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# ECONOMIC IMPACT OF THE CENTRAL COAST AEROSPACE, DEFENSE, AND PRECISION MANUFACTURING SECTOR



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**REACH** is a Regional Economic Action Coalition uniting public, private and civic leaders across the Central Coast of California. REACH's goal is to transform the quality of life on the Central Coast, a region of about 700,000 people in dozens of cities and towns in the Counties of San Luis Obispo and Santa Barbara. The mission of the private sector-led coalition is to increase economic prosperity through big thinking, bold action, and regional collaboration.

reachcentralcoast.org



#### **CONSULTING TEAM**





TIP Strategies, Inc., is a privately held firm providing consulting and advisory services to public and private sector clients. Established in 1995, the firm's core competencies are strategic planning for economic development, talent strategies, organizational development, resiliency planning, and equity initiatives. TIP is headquartered in Austin, Texas, with offices coast-to-coast.

**Lightcast** is the global leader in labor market analytics. Formerly Emsi Burning Glass, the firm has over two decades of experience providing businesses, communities, and education institutions with the best labor market data possible. Lightcast's data-driven insight enables better, faster decisions. The firm is headquartered in Boston, Massachusetts, and Moscow, Idaho.

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# EXECUTIVE SUMMARY



# **ABOUT THIS WORK**

This analysis was completed as a supplement to the preparation of a comprehensive economic development strategy (CEDS) for the Central Coast region of California, which encompasses the Counties of San Luis Obispo and Santa Barbara. It is one of four studies designed to gauge the economic impact of the region's target sectors. The other three are Agriculture and Agtech, Clean Tech and Renewable Energy, and Technology. The work was commissioned by REACH, an independent 501(c)(3) organization committed to creating a more prosperous and inclusive economy in the Counties of San Luis Obispo and Santa Barbara, and supported by funding from the US Economic Development Administration.

#### CENTRAL COAST TARGET SECTORS

- + Aerospace, Defense, and Precision Manufacturing
- + Agriculture and Agtech
- + Clean Tech and Renewable Energy
- + Technology

This report focuses on Aerospace, Defense, and Precision Manufacturing, a cluster that encompasses the region's rich air and space legacy along with the advanced manufacturing processes that contribute to multiple industries across the Central Coast.<sup>1</sup> Insights gained from this work, and from industry roundtables conducted as part of the CEDS planning process, will support the region's growth of this critical sector.



<sup>&</sup>lt;sup>1</sup> See the appendices for the definition of the two sectors used in this report: Aerospace and Defense (Figure 28, page 49) and Precision Manufacturing (Figure 29, page 50).

Key findings from the team's research and analysis are summarized in the remainder of this section. It is followed by an exploration of the landscape for Aerospace and Defense and for Precision Manufacturing in terms of each sector's assets, employment trends, and talent pipeline. The quantitative analyses presented in this overview draw on an extensive interactive data visualization created by TIP Strategies using proprietary data prepared by national labor market data provider, Lightcast.<sup>2</sup> The final section of the report presents the results of an economic impact analysis—as measured by job creation, earnings, and added tax revenue—conducted by Lightcast. Supporting details, including an explanation of the federal classification systems referenced in this work (Classification Systems, page 64) and a list of the industries that were used to define Aerospace and Defense (Figure 28, page 49) and Precision Manufacturing (Figure 29, page 50), are provided as appendices.

## **KEY FINDINGS**

### A pioneer in space launch, infrared, and sensing technologies, the Central Coast is well positioned for Aerospace, Defense, and Precision Manufacturing investment.

The region's roots in this pivotal sector date back to aerospace's earliest days. Less than a decade after the Wright brothers' successful flight in 1903, Santa Barbara was home to a growing aircraft manufacturing industry shaped by pioneers including the Loughead brothers and Jack Northrop (who would go on to found the predecessors of what are now Lockheed Martin and Northrop Grumman). The establishment of Camp Cooke near Lompoc by the US Army in 1941 and its subsequent transformation into one of the nation's largest Air Force installations, Vandenberg Air Force Base, fueled the sector's growth in the 1950s and 1960s. The facility officially became a US Space Force installation in May 2021, though the base has had a primary role in US space activities stretching back to the launch of Discoverer 1, the first–ever polar orbit satellite in 1959. Vandenberg Space Force Base (VSFB) is one of the nation's two space launch ranges and is used for ballistic missile testing and for both commercial (SpaceX, United Launch Alliance and Firefly, with others coming online) and government launch and landing activity. Continuing to maximize this unique asset is the subject of a number of studies by REACH, including <u>an economic impact analysis of VSFB</u> (April 2021), <u>a commercial space master plan</u> (June 2021), and <u>a review of waterfront infrastructure that supports the base and other key sectors</u> (December 2022).

The Central Coast's higher education assets represent another important factor influencing Aerospace, Defense, and Precision Manufacturing investment in the region. The presence of two top-tier public universities, the University of California, Santa Barbara (UC Santa Barbara) and California Polytechnic State University, San Luis Obispo (Cal Poly), attracts research dollars, entrepreneurial ventures, and talent to the Central Coast. High-profile research being conducted at facilities like the Cal Poly CubeSat Laboratory and Google's Quantum AI Santa Barbara campus helps to advance the knowledge base and to prepare future generations for the jobs of tomorrow.

<sup>&</sup>lt;sup>2</sup> The quantitative analyses presented throughout this report use proprietary employment data, including five-year projections, prepared by Lightcast. Employment figures reflect Lightcast's complete employment data, which includes both employed and self-employed workers. Projections are based on historical trend lines averaged across three scenarios and, therefore, do not capture employment associated with recent and/or planned investments. More information about Lightcast's data and methodology can be found <u>in their online knowledge base</u>.

Drawn by the region's many advantages, a network of major defense contractors, cutting-edge researchers, and precision manufacturers has taken root on the Central Coast, creating expertise in missile and spacecraft manufacturing, guidance systems, measuring and testing equipment, and other electronic product manufacturing. The region's growing recognition as the world's "Infrared Valley" reflects its role as a hub of semiconductor and sensor technology expertise centered on Goleta. Local Aerospace, Defense, and Precision Manufacturing innovators include the following companies:

- + Santa Barbara-based Umbra manufactures, launches, and operates satellites.
- + Santa Barbara-based Focalplane, now part of Lockheed Martin, designs and produces cutting-edge infrared sensors.
- + San Luis Obispo-based WhiteFox Defense Technologies, develops counter-drone technologies used by the military as well as commercially for public safety.
- + Goleta-based Nexus Photonics, develops photonic and laser products for sensors, quantum computing, and 5G networks.
- + San Luis Obispo-based Mantis Composites delivers 3D printing, carbon fiber, and engineering services for the automotive, aviation, and space industries.
- + San Luis Obispo-based Trust Automation designs, builds and supports control and power management systems for defense, semiconductor, industrial automation, and medical applications.

### Commercial space and advanced technology are expected to spur job growth across a \$2.3 billion sector with 9,800 jobs.

As defined for this work, the Aerospace and Defense sector currently employs about 7,000 workers in the region, with just over one-half of that figure attributed to military employment.<sup>3</sup> The Precision Manufacturing sector represents another 2,800 jobs. Together, these activities account for about 3 percent of Central Coast jobs. Employment trends have varied between the two sectors and between the two counties. Dramatic gains in Aerospace and Defense employment in the County of San Luis Obispo over the past two decades have been offset by job losses in the County of Santa Barbara. Both Central Coast counties have experienced consistent declines in Precision Manufacturing employment since 2001. However, strong growth forecasts for the commercial space industry and rising federal investment in space, national security, and advanced technology in areas such as semiconductors and quantum science point to increasing opportunities in Aerospace, Defense, and Precision Manufacturing.

Goods and services provided by businesses in Aerospace and Defense industries contributed \$1.45 billion to the gross regional product (GRP) of \$52.3 billion (2.8 percent) in 2022. Within this figure, military activities, search and guidance system manufacturing, and missile and space vehicle manufacturing were the three activities with the largest

<sup>&</sup>lt;sup>3</sup> The Defense and Aerospace sector as defined for this work includes both private sector and military employment (see Figure 28, page 49). Lightcast's military employment figures are estimates and are not allocated to specific installations. They include both active duty and Reserve military personnel. National Guard personnel are also included as they are a subset of the Reserves. According to Lightcast, Federal Government, Military (NAICS 901200) accounted for approximately 3,700 jobs combined in the two Central Coast counties in 2022. Data on federal civilian employment (NAICS 901119) is not available at a sufficient level of detail to determine the nature of the employment (i.e., whether it is associated with a military installation or with other federal facilities such as prisons or national parks) and was not included in this analysis. For comparison, the April 2021 economic impact analysis of VSFB prepared by Cal Poly cited the installation's employment at 2,912 military personnel and 1,375 federal civilian employees at the time of the study. Lightcast's projections of future military employment in the region do not capture Department of Defense projections for VSFB.

contribution to GRP, together accounting for more than 83 percent of the total. Precision Manufacturing industries contributed \$0.86 billion to GRP (1.6 percent of the total), with the manufacturing of scientific and industrial instruments and semiconductor and related devices accounting for just over 62 percent of this amount.

According to projections prepared by Lightcast, growth in Aerospace and Defense employment on the Central Coast is expected to slightly lag national trends, increasing 1 percent over 2022 levels by 2027, compared with an anticipated increase of 2 percent nationally. The sector's growth in the region is projected to outperform the state, which is expected to see a slight drop in Aerospace and Defense employment (a loss of 2 percent) during the period. Precision Manufacturing employment is projected to continue to decline slightly in both counties through 2027, resulting in a loss of -1 percent. By comparison, both the state and the US are expected to see a slight uptick during this period.

The retention of these jobs and/or the creation of the projected new jobs would have additional ripple effects on the economy. An economic impact analysis conducted by Lightcast found that each job in the Aerospace and Defense and Precision Manufacturing sectors support one additional job in the broader economy, as shown by their jobs multipliers of 1.88 and 1.96, respectively.<sup>4</sup> Based on a scenario in which focused business development efforts accelerated projected job growth over a five-year period, Lightcast's economic impact analysis found that growth in the sector could result in a total of more than 1,800 jobs collectively (1,190 from job gains in Aerospace and Defense and 647 from job gains in Precision Manufacturing), \$144 million in earnings, and \$13.7 million in tax revenues when the supply chain and household spending impacts for each sector are considered.<sup>5</sup>

### The region's strengths in manufacturing navigational, measuring, electromedical, and control instruments represent a unique advantage.

The influence of the Central Coast's aerospace and defense history is reflected in its strengths in the manufacturing of scientific equipment, measuring and testing instrumentation, and guidance systems. Taken as a group, these detailed industries account for more than 2,800 jobs and include several areas of specialization, meaning that employment in the industry exceeds expected levels based on national employment patterns. While these industries are included as part of the definitions for the specific sectors analyzed in this study, they represent components and equipment that support a wide range of industries. Collectively, industries in this group contributed more than \$1 billion to the region's gross regional product in 2022.

