineering Services	15,393	\$1,337,991	1,032
541380	Testing Laboratories	1,460	\$77,320	79
541420	Industrial Design Services	153	\$11,383	27
541511	Custom Computer Programming Services	7,862	\$614,367	1,053
541614	Process, Physical Distribution, and Logistics Consulting Services	432	\$24,259	105
541620	Environmental Consulting Services	1,114	\$75,542	127
541690	Other Scientific and Technical Consulting Services	2,077	\$130,130	614
541710	Research and Development in the Physical, Engineering, and Life Sciences	20,709	\$2,469,388	673
811210	Electronic Precision Equipment Repair and Maintenance	4,160	\$179,653	158
8113	Commercial and Industrial Machinery and Equipment (Except Automotive and Electronic) Repair and Maintenance	999	\$45,102	113

Size of Employees by Industry

NAICS Code	Industry Description	1-19 employees	20-99 employees	100-499 employees	500+ employees
311	Food Manufacturing	142	37	9	0
312	Beverage and Tobacco Product Manufacturing	33	7	2	0
313	Textile Mills	12	0	1	0
314	Textile Product Mills	54	8	0	0
315	Apparel Manufacturing	71	9	0	0
316	Leather and Allied Product Manufacturing	13	6	0	0
321	Wood Product Manufacturing	38	5	0	0
322	Paper Manufacturing	17	5	3	0
323	Printing and Related Support Activities	251	39	4	0

324	Petroleum and Coal Products Manufacturing	10	2	0	0
325	Chemical Manufacturing	115	32	12	3
326	Plastics and Rubber Products Manufacturing	64	33	8	1
327	Nonmetallic Mineral Product Manufacturing	61	23	1	0
331	Primary Metal Manufacturing	16	4	1	0
332	Fabricated Metal Product Manufacturing	329	89	16	0
333	Machinery Manufacturing	126	44	10	3
334	Computer and Electronic Product	222	84	34	4
335	Electrical Equipment, Appliance, and Component Manufacturing	53	13	6	1
336	Transportation Equipment Manufacturing	81	30	15	8
337	Furniture and Related Product Manufacturing	142	12	1	0
339	Miscellaneous Manufacturing	353	48	16	6
511210	Software Publishers	97	44	13	3
512110	Motion Picture and Video Production	117	1	0	0
512191	Teleproduction and Other Postproduction Services	17	0	1	0
517110	Wired Telecommunications carriers	174	38	8	3
517210	Wireless Telecommunications Carriers (Except Satellite)	83	35	4	0
517410	Satellite Telecommunications	4	0	0	0
517911	Telecommunications Resellers	23	2	0	0
517919	All Other Telecommunications	31	1	0	0
541330	Engineering Services	883	123	24	2
541380	Testing Laboratories	64	12	3	0
541420	Industrial Design Services	25	2	0	0
541511	Custom Computer Programming Services	973	69	10	1
541614	Process, Physical Distribution, and Logistics Consulting Services	101	4	0	0
541620	Environmental Consulting Services	111	14	2	0

Advanced Manufacturing

541690	Other Scientific and Technical Consulting Services	598	15	1	0
541710	Research and Development in the Physical, Engineering, and Life Sciences	495	130	41	7
811210	Electronic and Precision Equipment Repair and Maintenance	144	10	3	1
8113	Commercial and Industrial Machinery and Equipment (Except Automotive and Electronic) Repair and Maintenance)	98	13	2	0
	Total	6,241	1,043	251	43
	Percent of All Firms	82.36%	13.76%	3.31%	0.57%

APPENDIX E: LONG-TERM EMPLOYMENT PROJECTIONS

SOC	Description	2013 Jobs	2018 Jobs	Change	Annual Openings
Software Occupations		21,797	24,186	2,389	801
15-1130	Software Engineer/Programmer Analyst/Developers	14,440	16,119	1,679	536
15-1151	Computer User Support Specialists	5,891	6,500	609	221
15-1152	Computer Network Support Specialists	1,466	1,567	101	44
Engineering Occupations		11,580	12,453	873	496
17-2011	Aerospace Engineers	1,355	1,566	211	77
17-2031	Biomedical Engineers	468	573	105	34
17-2061	Computer Hardware Engineers	3,561	3,592	31	89
17-2071	Electrical Engineers	2,387	2,556	169	88
17-2111	Industrial Safety and Health Engineers	263	292	29	14
17-2141	Mechanical Engineers	3,546	3,874	328	194
Drafter and Technician Occupations		5,232	6,008	776	290
17-3013	Mechanical Drafters	388	402	14	9
17-3021	Aerospace Engineering and Operations Technicians	186	202	16	7
17-3024	Electro-Mechanical Technicians	308	336	28	12
17-3025	Environmental Engineering Technicians	214	269	55	16
17-3027	Mechanical Engineering Technicians	701	772	71	30
17-3029	Engineering Technicians, Except Drafters	1,619	1,707	88	52
19-4031	Chemical Technicians	550	836	286	75
19-4051	Nuclear Technicians	131	150	19	9
19-4091	Environmental Science and Protection Technicians, Environmental Health Specialists	493	627	134	49
29-9011	Occupational Health and Safety Specialists	642	707	65	31