### Aerospace, Defense, and Precision Manufacturing occupations have a mix of education and experience requirements.

Several of the occupations that support both the Aerospace and Defense sector and the Precision Manufacturing sector require a bachelor's degree for entry. Examples include engineers, software developers, logisticians, and managers. Regional institutions awarded more than 1,800 degrees in engineering fields of study in 2021. Virtually all of the region's engineering degrees granted in 2021 (97.1 percent) were at the bachelor's level or above and more than three-quarters

<sup>&</sup>lt;sup>4</sup> The employment multiplier for each sector includes the initial gain of one job (1.00), plus the estimated employment generated by that new job. In other words, the 1.88 multiplier for Aerospace and Defense includes the initial job, plus nearly one additional job (0.88). Likewise, for Precision Manufacturing, the initial job in the sector generates nearly one additional job (0.96), for an employment multiplier of 1.96. See Figure 21 (page 40) for an illustration of the ripple effects of job growth.

<sup>&</sup>lt;sup>5</sup> For details of the analyses, see Figure 22, page 42 (Aerospace and Defense) and Figure 25, page 45 (Precision Manufacturing).

(76.7 percent) were granted by Cal Poly, with an additional 20.0 percent of the total awarded by UC Santa Barbara.<sup>6</sup> Likewise, completions in programs that prepare workers for engineering technician positions were also largely awards of four or more years. Of the 111 degrees granted in technician-level engineering programs in 2021, 71 percent were bachelor's degrees or higher.

At the other end of the spectrum, degrees in production and fields related to the repair and maintenance of equipment were exclusively associate's degrees or awards of less than one year. As a result, completions in these two fields of study were granted by the region's community colleges, with the vast majority issued by Cuesta College or Allan Hancock College. The number of for-credit awards granted annually in these fields of study is relatively small; however, many occupations in manufacturing and repair industries tend to rely less on formal credentials and more on industry recognized certifications; on-the-job training; and apprenticeships, often provided through organized labor programs. Initiatives such as SLO Partners that offer upskilling opportunities and bootcamps in relevant skills are an important piece of the training network for these jobs. By offering a path for students and incumbent workers to learn about and access quality jobs, they can help meet employer demand for key occupations.



<sup>&</sup>lt;sup>6</sup> Westmont College awarded seven bachelor's degrees in engineering-related fields in 2021 representing 0.4 percent of the total. The remaining 3.0 percent of engineering-related degrees awarded in 2021 were associate's degrees or certificates of less than one year granted by the region's three community colleges.

### Targeted talent attraction and development efforts will be required to offset regional outmigration of workers.

One significant challenge facing the Central Coast across all sectors is the outmigration of the regional workforce. Data on migration by metropolitan statistical area (MSA)<sup>7</sup> shows a trend toward the increased net out-migration of workers in both Central Coast counties, although there are important differences. Worker outflows in the San Luis Obispo MSA have been largely characterized by the departure of workers under 25 and are likely driven by the movement of college students. The overall trend in the Santa Barbara MSA is similarly downward but appears to be less tied to academic calendars. Following an upward trend in net in-migration of workers between 2017 and 2018, strong net out-migration since late 2019 has culminated in several thousand fewer workers in the region. Reversing this trend will be important to the health of the Central Coast economy.



<sup>&</sup>lt;sup>7</sup> A metropolitan statistical area (MSA) is a designation of the US Office of Management and Budget used by federal statistical agencies. MSAs are composed of one or more counties (or county equivalents, such as parishes) that meet specific thresholds (e.g., population size, share living in urban areas), and which have strong economic ties as illustrated by factors such as employment and commuting. Informal MSA names are used in this report to improve readability. For example, the San Luis Obispo-Paso Robles, CA, MSA is referred to simply as the San Luis Obispo MSA; Santa Barbara MSA is used rather than Santa Maria-Santa Barbara, CA, MSA.

# SECTOR LANDSCAPE: AEROSPACE & DEFENSE



## **SECTOR OVERVIEW**

The role of "space" as a component of aerospace and defense technology has evolved commercially and militarily since the orbital and moon missions of the 1960s. Emblematic of the rapid technological advances in aerospace that have occurred over the past half century, the federal government rechristened Vandenberg Air Force Base as Vandenberg Space Force Base in May 2021.<sup>8</sup>

### **TRENDS & DIRECTIONS**

The global space economy was \$546 billion in 2022, 91 percent greater than a decade ago, and anticipated to grow to \$800 billion in the next five years.<sup>9</sup> Commercial space activities are hardly new. Satellite dishes have provided cable television service for many years. More recently, GPS navigation has become an essential feature of phones and automobiles. The growth and technological advancements in the space economy continue to accelerate. The US Space Force plans to spend \$1 billion over the next 5 years upgrading the launch ranges at Vandenberg and Cape Canaveral to ultimately support 300 launches annually.<sup>10</sup> At least three things are fueling changes:

- + New technology. Older satellite technology is geostationary. Newer technology, including SmallSats and CubeSats<sup>11</sup> (originally developed by Cal Poly and Stanford University), can be non-geostationary and lower orbiting, which allows for broader uses. These satellites are also less expensive to build and launch, so the barriers to market entry are less strenuous.
- + Increased investment. Although the public sector remains the primary driver of investment in the space economy, private sector investments are growing rapidly. A report from McKinsey speculates commercial funding into the space economy could surpass government funding by 2042, a trend that could lead to more public-private partnerships.<sup>12</sup>
- + New data and applications. New satellite technology is unlocking new data that can help inform on a wide range of issues, including climate change, food security, emergency response, and national defense. Furthermore, space data has the potential to transform industries and spur new technological applications, including edge computing and AI.<sup>13</sup>

### CENTRAL COAST

Location matters. Vandenberg's role as one of two federal spaceports in the nation's Western Range for government and commercial rocket launches has put the Central Coast at the forefront of the commercial space race. Vandenberg hosts the military's Space Launch Delta 30 (SLD 30), which oversees missile testing and space launch missions. Companies including SpaceX, Firefly Aerospace and Relativity Space are expanding operations at the base, where annual launches are

<sup>&</sup>lt;sup>8</sup> See the appendices for a list of resources that informed this section (Resources, page 65).

<sup>&</sup>lt;sup>9</sup> Space Foundation. <u>"Space Foundation Releases The Space Report 2023 Q2. Showing Annual Growth of Global Space Economy to \$546B</u>" press release, July 25, 2023.

<sup>&</sup>lt;sup>10</sup> Albon, Courtney. <u>"How the Space Force will manage surging launch demand."</u> C4ISRNET, May 9, 2023.

<sup>&</sup>lt;sup>11</sup> <u>"What are SmallSats and CubeSats,"</u> NASA webpage.

<sup>&</sup>lt;sup>12</sup> Brukardt, Ryan. <u>"How will the space economy change the world?,"</u> McKinsey Quarterly. November 28, 2022.

<sup>&</sup>lt;sup>13</sup> Coykendall, J; Hardin, K; Brady, A; and A. Hussain. <u>"Riding the exponential growth in space,"</u> Deloitte Insights. March 22, 2023.

expected to soar from just a handful to over 100 in coming years in response to national and commercial demand.<sup>14</sup> While rocket launches attract the spotlight, there are many companies based in the Central Coast region that contribute to space and aerospace-related activities:

- + Santa Barbara-based Umbra, a manufacturer, launcher, and operator of satellites.
- + San Luis Obispo-based Empirical Systems Aerospace, Inc. (ESAero), a designer of manned and unmanned electric aircraft.
- + San Luis Obispo-based Edge Autonomy, a developer of autonomous technologies and optics. As of 2021, locally based Edge Autonomy became an operating unit of Florida-based AE Industrial Partners.
- + San Luis Obispo-based Inspired Flight, a designer, developer, and manufacturer of commercial drones for industrial and government use in the US.
- + Goleta-based Deployable Space Systems, now part of Redwire, a leading supplier of space mission-enabling deployable solar arrays, structures and mechanisms.
- + San Luis Obispo-based ACI Jet, an operator of private aviation charters, maintenance and repair services, and aircraft management.

The talent pipeline for aerospace employment is also quite robust in the Central Coast region. Aerospace Engineering is one of several departments within Cal Poly's extensive engineering school. Cal Poly has also partnered with the US Air Force Research Laboratory as part of a student research program to introduce students to projects in aviation, unmanned aerial vehicles, and small satellite technology. Cuesta College, in partnership with ACI Jet and through financial support from the County of San Luis Obispo, recently launched technician courses in aviation maintenance which include training in general, airframe, and powerplant maintenance in accordance with Federal Aviation Administration requirements.



<sup>&</sup>lt;sup>14</sup> Scully, Jane. <u>"SpaceX Yearly Launch Rate at Vandenberg SFB Could Soar to 100 by 2025,"</u> Noozhawk.com, December 4, 2023.

### **EMPLOYMENT TRENDS**

The Aerospace and Defense sector accounts for roughly 7,000 jobs in the Central Coast counties, representing roughly 2 percent of the region's total employment. Employment in the sector encompasses a range of industries related to the manufacture and operation of aircraft and space vehicles (including engine, parts, and equipment manufacturing) and US defense personnel. The majority of Aerospace and Defense employment—roughly 5,900 jobs or 85 percent of the total—is located in the County of Santa Barbara. This figure includes an estimated 3,200 military personnel,<sup>15</sup> reflecting the presence of VSFB.

Over the past two decades, growth trajectories in Aerospace and Defense employment have varied widely between the two Central Coast counties. While the County of Santa Barbara has a significantly larger share of the sector's workforce, Aerospace and Defense employment in the sector has declined steadily during the period analyzed driven by losses in Other Aircraft Parts and Auxiliary Equipment Manufacturing (NAICS 336413)<sup>16</sup> and Federal Government, Military (NAICS 901200). By contrast, the County of San Luis Obispo has experienced a dramatic uptick in percentage terms, nearly doubling the size of its employment in the sector during the period, in part due to gains in Other Support Activities for Air Transportation (NAICS 488190). Growth rates in the County of San Luis Obispo are expected to continue to rise sharply in the coming years, a reflection of recent gains.



### FIGURE 1. CENTRAL COAST EMPLOYMENT TRENDS IN THE AEROSPACE & DEFENSE SECTOR WITH COMPARISONS TO THE STATE AND US

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): The Aerospace & Defense sector includes 15 detailed industries (6-digit NAICS) which are listed in the appendices.

<sup>&</sup>lt;sup>15</sup> See footnote on page 4 regarding Lightcast's military employment estimates.

<sup>&</sup>lt;sup>16</sup> NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. For additional information, see Classification Systems (page 64).

### INDUSTRY DETAIL

Within the Aerospace and Defense sector, Federal Government, Military (NAICS 901200) represents the largest component of employment, accounting for more than one-half (54 percent) of the total. Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing (NAICS 334511) is the next largest, comprising roughly one in five jobs. Other Aircraft Parts and Auxiliary Equipment Manufacturing (NAICS 336413), Guided Missile and Space Vehicle Manufacturing (NAICS 336414) and Other Support Activities for Air Transportation (NAICS 488190) round out the top five with each accounting for between 4 percent and 5 percent of the sector's employment.

Understanding areas of specialization within the sector can point to areas where industry targeting efforts may be beneficial. Specialization is based on an analysis of location quotients (LQ), a commonly used method for comparing the concentration of employment in an area to national patterns (see box below). Of the industries in the Aerospace and Defense sector with at least 100 jobs, the Central Coast is highly specialized in five of them, as shown in Figure 3 (page 13). For this analysis, an LQ of 2.00 or higher was used to denote a very high level of concentration. Industries related to the manufacture of space vehicle parts and equipment (NAICS 336419) and instrumentation manufacturing (NAICS 334511) met this threshold.

#### FIGURE 2. DISTRIBUTION OF CENTRAL COAST EMPLOYMENT IN THE AEROSPACE & DEFENSE SECTOR BY DETAILED INDUSTRY (6-DIGIT NAICS LEVEL)



Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc. Note(s): Total may not sum to 100 percent due to rounding.

#### LOCATION QUOTIENTS

A location quotient (LQ) analysis is a statistical technique used to highlight areas of relative concentration. LQs are typically calculated as an industry's share of total local employment divided by the same industry's share of employment at the national level. For example, if an industry represents 1 percent of US employment and 5 percent of local employment, its LQ would be 5.00, meaning that employment in the industry in the local area is five times as large as would be expected based on national patterns. An LQ of 1.25 or greater can suggest areas for targeting.

#### FIGURE 3. HIGHLY SPECIALIZED INDUSTRIES IN THE AEROSPACE & DEFENSE SECTOR CENTRAL COAST LQS BY DETAILED INDUSTRY (6-DIGIT NAICS LEVEL)

NAICS CODE	INDUSTRY	LQ	JOBS
336419	Other Guided Missile & Space Vehicle Parts & Auxiliary Equipment Manufacturing	15.01	245
334511	Search, Detection, Navigation, Guidance, Aeronautical, & Nautical System & Instrument Mfg.	5.05	1,459
336414	Guided Missile & Space Vehicle Manufacturing	1.90	295
423860	Transportation Equipment & Supplies (except Motor Vehicle) Merchant Wholesalers	1.78	126
336413	Other Aircraft Parts & Auxiliary Equipment Manufacturing	1.61	336

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes.

Collectively, the 15 industries that comprise the Aerospace and Defense sector contributed \$1.45 billion to the Central Coast economy in 2022. Known as gross regional product (GRP), this metric represents the total market value of goods and services produced in an area and is commonly used to show the size and performance of the economy. When viewed at the industry level, the military (\$0.63 billion) and navigation and guidance systems and instrumentation manufacturing (\$0.52 billion) were the sector's largest contributors. At the state level, the Aerospace and Defense sector as defined for this work added \$76.14 billion to the California economy (known as gross state product) in 2022.

**FIGURE 4. GROSS REGIONAL PRODUCT (GRP) IN BILLIONS: AEROSPACE & DEFENSE SECTOR** TOTAL GRP FOR THE SECTOR WITH SHARE REPRESENTED BY TOP THREE INDUSTRIES, 2022



Aerospace & Defense sector total GRP



Combined share of sector GRP (3 largest industries) Federal Government, Military \$0.63B (43.2%)

Search, Detection, Navigation & Guidance System Mfg. \$0.52B (35.8%)

**Guided Missile & Space Vehicle Manufacturing** \$0.06B (4.2%)

Source(s): Lightcast MR-SAM model, 2022. Note(s): Total of top three industries may not sum to combined share due to rounding.

### PEER METROS

Regions with aerospace and defense<sup>17</sup> activities differ considerably in their employment levels, depending to some extent on the labor intensity of their activities. Among the Central Coast's peers, illustrative examples include Colorado Springs, Colorado (home of the US Air Force Academy); Wichita, Kansas, and Charleston, South Carolina (commercial aircraft manufacturing); Tucson, Arizona, and Huntsville, Alabama (missiles and defense products); Hartford, Connecticut (aircraft engines and avionics); Cape Canaveral, Florida (space launches and related services); and Warner Robins, Georgia (maintenance and parts). A definition of location quotients (LQs) is featured on page 12.<sup>18</sup>



#### FIGURE 5. AEROSPACE & DEFENSE SECTOR EMPLOYMENT LEVELS AND CONCENTRATIONS CENTRAL COAST AND SECTOR COMPARISONS FOR PEER COUNTIES, 2022

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): The Sector Location Quotients (circle) represent the LQ for total employment in the sector as defined for this analysis. LQs above 1.00 indicate that the peer county's employment in the sector comprises a larger share of its total employment than would be expected based on national patterns.

<sup>&</sup>lt;sup>17</sup> Employment figures for the peer metros are based on the Aerospace and Defense sector definition used for the Central Coast. As such, employment levels in Figure 5 include Lightcast's estimate of military employment for the peer counties. See footnote on page 4 for more information on Lightcast's military employment estimates.

<sup>&</sup>lt;sup>18</sup> Regional peers were selected by TIP Strategies based on their alignment with business trends, industry development patterns, and academic drivers.

# TALENT PIPELINE

This section examines the current structure of the Aerospace and Defense workforce, as well as the region's talent pipeline, including an analysis of recent job postings and relevant degrees awarded by Central Coast postsecondary institutions.

### WORKFORCE COMPOSITION

The region's Aerospace and Defense sector currently employs roughly 7,000 workers with earnings per job of \$88,289.<sup>19</sup> Four out of five workers in the sector (79.5 percent) are male. The age structure of the regional Aerospace and Defense workforce mirrors the sector's statewide workforce, with approximately 85 percent of the workforce below the age of 55. Likewise, the racial and ethnic composition of the sector on the Central Coast is similar to the Aerospace and Defense workforce statewide. Roughly one-half of workers in the sector are White (53 percent for the Central Coast, 49 percent statewide). Hispanic/Latino workers comprise the next largest group, accounting for roughly one in four jobs (26 percent) at both the regional and state level. A demographic overview is provided in Figure 6 (page 16).



<sup>&</sup>lt;sup>19</sup> Earnings per jobs is the total industry earnings divided by the number of jobs in the industry. It encompasses a wide range of occupations across all the detailed industries in the sector. As a result, it is not comparable to measures like median hourly earnings, which is calculated for a single occupation or group of related occupations.



#### FIGURE 6. DEMOGRAPHIC OVERVIEW OF THE AEROSPACE & DEFENSE SECTOR

Source(s): Lightcast MR-SAM model, 2022. Note(s): Totals may not sum to 100 percent due to rounding. Racial and ethnic groups reflect a social interpretation of race or ethnicity based on self-identification. Looking at the composition of the sector's workforce by occupational classification, the Military-only Occupations group (SOC 55-9999)<sup>20</sup> accounts for the largest share of Aerospace and Defense jobs, representing 27 percent of regional employment in the sector.<sup>21</sup> At just 10 percent, Production Occupations (SOC 51-0000)<sup>22</sup> are the largest non-military group. Other occupational groups that represent more than 5 percent of the Aerospace and Defense workforce include the following:

- + Architecture and Engineering (SOC 17-0000)
- + Installation, Maintenance, and Repair (SOC 49-0000)
- + Management (SOC 11-0000); Business and Financial Operations Occupations (SOC 13-0000)
- + Transportation and Material Moving (SOC 53-0000)

When viewed at the detailed occupation level, Aircraft Mechanics and Service Technicians (SOC 49-3011) represent the largest non-military position, with slightly more than 300 workers (3 percent of the total).

Among the sector's 10 largest occupations, the nine non-military positions are expected to experience growth on the Central Coast in the coming years based on Lightcast's projections. Aircraft Mechanics and Service Technicians are expected to see the largest gains, with a 17.2 percent increase projected over 2022 levels by 2027. Other occupations with double-digit gains projected during the period include the following:

- + Logisticians (SOC 13-1081)
- + Laborers and Freight, Stock, and Material Movers, Hand (53-7062)
- + Software Developers (SOC 15-1252)
- + Human Resources Specialists (13-1071)
- + Inspectors, Testers, Sorters, Samplers, and Weighers (SOC 51-9061)

Typical entry-level education requirements for the sector's 10 largest occupations are mixed. Four require a bachelor's degree, a group that includes three of the fastest-growing occupations: Software Developers, Logisticians, and Human Resources Specialists. At the other end of the spectrum are three positions in the Production group—Miscellaneous Assemblers and Fabricators (SOC 51-2098); Electrical, Electronic, and Electromechanical Assemblers (SOC 51-2028); and Inspectors, Testers, Sorters, Samplers, and Weighers—which typically do not require any formal training beyond a high school diploma or equivalency. Aircraft Mechanics and Service Technicians is the only individual occupation in the top 10 that requires postsecondary training, such as a certificate program, that does not lead to a formal degree.

<sup>&</sup>lt;sup>20</sup> Like all industries that comprise the Aerospace and Defense sector, the Federal Government, Military (NAICS 901200) encompasses a variety of occupations. Many of these occupations have civilian counterparts and are classified as such (e.g., managers, IT technicians, instructors, and maintenance and repair workers). Military-only Occupations (SOC 55-9999) are those that do not have civilian equivalents (e.g., infantry, fighter pilot). According to Lightcast, slightly more than 1,800 of the sector's 7,000 jobs (27 percent) fell under this classification in 2022.

<sup>&</sup>lt;sup>21</sup> See footnote on page 4 regarding Lightcast's military employment estimates.

<sup>&</sup>lt;sup>22</sup> Capitalized occupation names and SOC codes shown in this report refer to the Standard Occupational Classification system, the framework used by federal agencies to classify workers into occupational categories for statistical purposes. See Classification Systems (page 64) for more information.

### EMPLOYER DEMAND

An analysis of job postings issued by Central Coast employers over a 12-month period (February 2022 to February 2023) provides a real-time understanding of the skills, qualifications, and educational requirements of the sector. Companies competing for talent in the region based on this analysis include global giants like Raytheon Technologies, Northrup Grumman, Lockheed Martin, SpaceX, General Dynamics, and Boeing, as well as locally based firms like Sonatech, ESAero, and ACI Jet.

Based on the more than 3,000 job postings issued during the period analyzed, demand in the region is largely driven by engineering and engineering-related activities. Computer positions are also highly sought after by Aerospace and Defense employers, including Software Developers (SOC 15-1252), Computer, All Other (SOC 15-1299), Software Quality Assurance Analysts & Testers (SOC 15-1253), and Information Security Analysts (SOC 15-1212).

A look at median hourly earnings in Figure 7 (page 19) reveals that in-demand occupations in Aerospace and Defense pay well above the regional median of \$20.41. Fourteen of the top 15 occupations (based on their share of total unique postings) exceeded this threshold, often by a wide margin. Architectural & Engineering Managers (SOC 11-9041) represents the highest-earning in-demand occupation, with a median hourly wage of \$78.31, followed by Software Developers (SOC 15-1252 at \$61.28 per hour); Electronic Engineers, Except Computer (SOC 17-2072, \$59.06) and Engineers, All Other (SOC 17-2199, \$56.85). When earnings are compared against living wage standards, nearly all of the top 15 advertised occupations at the time of this analysis paid enough to sustain a household with two adults and two children.<sup>23</sup>



<sup>&</sup>lt;sup>23</sup> Based on the <u>Living Wage Calculator</u> developed by Dr. Amy K. Glasmeier and the Massachusetts Institute of Technology. At the time of analysis, the living wage on the Central Coast for two adults (one working) with two children was \$46.47 per hour.