Production Occupations		86,867	89,823	2,956	2,753
49-0000	Installation, Maintenance and Repair Occupations	41,640	43,803	2,163	1,455
51-2000	Assemblers and Fabricators	16,869	16,433	436	301
51-3000	Food Processing Workers	4,816	5,320	504	234
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	734	794	60	34
51-4012	Computer Numerically Controlled Machine Tool Programmers	212	240	28	12
51-4031, 4032, 4033, 4034, 4035	Machine Setters, Operators and Tenders	2,115	2,017	98	33
51-4041	Machinists	4,248	4,386	138	133
51-4060 and 51-7030	Model Makers and Patternmakers, Metal, Plastic or Wood	77	75	2	1
51-4111	Tool and Die Makers	275	292	17	5
51-4120	Welders, Cutters, Solderers, and Brazers	3,339	3,353	14	97
51-8000	Plant and System Operators	2,156	2,232	76	108
51-9061	Inspectors, Testers, Sorters, Samplers and Weighers	4,548	4,987	439	194
51-9110	Packaging and Filling Machine Operators and Tenders	1,966	2,078	112	71
51-9120	Painting Workers	1,077	1,076	1	24
51-9198	Helpers - Production Workers	2,795	2,737	58	51

Source: Economic Modeling Specialists International. Dataset 2014.2 - QCEW Employees, Non-QCEW Employees, and Self-Employed

APPENDIX F: ANNUAL AWARDS OR COMPLETIONS BY PROGRAMS

Production Occupations

Institution	SOC All Production Occupations	49-0000 Installation, Maintenance and Repair Occupations	51-2000 Assemblers and Fabricators	51-3000 Food Processing Workers	51-4011 Computer- Controlled Machine Tool Operators, Metal and Plastic
A.A./A.S.					
Cuyamaca College	4	4			
Grossmont College	24	0		24	
Imperial College	3	0			
Mira Costa College	14	14			
Palomar College	30	9			
SD Adult	0	0			
SD City College	47	31			4
SD Mesa College	18	8		10	
SD Miramar College	74	49	25		
Southwestern College	23	20		3	
Certificates					
Cuyamaca College	58	4			
Grossmont College	40	0		40	
Imperial College	19	7			
Mira Costa College	65	65			
Palomar College	280	155		2	
SD Adult	922	505		373	
SD City College	291	153			23
SD Mesa College	26	10		16	
SD Miramar College	139	85	54		
Southwestern College	36	30		6	
Total	2,113	1,149	79	474	27

Production Occupations Cont.

Institution	51-4012 Computer Numerically Controlled Machine Tool Programmers	51-4031, 4032, 4033, 4034, 4035 Machine Setters, Operators and Tenders	51-4041 Machinists	51-4060 and 51-7030 Model Makers and Patternmakers, Metal, Plastic or Wood	51-4120 Welders, Cutters, Solderers and Brazers	51-8000 Plant and System Operators
A.A./A.S.						
Cuyamaca College						
Grossmont College						
Imperial College						3
Mira Costa College						
Palomar College				1	6	14
SD Adult						
SD City College	4	4	4			
SD Mesa College						
SD Miramar College						
Southwestern College						
Certificates						
Cuyamaca College						54
Grossmont College						
Imperial College					7	5
Mira Costa College						
Palomar College		30		38	30	25
SD Adult					44	
SD City College	23	46	23	23		
SD Mesa College						
SD Miramar College						
Southwestern College						
Total	27	80	27	62	87	101

Engineering Occupations

Institution	SOC All Engineering Occupations	17-2011 Aerospace Engineers	17-2031 Biomedical Engineers	17-2061 Computer Hardware Engineers	17-2071 Electrical Engineers	17-2111 Industrial Safety and Health Engineers	17-2141 Mechanical Engineers
B.A./B.S.							
CSUSM	0						
PLNU	0						
SDSU	178	23		24	46		85
UCSD	532	46	162	28	108	22	166
USD	40				15		25
Total	750	69	162	52	169	22	276