#### FIGURE 7. IN-DEMAND OCCUPATIONS IN THE AEROSPACE & DEFENSE SECTOR

ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023 WITH A COMPARISON TO FIVE-YEAR EMPLOYMENT TRENDS ON THE CENTRAL COAST (2016-2021)

DESCRIPTION	SHARE OF POSTING <u>S*</u>	2016	2021	PERCENT CHANG <u>E</u>	MEDIAN HOURLY EARNIN <u>GS</u>
Software Developers	8.5%	2,381	2,318	-2.6%	\$61.28
Computer, All Other	7.3%	739	1,058	43.2%	\$43.63
Industrial Engineers	5.2%	475	332	-30.1%	\$47.99
Electrical Engineers	4.7%	445	501	12.6%	\$54.75
Mechanical Engineers	4.4%	554	499	-9.9%	\$45.58
Police & Sheriffs Patrol Officers	4.0%	1,343	1,309	-2.5%	\$48.44
Architectural & Engineering Managers	3.0%	522	635	21.6%	\$78.31
Managers, All Other	2.8%	1,207	1,920	59.1%	\$54.86
Software Quality Assurance Analysts & Testers	2.3%	367	373	1.6%	\$47.54
Electronics Engineers, Except Computer	2.2%	396	367	-7.3%	\$59.06
Engineers, All Other	2.2%	307	522	70.0%	\$56.85
First-Line Supervisors of Retail Sales Workers	2.1%	2,569	2,257	-12.1%	\$19.86
Information Security Analysts	1.8%	131	222	69.5%	\$51.19
Buyers & Purchasing Agents	1.7%	688	745	8.3%	\$34.37
Industrial Engineering Technicians	1.6%	66	119	80.3%	\$37.72
Top Occupations Related to Aerospace & Defense	53.8%	12,190	13,177	8.1%	\$51.08
Central Coast Total Occupations (All Industries)		342,628	356,225	4.0%	\$20.41

\*Share of Central Coast job postings among the 15 detailed industries defining the Aerospace & Defense target in the 12-month period from February 2022 through February 2023.

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): The top 15 occupations by their share of regional job postings accounting for 53.8 percent of total job postings define the key occupations for the Aerospace & Defense target. Median hourly earnings are in 2021 USD and represent the Central Coast median for the occupation. Shaded values exceed the regional median for all Central Coast occupations.

### **SKILLS & REQUIREMENTS**

The top 10 specialized skills sought by Aerospace and Defense employers hiring in the region include technology skills (MATLAB, computer science, software engineering, SAP applications), project-oriented skills (systems engineering, earned value management, agile methodology), new product development, and electrical engineering and electronics skills.

A look at skills that are shared across all sectors reveals a focus on communication skills, problem solving, management and leadership skills, and planning and coordination. A range of security clearances (Secret, Top Secret, and Top Secret-Sensitive Compartmented Information) and certifications (CompTIA Security and Certified Information Systems Security Professional) dominate the list of desired qualifications. Other commonly requested qualifications include Airframe & Powerplant Certificate, Project Management Professional Certification, and a valid driver's license. Similar to other sectors, experience with Microsoft Office programs, such as Excel and PowerPoint, were among the general skills requested.

One way to illustrate the gap between the demand for a skill and the supply is to compare job postings (employer demand) with worker profiles (potential workforce) on the Central Coast. Figure 8 suggests there are a number of gaps between the experience of the Aerospace and Defense workforce and employer demands for specialized skills. Using this comparison, only a handful of skills sought by employers—systems engineering, project management, and earned value management—are reasonably well aligned with their availability in the workforce.

### FIGURE 8. TOP 10 SPECIALIZED SKILLS IN THE AEROSPACE & DEFENSE SECTOR RELATIVE TO THEIR AVAILABILITY IN THE WORKFORCE\*



ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023

\*Worker profile data was not reported for computer science skills.

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): Lightcast's worker profiles represent self-reported, publicly available information compiled from sources including thirdparty resume databases and job boards, the recruiting industry, opt-in data from employers and applicant tracking systems, sales and marketing CRM databases, and various consumer/identity databases. Profiles are standardized, de-duplicated, and normalized by Lightcast to facilitate analysis. Job postings also provide an understanding of the education and experience levels local employers are seeking. Nearly one-half (46.7 percent) of Aerospace and Defense sector job postings require four or more years of experience, with more than 1 in 10 (12.1 percent) requiring at least 10 years. Employers in the sector were also more likely to require a college degree, with nearly two-thirds (64.3 percent) requiring a bachelor's degree or higher. However, one-third of the job postings analyzed (33.0 percent) were open to job seekers with a high school diploma or equivalency (14.4 percent) or had no specific education requirement listed (18.6 percent).<sup>24</sup>

#### FIGURE 9. EMPLOYER REQUIREMENTS: AEROSPACE & DEFENSE SECTOR

ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023



Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): Includes non-staffing, unique, active job postings for full-time, part-time, and flexible positions between February 2022 and February 2023. Total may not sum to 100 percent due to rounding.

<sup>&</sup>lt;sup>24</sup> The lack of stated experience and education requirements in a job posting does not mean that no requirements exist, simply that none were specified.

### **DEGREES & AWARDS**

Central Coast postsecondary institutions granted just over 30,000 degrees and awards for credit<sup>25</sup> in 2021 across all fields of study, with the region's two public universities—UC Santa Barbara and Cal Poly—accounting for nearly one-half (46 percent) of the total. A table showing the full distribution of awards by institution is provided in the appendices (see Figure 37, page 58).

A look at this data for fields of study relevant to the Aerospace and Defense sector illustrates the potential supply of talent. The region's postsecondary institutions issued an average of roughly 1,800 awards annually in Engineering (CIP 14)<sup>26</sup> between 2017 and 2021. More than three-quarters (76.7 percent) of the awards made in this field of study during the most recent academic year were granted by Cal Poly, with an additional 20 percent awarded by UC Santa Barbara. The 1,829 awards granted in this field of study in 2021 represented 6 percent of the region's for-credit awards.

Bachelor's degrees comprised the vast majority of Engineering awards, accounting for 8 out of every 10 degrees awarded in the field during the 2021 academic year (82 percent). Advanced degrees represented an additional 15 percent. Just 3 percent of awards in Engineering were associate's degrees<sup>27</sup> and certificates of less than one year, the majority of which were awarded by Santa Barbara City College and Allan Hancock College.

Figure 10 (page 23) looks at the top five detailed programs within the broad Engineering field of study. Of these, Mechanical Engineering (CIP 14.1901) comprised the largest number of the awards granted in 2021, with 414 degrees representing 23 percent of awards in CIP 14. Electrical & Electronics Engineering (CIP 14.1001) followed, with 313 degrees (17 percent). Roughly 100 awards were granted in both Aerospace, Aeronautical, & Astronautical/Space Engineering, General (CIP 14.0201) and Industrial Engineering (CIP 14.3501).

Occupations related to these program areas include the following:

- + Aerospace Engineers (SOC 17-2011)
- + Mechanical Engineers (SOC 17-2141)
- + Materials Engineers (SOC 17-2131)
- + Aerospace Engineering Technicians (SOC 17-3021)
- + Industrial Production Managers (SOC 11-3051)

Other fields of study that could impact the sector's workforce (with the number of awards granted in 2021 shown in parenthesis) include Computer and Information Sciences and Support Services (630), Mechanic and Repair Technologies/Technicians (103), Engineering/Engineering-related Technologies/Technicians (111), Mathematics and Statistics (912), and Physical Sciences (662).

<sup>&</sup>lt;sup>25</sup> The federal dataset used in this analysis reports on awards and degrees conferred as part of a formal course of study. <u>Recognized postsecondary credentials</u> (typically <u>designated</u> as certificates eligible to be recorded on a transcript) are also included.
<sup>26</sup> CIP codes, shown in parentheses, refer to the Classification of Instructional Programs (CIP), the framework developed by the National Center for Education Statistics to categorize completions (degrees and awards granted for credit by eligible postsecondary institutions) within broad, generalized categories for tracking and analytical purposes. Additional information on this classification system can be found in the appendices (see Classification Systems, page 64).

<sup>&</sup>lt;sup>27</sup> Associate's degrees include certificates earned in more than one year and less than four.



#### FIGURE 10. AWARDS IN ENGINEERING FIELDS OF STUDY, 2017 TO 2021

NUMBER OF AWARDS MADE IN SELECTED DETAILED PROGRAM AREAS

Source(s): National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

# SECTOR LANDSCAPE: PRECISION MANUFACTURING



## **SECTOR OVERVIEW**

Many of the Central Coast's underlying strengths in optics, lasers, nanotechnology, semiconductors, and advanced materials are underpinned by precision engineering. This far-reaching field advances the design and manufacture of products with accuracy and efficiency and is an essential component of the Precision Manufacturing sector.<sup>28</sup>

### **TRENDS & DIRECTIONS**

In 2020, the National Academies of Sciences, Engineering, and Medicine (NASEM) released its quadrennial report on the National Nanotechnology Initiative (NNI). The report opened with a compelling statement:

"Global advances in medicine, food, water, energy, microelectronics, communications, defense, and other important sectors of the economy are increasingly driven by discoveries in nanoscience and the development of nanotechnologies and justify a continued focus by the United States on, and investments in, these fields."

This thought-provoking quote raises the question of how much life on the planet is (and will be) touched by advances in nanotechnology. The NASEM report went on to cite advances in quantum science as a direct offshoot of the NNI. The initiative aims to position the US as the global leader in electronics, medicine, clean energy and resources, agriculture, and defense—all strengths of the Central Coast.

There are other contributions to advancements in precision manufacturing besides nanotechnology. One area that has made significant leaps forward in recent years is additive manufacturing, or 3D printing as it is also known. Additive manufacturing techniques are successfully being applied in aerospace and medical technology. They offer the advantages of efficient three-dimensional shaping; mass-scale customization; elimination of molds, toolmaking, and fabrication; and maintenance reduction.

In short, American manufacturers and engineering schools are rolling out a range of new, under-the-radar technological advancements that will power the future of precision production.

### CENTRAL COAST

The Central Coast provides ample intellectual resources for precision manufacturing. UC Santa Barbara is home to AIM Photonics, the West Coast headquarters for the American Institute for Manufacturing Integrated Photonics. AIM is a collaborating force for government, industry, and academia as well as an advocate for integrated photonics manufacturing systems.<sup>29</sup> UC Santa Barbara is also home to the California NanoSystems Institute (whose work emphasizes applications for energy management, water purification, sustainability, quantum science, healthcare, and robotics) and the Quantum Foundry (the nation's first-ever National Science Foundation facility focused on the

<sup>&</sup>lt;sup>28</sup> See the appendices for a list of resources that informed this section (Resources, page 65).

<sup>&</sup>lt;sup>29</sup> The Central Coast has developed a critical mass of expertise in photonics, the science and application of light. Photonic technologies are already in wide use (bar code scanners, medical and scientific instrumentation, infrared cameras) and are quickly being adapted for use in applications such as gaming, cloud computing, military, and solar.

development of materials for quantum information-based technologies). The university also features the UC Santa Barbara NanoFabrication facility, which offers extensive nanofabrication cleanroom facilities that are staffed by trained experts and available for use by the private sector.

The region also has concentrated strengths in advanced materials. Cal Poly's Kenneth N. Edwards Western Coatings Technology Center focuses on applied research in polymers and coatings technology and maintains strong relationships with industry in these areas. UC Santa Barbara's Center for Polymers and Organic Solids has capabilities in polymer processing, with notable successes in the development of efficient light emitting diodes (LEDs) made from conducting polymers for semiconducting activities. In addition, UC Santa Barbara's International Center for Materials Research focuses on multidisciplinary research collaborations in materials science and engineering.

Companies based in the Central Coast region are putting these technological advancements to work. Recent examples include the following:

- + Goleta-based Nexus Photonics develops photonic and laser products for sensors, quantum computing, and 5G networks.
- + Santa Barbara- and Austin-based Shape Sensing Company develops 3D shape-sensing products used for medical, aerospace, and energy applications.
- + Goleta-based LaunchPoint Electric Propulsion Solutions (LaunchPoint EPS) manufactures advanced electric and hybrid-electric propulsion systems for the aerospace, thermal management, and power generation industries.
- + San Luis Obispo-based Mantis Composites delivers 3D printing, carbon fiber, and engineering services for the automotive, aviation, and space industries.
- + Goleta-based Transphorm, a semiconductor firm, specializes in gallium nitride (GaN) technologies for high-voltage power conversion.
- + Santa Barbara-based Resonant (now a business unit of Kyoto-based Murata Manufacturing) develops filtering technologies for radio frequencies.
- + San Luis Obispo-based Trust Automation, designs, builds and supports control and power management systems for defense, semiconductor, industrial automation, and medical applications.

### **EMPLOYMENT TRENDS**

The Precision Manufacturing sector accounts for just over 2,800 jobs in the Central Coast counties, representing roughly 1 percent of the region's total job base. Employment in the sector encompasses a range of manufacturing industries, including metal fabrication, machinery, computers and electronics, electrical equipment, and appliances. Four out of five of the region's Precision Manufacturing jobs (80 percent) are located in the County of Santa Barbara. Industries related to instrument manufacturing represent the largest group, with just over 1,300 jobs.

Like most of the US, employment in Precision Manufacturing has declined over the past two decades. However, the County of Santa Barbara has fared better than the state or the US, holding on to the majority of its jobs in the sector, despite volatility in the 2000s. Losses across multiple industries were partially offset by gains in Analytical Laboratory Instrument Manufacturing (NAICS 334516)<sup>30</sup> and Irradiation Apparatus Manufacturing (NAICS 334517). By comparison, the County of San Luis Obispo has lost more than 50 percent of its Precision Manufacturing employment since 2001. Job losses in computer and semiconductor machinery manufacturing during the early 2000s were the major factors in the Precision Manufacturing sector's decline in the county.



### FIGURE 11. CENTRAL COAST EMPLOYMENT TRENDS IN THE PRECISION MANUFACTURING SECTOR WITH COMPARISONS TO THE STATE AND US

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): The Precision Manufacturing sector includes 31 detailed industries (6-digit NAICS) which are listed in the appendices.

<sup>&</sup>lt;sup>30</sup> NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. For additional information, see Classification Systems (page 64).

### INDUSTRY DETAIL

Although no single industry dominates the sector, the Navigational, Measuring, Electromedical, and Control Instruments Manufacturing group (NAICS 334500) represents a major share of the Central Coast's Precision Manufacturing employment. Detailed industries in this group—which include the manufacture of lab instruments, irradiation apparatus, electrical measuring and testing equipment, and industrial process control instruments account for slightly more than 1,300 jobs (roughly 45 percent of the sector's employment). If the nearly 1,500 jobs in Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing (NAICS 334511) captured as part of the Aerospace and Defense sector are added, employment in instrumentation manufacturing is closer to 2,800 jobs.

Of the industries in the Precision Manufacturing sector with at least 100 jobs, the Central Coast is highly specialized in eight. (See page 12 for information on industry specialization and location quotients.) For this analysis, an LQ of 2.00 or higher was used to denote a very high level of concentration. All but two of the specialized industries met this threshold. In addition to instrumentation, these industries include the manufacture of electrical equipment and components, optical equipment, and semiconductors and related devices.

#### **FIGURE 12. DISTRIBUTION OF CENTRAL COAST EMPLOYMENT IN THE PRECISION MFG. SECTOR** BY DETAILED INDUSTRY (6-DIGIT NAICS LEVEL)



Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc. Note(s): Total may not sum to 100 percent due to rounding.

#### FIGURE 13. HIGHLY SPECIALIZED INDUSTRIES IN THE PRECISION MANUFACTURING SECTOR CENTRAL COAST LQS BY DETAILED INDUSTRY (6-DIGIT NAICS LEVEL)

NAICS	INDUSTRY	LQ	JOBS
334517	Irradiation Apparatus Manufacturing	9.81	298
335932	Noncurrent-Carrying Wiring Device Manufacturing	6.24	148
334516	Analytical Laboratory Instrument Manufacturing	5.76	513
333314	Optical Instrument & Lens Manufacturing	2.89	136
334515	Instrument Manufacturing for Measuring & Testing Electricity & Electrical Signals	2.82	234
335999	All Other Miscellaneous Electrical Equipment & Component Manufacturing	2.20	146
334513	Instr. & Related Products Mfg. for Measuring, Displaying, & Controlling Ind. Process Variables	1.46	190
334413	Semiconductor & Related Device Manufacturing	1.18	488

Source(s): BLS; Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc. Note(s): NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes.

Collectively, the 31 industries that comprise the Precision Manufacturing sector contributed \$0.86 billion to the Central Coast economy in 2022. Known as gross regional product (GRP), this metric represents the total market value of goods and services produced in an area and is commonly used to show the size and performance of the economy. When viewed at the industry level, Analytical Laboratory Instrument Manufacturing was the sector's largest contributor, adding \$0.23 billion or about 27 percent of the Precision Manufacturing sector's total GRP. Irradiation Apparatus Manufacturing and Semiconductor and Related Device Manufacturing each accounted for an additional 18 percent. At the state level, the sector as defined for this work added \$124.90 billion to the California economy (known as gross state product) in 2022.

FIGURE 14. GROSS REGIONAL PRODUCT (GRP) IN BILLIONS: PRECISION MANUFACTURING SECTOR TOTAL GRP FOR THE SECTOR WITH SHARE REPRESENTED BY TOP THREE INDUSTRIES, 2022

\$0.86B Precision Manufacturing sector total GRP

**62.6%** Combined share of sector GRP (3 largest industries) Analytical Laboratory Instrument Manufacturing \$0.23B (26.7%)

Irradiation Apparatus Manufacturing \$0.16B (18.4%)

Semiconductor & Related Device Manufacturing \$0.15B (17.5%)

Source(s): Lightcast MR-SAM model, 2022.

Note(s): Total of top three industries may not sum to combined share due to rounding.



### PEER METROS

No region in the world is more associated with precision optical products than Rochester, New York, with a long and storied history in this field. Even as the industry has morphed and Rochester's role has receded, its employment level in precision manufacturing remains impressive among its peers. The Central Coast's other peers remain a bit more under the radar. The Connecticut River Valley, from Springfield, Massachusetts, to New Haven, Connecticut, is a region where precision manufacturing technologies had an early foothold, especially for military applications. Proximity to top-notch engineering schools can also be linked to nascent economic development success in precision manufacturing. Examples include Madison (University of Wisconsin), Ann Arbor (University of Michigan), and Lafayette, Indiana (Purdue University). Another peer, Saratoga Springs, New York, traces its manufacturing success to somewhat recent developments. Located in Saratoga County, it is a model of the benefits that regional spillover development can bring. The Albany NanoTech Complex and regional strengths in semiconductor technologies have contributed to a booming R&D and manufacturing community in Upstate New York, with one of the nation's largest semiconductor companies, Global Foundries, now headquartered north of Albany, just outside Saratoga Springs. A definition of location quotients (LQs) is featured on page 12. <sup>31</sup>

#### FIGURE 15. PRECISION MANUFACTURING SECTOR EMPLOYMENT LEVELS AND CONCENTRATIONS CENTRAL COAST AND SECTOR COMPARISONS FOR PEER COUNTIES, 2022



Source(s): BLS; Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc. Note(s): The Sector Location Quotients (circle) represent the LQ for total employment in the sector as defined for this analysis. LQs above 1.00 indicate that the peer county's employment in the sector comprises a larger share of its total employment than would be expected based on national patterns.

<sup>&</sup>lt;sup>31</sup> Regional peers were selected by TIP Strategies based on their alignment with business trends, industry development patterns, and academic drivers.

# TALENT PIPELINE

This section examines the current structure of the Precision Manufacturing workforce, as well as the region's talent pipeline, including an analysis of recent job postings and relevant degrees awarded by Central Coast postsecondary institutions.

### WORKFORCE COMPOSITION

The region's Precision Manufacturing sector employs roughly 2,800 workers with earnings per job of \$146,490.<sup>32</sup> The majority of the workforce (70 percent) is male. The regional Precision Manufacturing workforce is older on average than workers in the sector statewide; 38 percent of the sector's Central Coast workforce is 55 years and older, compared with just 29 percent at the state level. The racial and ethnic composition of the sector in the Central Coast is significantly less diverse on average than the state. More than one-half (53 percent) of the region's Precision Manufacturing workforce is White, compared with slightly more than one-third (35 percent) of workers in the sector at the state level. A demographic overview is provided in Figure 16 (page 32).

Looking at the composition of the sector's workforce by occupational classification, the Production Occupations group (SOC 51-0000)<sup>33</sup> accounts for the largest share of Precision Manufacturing jobs, representing 35 percent of regional employment in the sector. When viewed at the detailed occupation level, five of the 10 largest positions in the sector are Production jobs, including assemblers and fabricators, quality control inspectors, supervisors, and machinists. The remaining five are positions in electrical and electronics engineering, software development, and management.

Among the sector's 10 largest occupations, all are expected to experience growth on the Central Coast in the coming years based on Lightcast's projections. Software Developers (SOC 15-1252) is set to experience the largest increase, with a 13.3 percent increase projected over 2022 levels by 2027. Inspectors, Testers, Sorters, Samplers, and Weighers (SOC 51-9061) is the only other top 10 occupation projected to see double-digit gains (10.7 percent) during the period. The slowest growth rates over the next 5 years are projected for Electrical and Electronic Engineering Technologists and Technicians (SOC 17-3023), Architectural and Engineering Managers (11-9041), and Electrical Engineers (SOC 17-2071).

Typical entry-level education requirements for the sector's 10 largest occupations are evenly divided. The five Production jobs typically do not require any formal training beyond a high school diploma or equivalency. Of the five remaining positions, all but one requires a bachelor's degree for entry. Only one occupation among the 10 largest—Electrical and Electronic Engineering Technologists and Technicians (SOC 17-3023)—typically requires an associate's degree.

<sup>&</sup>lt;sup>32</sup> Earnings per jobs is the total industry earnings divided by the number of jobs in the industry. It encompasses a wide range of occupations across all the detailed industries in the sector. As a result, it is not comparable to measures like median hourly earnings, which is calculated for a single occupation or group of related occupations.

<sup>&</sup>lt;sup>33</sup> Capitalized occupation names and SOC codes shown in this report refer to the Standard Occupational Classification system, the framework used by federal agencies to classify workers into occupational categories for statistical purposes. See Classification Systems (page 64) for more information.



#### FIGURE 16. DEMOGRAPHIC OVERVIEW OF THE PRECISION MANUFACTURING SECTOR

Note(s): Totals may not sum to 100 percent due to rounding. Racial and ethnic groups reflect a social interpretation of race or ethnicity based on self-identification.