Computer/Software Occupations

Institution	SOC All Computer/ Software Occupations	15-1132 Software Engineer/Pro grammer Analyst/Deve loper, Applications	15-1133 Software Developers, Systems Software	15-1151 Computer User Support Specialists	15-1152 Computer Network Support Specialists
B.A./B.S.					
CSUSM	87	29	29		29
PLNU	18	6	6		6
SDSU	213	79	79		55
UCSD	619	225	211		183
USD	18	6	6		6
A.A./A.S.					
Cuyamaca College	0				
Grossmont College	9	3	3		3

Imperial College	31	15	15		1
Mira Costa College	12	4	4		4
Palomar College	23	8	8		7
SD Adult	0				
SD City College	10	5	5		
SD Mesa College	14	7	7		
SD Miramar College	6	3	3		
Southwestern College	15	4	4	3	4
Certificates					
Cuyamaca College	2	1	1		
Grossmont College	12	4	4		4
Imperial College	10	5	5		
Mira Costa College	9	3	3		3
Palomar College	47	15	15	4	13
SD Adult	0				
SD City College	2	1	1		
SD Mesa College	12	6	6		
SD Miramar College	10	5	5		
Southwestern College	8			4	4
Total	1,187	434	420	11	322

Drafting and Technician Occupations

Institution	SOC All Drafter and Technician Occupations	17-3013 Mechanical Drafters	17-3021 Aerospace Engineering and Operations Technicians	17-3029 Engineering Technicians, Except Drafters	29-9011 Occupational Health and Safety Specialists
B.A./B.S.					
CSUSM					
National University	6		4	2	
PLNU	7		7		
SDSU					
UCSD	47		47		
USD	10		10		
A.A./A.S.					
Cuyamaca College	12	6			6
Grossmont College	0				
Imperial College	0				
Mira Costa College	8	3		5	
Palomar College	10	10			
SD Adult	0				
SD City College	9			9	
SD Mesa College	3				
SD Miramar College	15		15		
Southwestern College	16	4		8	2
Cuyamaca College	6	3			3
Grossmont College	0				
Imperial College	4			4	
Mira Costa College	23	6		17	
Palomar College	10	10			
SD Adult	242			242	
SD City College	68	1		67	
SD Mesa College	0				

SD Miramar College	28		28		
Southwestern College	20	5		9	6
Total	469	48	43	361	17

Institution	19-4031 Chemical Technicians	19-4051 Environmental Science and Protection Technicians, Environmental Health Specialists	17-3025 Environmental Engineering Technicians	19-4051 Nuclear Technicians	17-3024 Electro-Mechanical Technicians
B.A./B.S.					
CSUSM					
National University		4	2		
PLNU		7			
SDSU					
UCSD		47			
USD		10			
A.A./A.S.					
Cuyamaca College					
Grossmont College					
Imperial College					
Mira Costa College					
Palomar College					
SD Adult					
SD City College					2
SD Mesa College	3				
SD Miramar College					
Southwestern College	2				
Cuyamaca College					
Grossmont College					
Imperial College					

Mira Costa College		10			
Palomar College					
SD Adult					
SD City College					
SD Mesa College					
SD Miramar College					
Southwestern College					
Total	5	78	2	0	2

APPENDIX G: JOB GAPS DATA

Description	Supply (Total Awards in 2012)	Demand (Annual Openings)	Over- Supply/ Job Gap*
Software Occupations			
Software Engineer/Programmer Analyst/Developer	434	536	-102
Computer User Support Specialists	11	221	-210
Computer Network Support Specialists	322	44	278
Engineering Occupations			
Aerospace Engineers	69	77	-8
Biomedical Engineers	162	34	-128
Computer Hardware Engineers	52	89	-37
Electrical Engineers	169	88	81
Industrial Safety and Health Engineers	22	14	8
Mechanical Engineers	276	194	82
Drafter and Technician Occupations			
Mechanical Drafters	48	9	39
Aerospace Engineering and Operations Technicians	43	7	36
Electro-Mechanical Technicians	2	17	-17
Environmental Engineering Technicians	2	16	-14
Mechanical Engineering Technicians	0	30	-30
Engineering Technicians, Except Drafters	361	52	309
Chemical Technicians	5	75	-70
Nuclear Technicians	0	9	-9
Environmental Science and Protection Technicians, Environmental Health Specialists	78	49	29
Occupational Health and Safety Specialists	17	31	-14
Production Occupations			
Installation, Maintenance and Repair Occupations	1149	1,455	-306
Assemblers and Fabricators	79	301	-222
Food Processing Workers	474	234	240

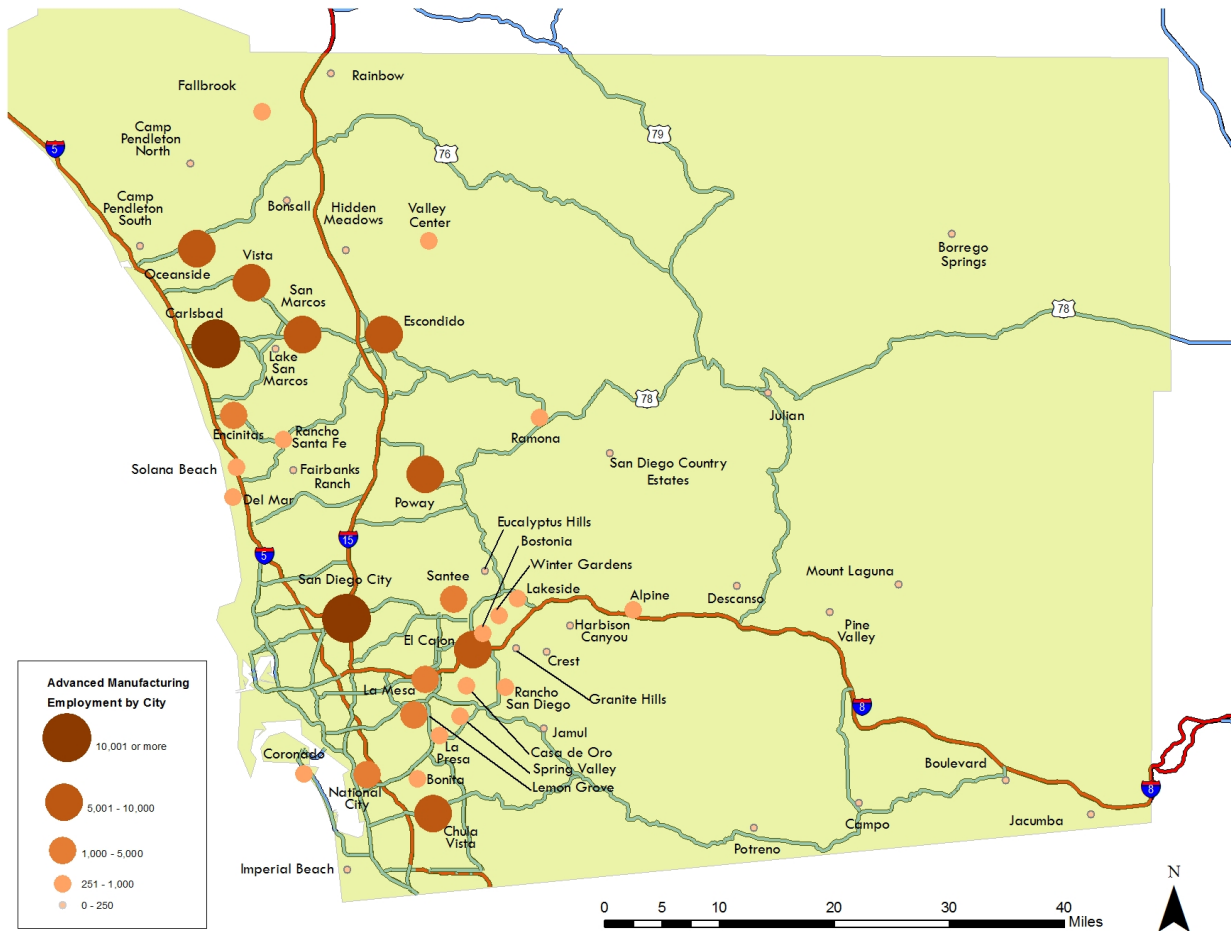
Computer-Controlled Machine Tool Operators, Metal and Plastic	27	34	-7
Computer Numerically Controlled Machine Tool Programmers	27	12	15
Machine Setters, Operators and Tenders	80	33	47
Machinists	27	133	-106
Model Makers and Patternmakers, Metal, Plastic or Wood	62	1	61
Tool and Die Makers	0	5	-5
Welders, Cutters, Solderers, and Brazers	87	97	-10
Plant and System Operators	101	108	-7
Inspectors, Testers, Sorters, Samplers and Weighers	0	194	-194
Packaging and Filling Machine Operators and Tenders	0	71	-71
Painting Workers	0	24	-24
Helpers - Production Workers	0	51	-51