### EMPLOYER DEMAND

An analysis of job postings issued by Central Coast employers over a 12-month period (February 2022 to February 2023) provides a real-time understanding of the skills, qualifications, and educational requirements of the sector. Employers competing for talent in the region based on this analysis reflect the Central Coast's strengths in the manufacture of electronic products including laboratory equipment, precision instruments, sensors, and other electronic components.

Companies represented in the more than 1,400 job postings issued during the period analyzed include consumer products manufacturers (Apple, Dell, Intel, Cisco, and Garmin), as well as firms focused on industrial and scientific markets (Agilent Technologies, Ametek, Bruker, Sensata, Senseeker Engineering, Thermo Fisher Scientific) and aerospace and defense contractors (L3 Harris, Teledyne FLIR, Safran). The top 15 occupations in the Precision Manufacturing hiring pipeline—the "in-demand" occupations shown in Figure 17 (page 34)—represent a mix of activities, including engineering, software development, computer networking and support, management, and sales.

The top 15 occupations (based on their share of total unique postings) shown in Figure 17 all have median hourly wage rates above the regional median of \$20.41, with the majority paying well above this threshold. Engineers, software developers, and management positions were among the highest-paying positions. When earnings are compared against living wage standards, the majority of advertised occupations at the time of this analysis paid enough to sustain a household with two adults and two children.<sup>34</sup> Occupations that fell below this standard include Maintenance & Repair Workers, General (SOC 49-9071), the largest of the in-demand occupations, and Inspectors, Testers, Sorters, Samplers, & Weighers (SOC 51-9061), one of the fastest-growing occupations among the top 15.



<sup>&</sup>lt;sup>34</sup> Based on the <u>Living Wage Calculator</u> developed by Dr. Amy K. Glasmeier and the Massachusetts Institute of Technology. At the time of analysis, the living wage on the Central Coast for two adults (one working) with two children was \$46.47 per hour.
#### FIGURE 17. IN-DEMAND OCCUPATIONS IN THE PRECISION MANUFACTURING SECTOR

ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023 WITH A COMPARISON TO FIVE-YEAR EMPLOYMENT TRENDS ON THE CENTRAL COAST (2016-2021)

DESCRIPTION	SHARE OF POSTINGS*	2016	2021	PERCENT CHANGE	MEDIAN HOURLY EARNINGS
Software Developers	7.8%	2,381	2,318	-2.6%	\$61.28
Architectural & Engineering Managers	4.4%	522	635	21.6%	\$78.31
Industrial Engineering Technicians	4.3%	66	119	80.3%	\$37.72
Computer, All Other	3.7%	739	1,058	43.2%	\$43.63
Industrial Engineers	3.6%	475	332	-30.1%	\$47.99
Managers, All Other	3.5%	1,207	1,920	59.1%	\$54.86
Sales Reps, Non-Technical & Scientific Products	3.3%	2,308	2,063	-10.6%	\$30.11
Electrical Engineers	3.0%	445	501	12.6%	\$54.75
Mechanical Engineers	2.9%	554	499	-9.9%	\$45.58
Computer Systems Analysts	2.8%	876	844	-3.7%	\$49.10
Operations Research Analysts	2.6%	135	85	-37.0%	\$38.05
Buyers & Purchasing Agents	2.4%	688	745	8.3%	\$34.37
Maintenance & Repair Workers, General	1.9%	3,172	3,312	4.4%	\$22.32
Computer User Support Specialists	1.9%	997	1,015	1.8%	\$28.59
Inspectors, Testers, Sorters, Samplers, & Weighers	1.8%	594	751	26.4%	\$22.52
Top Occupations Related to Precision Manufacturing	49.8%	15,159	16,197	6.8%	\$47.34
Central Coast Total Occupations (All Industries)		342,628	356,225	4.0%	\$20.41

\*Share of Central Coast job postings among the 31 detailed industries defining the Precision Manufacturing target in the 12month period from February 2022 through February 2023.

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): The top 15 occupations by their share of regional job postings accounting for 49.8 percent of total job postings define the key occupations for the Precision Manufacturing target. Median hourly earnings are in 2021 USD and represent the Central Coast median for the occupation. Shaded values exceed the regional median for all Central Coast occupations.

### **SKILLS & REQUIREMENTS**

The top 10 specialized skills sought by employers hiring Precision Manufacturing workers in the region encompass a broad mix including new product development, project-oriented skills (systems engineering, project management), and knowledge of quality control and compliance (export control, auditing, quality management systems).

A look at skills that are shared across jobs in all sectors reveals a focus on communication skills, management and operations, problem solving, and computer literacy, with these and related traits among the most common basic skills listed. Security clearances, including Secret and Top Secret-Sensitive Compartmented Information were among the most frequently requested qualifications. Other desired qualifications include a Master of Business Administration, Project Management Professional Certification, and a valid driver's license. Similar to other sectors, experience with Microsoft Office programs, such as Excel and PowerPoint, were among the general skills requested.

One way to illustrate the gap between the demand for a skill and the supply is to compare job postings (employer demand) with worker profiles (potential workforce). By this measure, employer demand and skills availability among the Precision Manufacturing workforce in the Central Coast are mismatched (Figure 18). Of those skills for which profile data are available, only the demand for project management skills is reasonably well aligned with the availability of those skills in the relevant workforce. The largest gap, roughly 8 percentage points, is seen in auditing skills.

### FIGURE 18. TOP 10 SPECIALIZED SKILLS IN THE PRECISION MANUFACTURING SECTOR RELATIVE TO THEIR AVAILABILITY IN THE WORKFORCE\*



ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023

\*Worker profile data was not reported for the following skills: export control and presentation skills. Source(s): BLS; Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc. Note(s): Lightcast's worker profiles represent self-reported, publicly available information compiled from sources including third-party resume databases and job boards, the recruiting industry, opt-in data from employers and applicant tracking systems, sales and marketing CRM databases, and various consumer/identity databases. Profiles are standardized, de-duplicated, and normalized by Lightcast to facilitate analysis. Job postings also provide an understanding of the education and experience levels local employers are seeking. Nearly one-third (32.3 percent) of positions posted by regional employers in the Precision Manufacturing sector did not require any experience.<sup>35</sup> One in four postings analyzed (25.5 percent) did not list any minimum level of education. And just over one in 10 postings analyzed (11.8 percent) were open to job seekers with a high school diploma or equivalency. However, by far the most common requirement was a bachelor's degree, which was the threshold for entry for slightly more than one-half (53.4 percent) of the Precision Manufacturing sector postings.

#### YEARS OF EXPERIENCE EDUCATION LEVEL 100% 100% 10+ Years Graduate Degree 3.7% 8.7% 7 - 9 Years Bachelor's Degree 4 - 6 Years 11.3% Associate's Degree 2 - 3 Years High School or GED 0 - 1 Years 20.7% 53.4% No Education Requirement Listed No Experience Listed 15.8% 50% 50% 5.6% 11.2% 11.8% 32.3% 25.5% 0% 0%

#### FIGURE 19. EMPLOYER REQUIREMENTS: PRECISION MANUFACTURING SECTOR

ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): Includes non-staffing, unique, active job postings for full-time, part-time, and flexible positions between February 2022 and February 2023. Total may not sum to 100 percent due to rounding.

<sup>&</sup>lt;sup>35</sup> The lack of stated experience and education requirements in a job posting does not mean that no requirements exist, simply that none were specified.

### **DEGREES & AWARDS**

Central Coast postsecondary institutions granted just over 30,000 degrees and awards for credit<sup>36</sup> in 2021 across all fields of study, with the region's two public universities—UC Santa Barbara and Cal Poly—accounting for nearly one-half (46 percent) of the total. A table showing the full distribution of awards by institution is provided in the appendices (see Figure 37, page 58).

A look at this data for fields of study relevant to the Precision Manufacturing sector illustrates the potential supply of talent. Relevant programs of study include the following:

- + Precision Production (CIP 48)<sup>37</sup>
- + Engineering Technologies/Technicians (CIP 15)
- + Mechanic and Repair Technologies/Technicians (CIP 47)

The region's postsecondary institutions issued 280 for-credit awards in these three fields of study in 2021, the majority of which (72 percent) were associate's degrees <sup>38</sup> or certificates of less than one year. Nearly all of the 201 awards at this level were issued by Cuesta College (102 awards) or Allan Hancock College (85), with just 5 percent granted by Santa Barbara City College (14). The other 28 percent were awards at the bachelor's degree level or above, granted by Cal Poly in programs related to Engineering Technologies/Technicians.

Awards in relevant detailed program areas within the broad fields of study bulleted above are shown in Figure 20 (page 38). Only two detailed programs within Precision Production (CIP 48) were offered by area institutions between 2017 and 2021: Welding Technology/Welder (CIP 48.0508) and Machine Tool Technology/Machinist (CIP 48.0501). Other program areas under which awards were granted during the period include Industrial Technology/Technician (CIP 15.0612); Electrical/Electronics Equipment Installation & Repair Technology/Technician, General (CIP 47.0101); and Drafting & Design Technology/ Technician, General (CIP 15.1301).

Occupations related to these program areas include the following:

- + Welders, Cutters, Solderers, and Brazers (SOC 51-4121)
- + Machinists (SOC 51-4041)
- + Industrial Engineering Technicians (SOC 17-3026)
- + Electrical and Electronics Repairers, Commercial and Industrial Equipment (SOC 49-2094)
- + Electrical and Electronics Drafters (SOC 17-3012)

<sup>&</sup>lt;sup>36</sup> The federal dataset used in this analysis reports on awards and degrees conferred as part of a formal course of study. <u>Recognized</u> <u>postsecondary credentials</u> (typically <u>designated</u> as certificates eligible to be recorded on a transcript) are also included.

<sup>&</sup>lt;sup>37</sup> CIP codes, shown in parentheses, refer to the Classification of Instructional Programs (CIP), the framework developed by the National Center for Education Statistics to categorize completions (degrees and awards granted for credit by eligible postsecondary institutions) within broad, generalized categories for tracking and analytical purposes. Additional information on this classification system can be found in the appendices (see Classification Systems, page 64).

<sup>&</sup>lt;sup>38</sup> Associate's degrees include certificates earned in more than one year and less than four.

### FIGURE 20. AWARDS IN SELECTED FIELDS OF STUDY RELATED TO PRECISION MANUFACTURING, 2017 TO 2021



Source(s): National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

# ECONOMIC IMPACT



# **ECONOMIC IMPACT ANALYSIS**

When new businesses are attracted to the Central Coast, or an existing business expands its operations, the regional economy is affected through several mechanisms. These mechanisms include spending on land, buildings, or equipment (capital expenditures); costs associated with hiring workers; revenues generated through the sales of goods and services; and the payment of taxes.

Economic impact analysis provides a tool for understanding how this new economic activity—spending on buildings, equipment, hiring, supplies, materials and so on—ripples through the economy. These ripples occur across all industries in the economy and can be described as one of the following four types of effects:

- + Initial effect. The initial shock to the economy caused by the initial purchases.
- + Direct effect. Additional activity that occurs as impacted industries spend money in their supply chain industries.
- + Indirect effect. Additional shocks as the supply chain industries generate more activity through their interindustry spending.
- + Induced effect. Economic activity created by the household sector as businesses raise salaries or hire more people.