APPENDIX H: ADVANCED MANUFACTURING EDUCATION AND TRAINING

Company Name	Type of Training	# Trained Annually	Website
CACT, City College	Advanced Rapid Prototyping Technical Assistance, Lean and Six Sigma, Master CAM & CNC Machining, RF Technician 1-4, Team Building & Change Mgmt., EPA Certification	300	www.makingitincalifornia.com/centers_san_diego.php
County of SD- Comprehensive Training Systems (CTS)	Comprehensive Training Systems (CTS)	80	www.ctsjobs.org
Cuyamaca College	Engineering Graphics, CADD, 3D Solid Modeling, Dimension and Tolerance, Electronic Drafting, Survey Drafting	295	www.cuyamaca.edu
Employee Training Institute	Engineering Graphics, Manufacturing, Supply Chain Management (SCM)	732	www.TrainWithETi.com
Imperial Valley Regional Occupational Program	Machining, Welding, Blueprint Reading	~40	www.ivrop.org
Machinists Apprenticeship	Machining, CAD, CAM, CNC, Environmental, Health and Safety (ES&H) Instruction	***	www.calapprenticeship.org/programs/machinists_apprenticeship.php
Mira Costa College	OSHA Safety, Machine Shop Math, Blueprint Reading, Computer-Assisted Inspection, Machine Tool, Fixture Tooling, Machining (manual and CNC), CNC Programming, Shop Inspection, CAD, CNC Lathes and Milling	47	www.miracostatraining.com/Machinist_Program.html
Progressive Edge	Lean Six Sigma	***	www.progressiveedge.com
Quality Controlled Manufacturing Inc. (QCMI)/ Grande Foundation		10	qualitycontrolledmanufacturinginc.com ,.

San Diego State University	Lean Six Sigma	50	www.ces.sdsu.edu
San Diego City College	Machine Technology Courses (MACT), Manufacturing Engineering Technology (MFET) program, Lean Manufacturing, Manufacturing Automation, CNC, Electrical Discharge Machining (EDM), CAD/CAM, CNC Vertical Machining	MACT ~500 MFET ~120	
SD Continuing Education	Metal Fabrication, Flux Cored Arc Welding (FCAW), Gas Metal Arc Welding (GMAW), Shielded Metal Arc Welding (SMAW), Plasma Arc Welding (PAW), Gas Tungsten Arc Welding (GTAW), Pipe Welding	3,136	www.sdce.edu/job-training/welding www.sdce.edu/job-training/metal-trades
SD County Career Technical Education and Regional Occupational Program	Biotechnology Services, Cabinetmaking, Computer Integrated Manufacturing, Drafting/Computer-Aided, Fine Woodworking, Furniture Manufacturing/Finishing, Guitar Manufacturing, Machine Tool Technology, Metal Design, Fabrication, and Welding,	2,630	www.sdcoe.net/student-services/rop/Pages/default.aspx
Southwestern College	CADD, 3SD Modeling, CAD/CAM	~175	www.swccd.edu/index.aspx?page=2190
UCSD Extension	Lean Six Sigma	126	www.extension.ucsd.edu
University of San Diego	Lean Six Sigma	30	www.sandiego.edu
Workshops for Warriors	CAD/CAM Software, CNC Machines, Machining, Welding	256	www.workshopsforwarriors.org

APPENDIX I: MAP OF ADVANCED MANUFACTURING FIRMS



Data source InfoUSA.

Map designed by Centers of Excellence, San Diego and Imperial Region.

APPENDIX J: EMPLOYER SURVEY

This instrument has been edited and cleaned to include only key questions from the survey.

1. In what county is the facility you work located?
 - San Diego County
 - Imperial County
 - Neither

2. In what zip code is your facility located?

3. Does the company you work for manufacture or produce products or goods?
 - Yes
 - No

4. Are you familiar with manufacturing jobs and their specific job duties and requirements (skills, experience, education) at your company?
 - Yes
 - No

5. Does your company use any of the following manufacturing processes:
 - Computer technologies (e.g. CAD/CAM)
 - High-precision technologies
 - Robotics, automation, sustainable technologies
 - Information technologies
 - Nanotechnology
 - Lean production processes
 - Cutting edge materials
 - None of the above

6. From the following list please select one primary and, if applicable, secondary industries that best describe the type of products or goods your company produces.