Impacts across these four categories can be measured in terms of changes to employment (the number of full- and parttime jobs required to support the change in activity), changes to sales (a measure of the business revenue generated by increased economic activity), and changes to total income (including labor income, or earnings, and non-labor income received from investments). Figure 21 provides an illustration of the types of impacts.

#### FIGURE 21. ILLUSTRATION OF RIPPLE EFFECTS OF INITIAL ECONOMIC IMPACT RIPPLE EFFECTS OF INITIAL ECONOMIC IMPACT



Source(s): TIP Strategies, Inc., illustration of Lightcast's economic impact approach.

### METHODOLOGY

Economic impact analysis relies on a complex methodology known as input-output (IO) modeling. In simplest terms, IO models use national data on inter-industry relationships to look at how increased demand in one industry translates to economic activity across all industries. Demand is typically stated in terms of increased sales, earnings, or employment in the industry in question. Regardless of the type of demand used in the analysis—sales, earnings, or jobs—the model uses these complex inter-industry relationships to translate the increased demand into economic impacts across those same indicators. In other words, a scenario in which the anticipated demand is stated as an increase in employment can show the estimated impacts in jobs, as well as in sales or earnings. IO analysis also produces multipliers for these indicators that can be used to estimate the potential impact of a future change in economic activity.

IO modeling is often used to run scenarios in order to understand the impact a new employer might have on regional demand for other industries. If an automaker were to build a new manufacturing facility, for example, the affected industries would include inputs from obvious suppliers (like manufacturers of automotive parts, electronic components, and tires) as well as less apparent goods and services (like logistics operators, advertisers, machinery repair services, and property maintenance) along with the purchases made by these suppliers. As might be expected, the extent to which an industry's purchases are made from suppliers in the region or are imported from firms outside the region can have a major influence on its economic impact. As a result, IO models are calibrated to account for this factor.<sup>39</sup>

Each round of spending, first by the automaker (the initial effects), then by its suppliers (the direct effects), and its suppliers' suppliers (the indirect effects) also translates to increased demand for labor, both for the automaker and for companies throughout the supply chain. As illustrated in Figure 21 (page 40), this increased demand for goods, services, and labor ripples across the economy again as workers in all industries spend their earnings at local businesses (the induced effects).

As stated, IO models typically use jobs, earnings, or sales as the starting point for economic impact analysis. In the automotive plant example, the regional economic impact can be modeled based on the number of new jobs created by the automaker, the earnings associated with those new jobs, or the expected sales (calculated from the anticipated number of new vehicles produced annually). Likewise, model results can be reported for those same categories.

Lightcast's analysis of the economic impact of the Aerospace and Defense and the Precision Manufacturing sectors presented in this section measures impacts in terms of the change in jobs and labor income (earnings). While other models focus on sales (or output), Lightcast's IO model, which is described in detail in the appendices, uses income because it provides a more meaningful measure of new economic activity. Unlike sales, which include the costs associated with producing goods and services (such as the cost of labor and materials), income is a net measure that excludes these intermediary costs. <sup>40</sup>

 <sup>&</sup>lt;sup>39</sup> Estimates of in-region and imported purchases for the Central Coast region are provided in Figure 36 (page 57).
 <sup>40</sup> The value in this approach is supported by economists' use of gross domestic product when considering the growth of national economies, as this measure represents the final value of goods and services after the costs of goods has been subtracted.

Five-year projections of job growth by detailed industry prepared by Lightcast were used as the starting point to model the economic impact of the two sectors on the Central Coast economy.<sup>41</sup> To reflect the potential contribution that proactive business retention, expansion, and recruitment efforts targeted on the sector could make to regional job growth, Lightcast's proprietary five-year projection for each sector was increased by 10 percent.<sup>42</sup> This approach resulted in the total initial figures used to model each sector's direct, indirect, and induced effects on employment and labor income (earnings). The remainder of this section presents further details about the results of the scenarios, including an estimate of the resulting change in tax revenues<sup>43</sup> as well as jobs and earnings multipliers for each sector.

### **RESULTS: AEROSPACE & DEFENSE**

Based on Lightcast's analysis, the addition of 634 jobs in this sector through 2027 (the initial impact) would result in another 556 jobs from direct, indirect, and induced effects, for a total change of 1,190 jobs. The additional employment gain (556 jobs) represents the sum of impacts generated by spending in the industry's supply chain (direct), additional purchases in the suppliers' supply chain (indirect), and consumption of goods and services by households of workers in the industry (induced). Stated another way, each job in the Aerospace and Defense sector supports roughly 1 additional job on the Central Coast, for a total jobs multiplier of 1.88. Likewise, each dollar earned by workers in the sector generates an additional 82 cents in earnings for workers in other sectors (an earnings multiplier of 1.82).

EMPLOYMENT & EARNINGS							
	INITIAL	DIRECT	INDIRECT	INDUCED	TOTAL		
Jobs (Number)	634	173	61	323	1,190		
Jobs (Multiplier)	1.00	0.27	0.10	0.51	1.88		
Earnings (in Millions \$US)	\$45.11	\$13.04	\$3.92	\$20.07	\$82.14		
Earnings (Multiplier)	1.00	0.29	0.09	0.44	1.82		
	TAX REVENUES						
LOCAL STATE FEDERAL TOTAL							
Added Tax Revenues (in Millio	Added Tax Revenues (in Millions \$US)         \$2.79         \$2.39         \$1.62         \$6.79						

#### FIGURE 22. ECONOMIC IMPACT OF THE AEROSPACE & DEFENSE SECTOR SCENARIO: PROJECTED JOB GAINS IN THE SECTOR FROM 2022 TO 2027, PLUS 10 PERCENT

Source(s): Lightcast MR-SAM model, 2022.

Note(s): The model output contains decimal points which are rounded to whole numbers. As a result, figures may not sum to the total shown.

<sup>&</sup>lt;sup>41</sup> Because Lightcast's IO model captures economic activity at the 6-digit NAICS level, all inputs to the model (whether jobs, sales, or earnings), must correspond to that detailed industry level. For this work, the initial jobs number represents the sum of the projected job growth, plus 10 percent, for each of the sector's detailed industries, including military employment in the case of Aerospace and Defense. (See Figure 28, page 49, for a list of the 15 detailed industries comprising the Aerospace and Defense sector; a list of the 31 detailed industries encompassed in the Precision Manufacturing sector definition is provided as Figure 29, page 50). Where industries were projected to lose jobs, Lightcast assumed that all jobs were retained.

<sup>&</sup>lt;sup>42</sup> Model assumptions, including the 10 percent increase in job growth over initial projections, were determined by Lightcast based on their understanding of economic conditions, expected industry trends, and regional objectives in support of the target sectors. <sup>43</sup> Data represent taxes on production and imports (TPI). The analysis estimates the tax implications of adding jobs in the sector by measuring the change in local, state, and federal tax revenue through increased industry sales, specifically general sales and property taxes. This change in tax revenue corresponds to the ripple effects of job creation and cannot be tied to a specific timeframe. See the Glossary (page 62) for more information on TPI.

The Aerospace and Defense sector's employment impact stretches across all aspects of the economy. Figure 23 looks at the largest expected change in jobs by industry and occupation. The largest effects from job growth in Aerospace and Defense are seen in Transportation and Warehousing (NAICS 48) and Manufacturing (NAICS 31–33). Of the total impact estimated in Lightcast's analysis, nearly 600 jobs (50 percent) are in these two industry sectors. Three industry sectors (government, professional services, and healthcare and social assistance) each account for an additional 5 percent to 7 percent of the total.

When industry impacts are translated to occupations (using Lightcast's regional staffing patterns data), the top five occupational groups combined account for one-half (50 percent) of the estimated employment gains. The largest impact is seen in Transportation and Material Moving occupations (SOC 53), which represent just over 13 percent of the total. Rounding out the top five are office workers, maintenance and repair services, management positions, and business and financial occupations, which collectively represent an additional 37 percent of the total impact.

#### **FIGURE 23. LARGEST IMPACTS FROM AEROSPACE & DEFENSE SECTOR JOB CREATION SCENARIO** TOP FIVE INDUSTRY SECTORS (2-DIGIT NAICS LEVEL) AND OCCUPATIONAL GROUPS AFFECTED



#### INDUSTRY SECTORS

Source(s): Lightcast MR-SAM model, 2022.

Job growth in the region will also lead to an increase in earnings, thanks to the extra spending of new employees and the ripple effect these purchases create. The increase in Aerospace and Defense jobs in Lightcast's impact scenario would add \$82.1 million dollars in earnings to the Central Coast economy. The majority of the earnings impact—more than \$25 million, amounting to 31 percent of the total—would occur in the Manufacturing sector (NAICS 31-33). Additional earnings in Transportation and Warehousing (NAICS 48) and Wholesale Trade (NAICS 42) round out the three largest contributors to earnings from job creation in the sector. Additional details are provided in the appendices.

FIGURE 24. LARGEST EARNINGS IMPACTS FROM AEROSPACE & DEFENSE SECTOR JOB CREATION SCENARIO TOP THREE INDUSTRY SECTORS (2-DIGIT NAICS LEVEL) AFFECTED



Source(s): Lightcast MR-SAM model, 2022.



\$15.2M

Transportation & Warehousing



\$6.4M Wholesale Trade



### **RESULTS: PRECISION MANUFACTURING**

Based on Lightcast's analysis, the addition of 331 jobs in this sector through 2027 (the initial impact) would result in another 316 jobs from direct, indirect, and induced effects, for a total change of 647 jobs. The additional employment gain (316 jobs) represents the sum of impacts generated by spending in the industry's supply chain (direct), additional purchases in the suppliers' supply chain (indirect), and consumption of goods and services by households of workers in the industry (induced). Stated another way, each job in the Precision Manufacturing sector supports 1 additional job on the Central Coast, for a total jobs multiplier of 1.96. Likewise, the sector's earnings multiplier of 1.53 indicates that each dollar earned by Precision Manufacturing workers generates an additional 53 cents in earnings for workers in other sectors (for an earnings multiplier of 1.53). The remainder of this section presents additional details about the impacts.

EMPLOYMENT & EARNINGS								
INITIAL DIRECT INDIRECT INDUCED TOTAL								
Jobs (number)	331	40	16	261	647			
Jobs (multiplier)	1.00	0.12	0.05	0.79	1.96			
Earnings (in millions \$US)	\$40.38	\$4.02	\$0.98	\$16.36	\$61.75			
Earnings (multiplier)	1.00	0.10	0.02	0.41	1.53			
	TAX REVENUES							
LOCAL STATE FEDERAL TOTAL								
Added tax revenues (in million	Added tax revenues (in millions \$US) \$2.60 \$2.32 \$1.97 \$6.89							

#### FIGURE 25. ECONOMIC IMPACT OF THE PRECISION MANUFACTURING SECTOR SCENARIO: PROJECTED JOB GAINS IN THE SECTOR FROM 2022 TO 2027, PLUS 10 PERCENT

Source(s): Lightcast MR-SAM model, 2022.

Note(s): The model output contains decimal points which are rounded to whole numbers. As a result, figures may not sum to the total shown.