Aircraft/aerospace	Food/edible goods	Lumber and wood products, except furniture	Primary metal industries
Apparel, finished products from fabrics & similar materials	Furniture	Measure/analyze/control instruments, photo/medical/ophthalmic goods, watches/clocks	Printing, publishing and allied industries
Automotive	Fixtures/fittings	Sporting and athletic goods	Signs and advertising specialties
Biotechnology	Games and toys	Stone, clay, glass, and concrete products	Tobacco products
Clean technology	Industrial and commercial machinery and computer equipment	Textile mill products	Transportation equipment
Chemicals and allied	Information and	Paper and allied products	Other (Specify)

products	communication technologies		
Electronic, electronic equipment and components, except computer equipment	Jewelry	Petroleum and miscellaneous plastic products	
Fabricate metal products, except machinery & transport equipment	Leather and leather products	Precious metals	

7. Approximately how many employees currently work at your location?
 - 1-20
 - 21-50
 - 51-150
 - 151-500
 - 501 or more

8. Which of the following occupational groups does your company currently employ? (Please select all that apply)
 - Computer/Software Occupations
 - Engineers
 - Drafters and Technicians
 - Production Occupations (assemblers, machinists, operators, welders, etc.)
 - None of the above

9. Which specific Computer/Software occupations does your company employ?
 - Software Engineer/Programmer Analyst/Developer (Applications and Systems)
 - Computer User Support Specialists/Technical Support/IT Specialists
 - Computer Network Support Specialists/LAN Specialists
 - Other: (4) _____

10. Please indicate whether your company has had (1) No difficulty, (2) Some difficulty, or (3) Significant difficulty in finding qualified employees to fill the following Computer/Software positions:
 - Software Engineer/Programmer Analyst/Developer (Applications and Systems)
 - Computer User Support Specialists/Technical Support/IT Specialists
 - Computer Network Support Specialists/LAN Specialists
 - Other

11. For Software Engineer/Programmer Analyst/Developer please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:

Software Engineer/Programmer Analyst/Developer	Computer User Support Specialists/Technical Support/IT Specialists	Computer Network Support Specialists/LAN Specialists
C++	Computer hardware and software	Local Area Network (LAN)
Electrical Engineering	Programming	Computer servers
JavaScript	Telecommunications	Hard disk arrays
Linux	Customer Service	Circuit testing
Software Engineering	Other:	Network security
SQL		Transaction security
Other:		Other:

12. Please indicate how many (1) Current employees your company has for each occupation, as well as how many, (2) Replacement positions (i.e. retirement), (3) More employees, or (4) Fewer employees your company expects to have in each Computer/Software occupation over the next 12 months.

13. Which specific Engineer occupations does your company employ?

- Agricultural Engineers
- Biomedical Engineers
- Computer Hardware Engineers
- Electrical Engineers
- Environmental Engineers
- Industrial Safety and Health Engineers
- Other: _____

14. Please indicate whether your company has had (1) No difficulty, (2) Some difficulty, or (3) Significant difficulty in finding qualified employees to fill the following Engineer positions:

- Agricultural Engineers
- Biomedical Engineers
- Computer Hardware Engineers
- Electrical Engineers
- Environmental Engineers
- Industrial Safety and Health Engineers
- Other: _____

15. For Agricultural Engineers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with following skills/knowledge:

- Product Sales
- Sales Management
- Other: _____

16. For Biomedical Engineers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with following skills/knowledge:

- Chemistry
- Geology
- Hydraulics

- Hydrology
 - Mathematics
 - Physics
 - Other
17. For Computer Hardware Engineers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Electrical Engineering
 - Hardware Engineering
 - Simulation
 - Verilog
 - VHSIC Hardware Description Language (VHDL)
 - Other
18. For Electrical Engineers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Circuit Design
 - Electrical Engineering
 - Physics
 - Repair
 - Simulation
 - Validation
 - Other
19. For Environmental Engineers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Business Development
 - Environmental Engineering
 - Environmental Science
 - Geology
 - Permitting
 - Other
20. For Industrial Safety and Health Engineers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Environmental Compliance
 - Environmental Health & Safety
 - Failure Modes and Effects Analysis (FMEA)
 - Hazardous Waste
 - Occupational Safety
 - Training Programs
 - Other
21. Please indicate how many (1) Current employees your company has for each occupation, as well as how many, (2) Replacement positions (i.e. retirement), (3) More employees, or (4) Fewer employees your company expects to have in each Engineering occupation over the next 12 months:
- Agricultural Engineers
 - Biomedical Engineers
 - Computer Hardware Engineers
 - Electrical Engineers
 - Environmental Engineers
 - Industrial Safety and Health Engineers
 - Other

22. Which specific Drafters and Technician occupations does your company employ?
- Mechanical Drafters
 - Aerospace Engineering and Operations Technicians
 - Civil Engineering Technicians
 - Electro-Mechanical Technicians
 - Environmental Engineering Technicians
 - Mechanical Engineering Technicians
 - Engineering Technicians, Except Drafters
 - Chemical Technicians
 - Nuclear Technicians
 - Environmental Science and Protection Technicians, Environmental Health Specialists
 - Other
23. For Mechanical Drafters, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- AutoCAD
 - Computer Aided Drafting/Design (CAD)
 - Mechanical Design/Engineering
 - Other
24. For Aerospace Engineering and Operations Technicians, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- .NET Programming
 - Computer Engineering
 - Debugging
 - Electrical Engineering
 - Hypertext Preprocessor
 - JavaScript
 - Other
25. For Civil Engineering Technicians, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Calibration
 - Computer Aided Drafting/Design (CAD)
 - Repair
 - Simulation
 - Soldering
 - Systems Integration
 - Other
26. For Electro-Mechanical Technicians, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Inspection
 - Oscilloscopes
 - Repair
 - Schematic Diagrams
 - Soldering
 - Other
27. For Environmental Engineering Technicians, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Biology

- Chemistry
 - Environmental Health & Safety
 - Environmental Science
 - Inspection
 - Physics
 - Other
28. For Mechanical Engineering Technicians, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Hand/Power Tools
 - Repair
 - Schematic Diagrams
 - Soldering
 - Wiring Diagrams
 - Other
29. For Engineering Technicians, Except Drafters, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Calibration
 - Cell Culturing
 - Inspection
 - Machine Operation
 - Manufacturing Processes
 - Repair
 - Other
30. For Chemical Technicians, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Chemistry
 - Enterprise Resource Planning (ERP)
 - Laboratory Equipment
 - Laboratory Procedures
 - Mathematics
 - Product Development
 - Other
31. For Nuclear Technicians, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Construction Management
 - Environmental Compliance
 - Inspection
 - Liquid Scintillation
 - Surveys
 - Other
32. For Environmental Science and Protection Technicians, Environmental Health Specialists, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Environmental Health & Safety
 - Hazardous Waste
 - Manufacturing Processes
 - Repair
 - Training Programs

- Other
33. Please indicate how many (1) Current employees your company has for each occupation, as well as how many, (2) Replacement positions (i.e. retirement), (3) More employees, or (4) Fewer employees your company expects to have in each Drafter and Technician occupation over the next 12 months:
- Mechanical Drafters
 - Aerospace Engineering and Operations Technicians
 - Civil Engineering Technicians
 - Electro-Mechanical Technicians
 - Environmental Engineering Technicians
 - Mechanical Engineering Technicians
 - Engineering Technicians, Except Drafters
 - Chemical Technicians
 - Nuclear Technicians
 - Environmental Science and Protection Technicians, Environmental Health Specialists
 - Other
34. Which specific Production Occupations (assemblers, machinists, operators, welders, etc.) does your company employ?
- Occupational Health and Safety Specialists (1)
 - Installation, Maintenance and Repair Occupations (2)
 - Assemblers and Fabricators (3)
 - Food Processing Workers (4)
 - Computer-Controlled Machine Tool Operators, Metal and Plastic (5)
 - Computer Numerically Controlled Machine Tool Programmers (6)
 - Machinists (7)
 - Model Makers and Pattern makers, Metal, Plastic or Wood (8)
 - Tool and Die Makers (9)
 - Welding, Soldering and Brazing Workers (10)
 - Plant and System Operators (11)
 - Inspectors, Testers, Sorters, Samplers and Weighers (12)
 - Packaging and Filling Machine Operators and Tenders (13)
 - Painting Workers (14)
 - Helpers - Production Workers (15)
 - Machine Setters, Operators and Tenders (16)
 - Other: (17) _____
35. Please indicate whether your company has had (1) No difficulty, (2) Some difficulty, or (3) Significant difficulty in finding qualified employees to fill the following Production Occupation (assemblers, machinists, operators, welders, etc.) positions:
- Occupational Health and Safety Specialists
 - Installation, Maintenance and Repair Occupations
 - Assemblers and Fabricators
 - Food Processing Workers
 - Computer-Controlled Machine Tool Operators, Metal and Plastic
 - Computer Numerically Controlled Machine Tool Programmers
 - Machinists
 - Model Makers and Pattern makers, Metal, Plastic or Wood
 - Tool and Die Makers
 - Welding, Soldering and Brazing Workers

- Plant and System Operators
 - Inspectors, Testers, Sorters, Samplers and Weighers
 - Packaging and Filling Machine Operators and Tenders
 - Painting Workers
 - Helpers - Production Workers
 - Machine Setters, Operators and Tenders
 - Other
36. For Occupational Health and Safety Specialists, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Chemistry
 - Inspection
 - Occupational Safety
 - Toxicology
 - Other
37. For Installation, Maintenance and Repair Occupations, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Hand/Power Tools
 - HVAC
 - Inspection
 - Plumbing
 - Repair
 - Schematic Diagrams
 - Other
38. For Assemblers and Fabricators, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Environmental Compliance
 - Hard/Power Tools
 - Mathematics
 - Oracle
 - SAP
 - Schematic Diagrams
 - Six Sigma
 - Other
39. For Food Processing Workers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Active listening
 - Hand/Finger dexterity
 - Deductive reasoning
 - Oral comprehension
 - Operation control
 - Other
40. For Computer-Controlled Machine Tool Operators, Metal and Plastic, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Blueprint reading
 - Calipers
 - CNC Mill
 - Computer Numerical Control (CNC)

- Grinders
 - Inspection
 - Lathes
 - Machine Operation
 - Machining
 - Micrometers
 - Other
41. For Computer Numerically Controlled Machine Tool Programmers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- 5-Axis Machining
 - Computer Aided Manufacturing (CAM)
 - Computer Numerical Control (CNC)
 - Inspection
 - Lathes
 - Machining
 - Micrometers
 - Other
42. For Machinists, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Computer Numerical Control (CNC)
 - Lathes
 - Machining
 - Mathematics
 - Micrometers
 - Repair
 - Other
43. For Model Makers and Pattern makers, Metal, Plastic or Wood, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Calipers
 - Capability Maturity Model (CMM)
 - Computer Aided Drafting/Design (CAD)
 - Inspection
 - Machine Operation
 - Prototyping
 - Other
44. For Tool and Die Makers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Blueprint Reading
 - Lathes
 - Machining
 - Repair
 - Other
45. For Welding, Soldering and Brazing Workers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Hand/Power Tools
 - Inspection

- Repair
 - Schematic Diagrams
 - Soldering
 - Other
46. For Plant and System Operators, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Blueprint Reading
 - HVAC
 - Inspection
 - Repair
 - Schematic Diagrams
 - Other
47. For Inspectors, Testers, Sorters, Samplers and Weighers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Calibration
 - Calipers
 - Inspection
 - Mathematics
 - Micrometers
 - Validation
 - Other
48. For Packaging and Filling Machine Operators and Tenders, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Inventory Maintenance
 - Logistics
 - Packaging
 - Other
49. For Painting Workers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Blueprint Reading
 - Inspection
 - Machine Operation
 - Manufacturing Processes
 - Painting
 - Repair
 - Technical Writing/Editing
 - Other
50. For Helpers - Production Workers, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:
- Environmental Compliance
 - Inspection
 - Machine Operation
 - Mathematics
 - Repair
 - Other
51. For Machine Setters, Operators and Tenders, please indicate if your company has (1) No difficulty, (2) Some difficulty, or (3) Great difficulty hiring applicants with the following skills/knowledge:

- Blueprint Reading
 - Computer Numerical Control (CNC)
 - Grinders
 - Hand/Power Tools
 - Inspection
 - Lathes
 - Machine Operation
 - Machining
 - Schematic Diagrams
 - Other
52. Please indicate how many (1) Current employees your company has for each occupation, as well as how many, (2) Replacement positions (i.e. retirement), (3) More employees, or (4) Fewer employees your company expects to have in each Production Occupation (assemblers, machinists, operators, welders, etc.) over the next 12 months:
- Occupational Health and Safety Specialists
 - Installation, Maintenance and Repair Occupations
 - Assemblers and Fabricators
 - Food Processing Workers
 - Computer-Controlled Machine Tool Operators, Metal and Plastic
 - Computer Numerically Controlled Machine Tool Programmers
 - Machinists
 - Model Makers and Pattern makers, Metal, Plastic or Wood
 - Tool and Die Makers
 - Welding, Soldering and Brazing Workers
 - Plant and System Operators
 - Inspectors, Testers, Sorters, Samplers and Weighers
 - Packaging and Filling Machine Operators and Tenders
 - Painting Workers
 - Helpers - Production Workers
 - Machine Setters, Operators and Tenders
 - Other
53. Are there any external training or certification program(s) that your company uses?
- Yes
 - No
54. Are there any external training or certification program(s) that your company uses? If yes, which ones?
55. Are there any internal training programs within your company?
- Yes
 - No

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