Figure 26 looks at the largest expected change in jobs by industry and occupation. The majority of the effects from employment gains in Precision Manufacturing are seen in the Manufacturing industry sector (NAICS 31-33). Of the total job impact estimated in Lightcast's analysis, just over 340 jobs (53 percent) occur in this sector. However, additional employment is spurred across all aspects of the economy, including Health Care & Social Assistance (NAICS 62), Professional, Scientific, & Technical Services (NAICS 54), Accommodation & Food Services (NAICS 72), and Construction (NAICS 23), which together represent an additional 21 percent of the scenario's estimated impact.

Likewise, when industry impacts are translated to occupations, the largest gains—one out of five jobs (20 percent)—are seen in Production occupations (SOC 51). Impacts on the remaining top five occupational groups are relatively evenly split across a range of business, management, and engineering occupations.

#### FIGURE 26. LARGEST IMPACTS FROM PRECISION MANUFACTURING SECTOR JOB CREATION SCENARIO TOP FIVE INDUSTRY SECTORS (2-DIGIT NAICS LEVEL) AND OCCUPATIONAL GROUPS AFFECTED



Source(s): Lightcast MR-SAM model, 2022.

Job growth in the region will also lead to an increase in earnings, thanks to the extra spending of new employees and the ripple effect these purchases create. The increase in Precision Manufacturing jobs in Lightcast's impact scenario would add \$61.7 million dollars in earnings to the Central Coast economy. The vast majority of the earnings impact—more than \$41 million (67 percent of the total)—would occur in the Manufacturing sector (NAICS 31-33). Additional earnings in Health Care and Social Assistance (NAICS 62) and Professional, Scientific, and Technical Services (NAICS 54) represent just 6 percent and 4 percent, respectively, of the total. Additional details are provided in the appendices.

### FIGURE 27. LARGEST EARNINGS IMPACTS FROM PRECISION MANUFACTURING SECTOR JOB CREATION SCENARIO

TOP THREE INDUSTRY SECTORS (2-DIGIT NAICS LEVEL) AFFECTED



Source(s): Lightcast MR-SAM model, 2022.



Health Care & Social Assistance



\$2.7M

Professional, Scientific, & Technical Services



# APPENDICES



# **SUPPORTING DETAIL**

### SECTOR DEFINITIONS

Tables in this section represent the detailed industries that comprise the definition of the sectors agreed upon at the outset of the study. These definitions form the basis of all analyses and exhibits presented in this report. Definitions are based on the North American Industrial Classification System (NAICS), the framework used by federal agencies to classify business establishments for statistical purposes. The identified industries are mutually exclusive across the sectors analyzed in the four studies (i.e., no detailed industry appears in the definition of more than one sector).

#### FIGURE 28. INDUSTRIES COMPRISING THE AEROSPACE & DEFENSE SECTOR 6-DIGIT NAICS LEVEL

NAICS CODE	INDUSTRY
332994	Small Arms, Ordnance, and Ordnance Accessories Manufacturing
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
334519	Other Measuring and Controlling Device Manufacturing
336411	Aircraft Manufacturing
336412	Aircraft Engine and Engine Parts Manufacturing
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing
336414	Guided Missile and Space Vehicle Manufacturing
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
423860	Transportation Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers
488111	Air Traffic Control
488119	Other Airport Operations
488190	Other Support Activities for Air Transportation
611512	Flight Training
901200	Federal Government, Military

Source(s): REACH; Lightcast; TIP Strategies, Inc.

#### FIGURE 29. INDUSTRIES COMPRISING THE PRECISION MANUFACTURING SECTOR 6-DIGIT NAICS LEVEL

NAICS CODE	INDUSTRY
332721	Precision Turned Product Manufacturing
332813	Electroplating, Plating, Polishing, Anodizing, and Coloring
333242	Semiconductor Machinery Manufacturing
333314	Optical Instrument and Lens Manufacturing
334111	Electronic Computer Manufacturing
334112	Computer Storage Device Manufacturing
334118	Computer Terminal and Other Computer Peripheral Equipment Manufacturing
334210	Telephone Apparatus Manufacturing
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing
334290	Other Communications Equipment Manufacturing
334310	Audio and Video Equipment Manufacturing
334412	Bare Printed Circuit Board Manufacturing
334413	Semiconductor and Related Device Manufacturing
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing
334417	Electronic Connector Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing
334419	Other Electronic Component Manufacturing
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
334513	Instruments and Related Products Mfg. for Measuring, Displaying, and Controlling Industrial Process Variables
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
334516	Analytical Laboratory Instrument Manufacturing
334517	Irradiation Apparatus Manufacturing
334613	Blank Magnetic and Optical Recording Media Manufacturing
334614	Software and Other Prerecorded Compact Disc, Tape, and Record Reproducing
335912	Primary Battery Manufacturing
335921	Fiber Optic Cable Manufacturing
335931	Current-Carrying Wiring Device Manufacturing
335932	Noncurrent-Carrying Wiring Device Manufacturing
335991	Carbon and Graphite Product Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing
336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing

Source(s): REACH; Lightcast; TIP Strategies, Inc.

### DETAILED IMPACTS

The following tables provide additional detail regarding the anticipated effects on the Central Coast economy by industry (employment and earnings) and by occupation (employment) associated with Lightcast's economic impact analyses.

### **AEROSPACE & DEFENSE**

### FIGURE 30. IMPACT OF AEROSPACE & DEFENSE JOB CREATION BY INDUSTRY

2-DIGIT NAICS LEVEL

NAICS CODE	INDUSTRY SECTOR	CHANGE IN JOBS
48	Transportation and Warehousing	325
31	Manufacturing	270
90	Government	78
54	Professional, Scientific, and Technical Services	66
62	Health Care and Social Assistance	63
56	Administrative and Support and Waste Management and Remediation Services	57
53	Real Estate and Rental and Leasing	52
42	Wholesale Trade	48
72	Accommodation and Food Services	41
81	Other Services (except Public Administration)	39
23	Construction	38
52	Finance and Insurance	30
44	Retail Trade	27
61	Educational Services	16
71	Arts, Entertainment, and Recreation	14
51	Information	13
55	Management of Companies and Enterprises	10
11	Agriculture, Forestry, Fishing and Hunting	2
21	Mining, Quarrying, and Oil and Gas Extraction	1
22	Utilities	1
	TOTAL	1,190

Source(s): Lightcast MR-SAM model, 2022.

Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. The model output contains decimal points which were rounded to whole numbers. As a result, figures may not sum to the total shown in Figure 22 (page 42).

### FIGURE 31. IMPACT OF AEROSPACE & DEFENSE JOB CREATION BY OCCUPATION 2-DIGIT SOC LEVEL

SOC CODE	OCCUPATION	CHANGE IN JOBS
53-0000	Transportation and Material Moving Occupations	160
43-0000	Office and Administrative Support Occupations	124
49-0000	Installation, Maintenance, and Repair Occupations	116
11-0000	Management Occupations	101
13-0000	Business and Financial Operations Occupations	99
51-0000	Production Occupations	96
41-0000	Sales and Related Occupations	92
17-0000	Architecture and Engineering Occupations	73
55-0000	Military-only Occupations	41
15-0000	Computer and Mathematical Occupations	39
35-0000	Food Preparation and Serving Related Occupations	37
37-0000	Building and Grounds Cleaning and Maintenance Occupations	31
47-0000	Construction and Extraction Occupations	30
39-0000	Personal Care and Service Occupations	28
29-0000	Healthcare Practitioners and Technical Occupations	27
31-0000	Healthcare Support Occupations	26
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	24
25-0000	Educational Instruction and Library Occupations	14
33-0000	Protective Service Occupations	9
19-0000	Life, Physical, and Social Science Occupations	7
21-0000	Community and Social Service Occupations	6
23-0000	Legal Occupations	6
45-0000	Farming, Fishing, and Forestry Occupations	3
99-0000	Unclassified Occupations	1
	TOTAL	1,190

Source(s): Lightcast MR-SAM model, 2022.

Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. SOC codes refer to the Standard Occupational Classification system, the framework used by federal agencies to classify workers into occupational categories for statistical purposes. The model output contains decimal points which were rounded to whole numbers. As a result, figures may not sum to the total shown in Figure 22 (page 42).

#### FIGURE 32. IMPACT OF AEROSPACE & DEFENSE JOB CREATION ON INDUSTRY EARNINGS (IN MILLIONS) 2-DIGIT NAICS LEVEL

NAICS	INDUSTRY SECTOR	INITIAL	DIRECT	INDIRECT		TOTAL
31	Manufacturing	\$21.69	\$2.94	\$0.45	\$0.37	\$25.45
48	Transportation and Warehousing	\$13.76	\$0.98	\$0.14	\$0.30	\$15.18
42	Wholesale Trade	\$5.75	\$0.24	\$0.05	\$0.40	\$6.43
54	Professional, Scientific, and Technical Services	\$0.00	\$2.74	\$0.70	\$2.32	\$5.76
90	Government	\$3.89	\$0.07	\$0.03	\$1.44	\$5.43
62	Health Care and Social Assistance	\$0.00	\$0.01	\$0.01	\$4.59	\$4.61
53	Real Estate and Rental and Leasing	\$0.00	\$1.35	\$0.48	\$1.08	\$2.91
23	Construction	\$0.00	\$0.30	\$0.11	\$2.26	\$2.67
52	Finance and Insurance	\$0.00	\$0.78	\$0.43	\$1.29	\$2.50
56	Administrative and Support and Waste Management and Remediation Services	\$0.00	\$1.09	\$0.63	\$0.69	\$2.42
55	Management of Companies and Enterprises	\$0.00	\$1.28	\$0.34	\$0.36	\$1.98
81	Other Services (except Public Administration)	\$0.00	\$0.45	\$0.10	\$0.91	\$1.47
72	Accommodation and Food Services	\$0.00	\$0.13	\$0.13	\$1.20	\$1.46
51	Information	\$0.00	\$0.46	\$0.17	\$0.82	\$1.44
44	Retail Trade	\$0.00	\$0.05	\$0.03	\$1.14	\$1.22
61	Educational Services	\$0.02	\$0.05	\$0.01	\$0.38	\$0.46
71	Arts, Entertainment, and Recreation	\$0.00	\$0.10	\$0.06	\$0.28	\$0.45
11	Agriculture, Forestry, Fishing and Hunting	\$0.00	\$0.00	\$0.00	\$0.11	\$0.12
22	Utilities	\$0.00	\$0.02	\$0.02	\$0.07	\$0.11
21	Mining, Quarrying, and Oil and Gas Extraction	\$0.00	\$0.01	\$0.01	\$0.06	\$0.07
	TOTAL	\$45.11	\$13.04	\$3.92	\$20.07	\$82.14

Source(s): Lightcast MR-SAM model, 2022.

Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. Initial, direct, indirect, and induced impacts may not sum to total due to rounding.

### PRECISION MANUFACTURING

#### FIGURE 33. IMPACT OF PRECISION MANUFACTURING JOB CREATION BY INDUSTRY 2-DIGIT NAICS LEVEL

NAICS CODE	INDUSTRY SECTOR	CHANGE IN JOBS
31	Manufacturing	342
62	Health Care and Social Assistance	49
54	Professional, Scientific, and Technical Services	30
72	Accommodation and Food Services	28
23	Construction	28
81	Other Services (except Public Administration)	23
53	Real Estate and Rental and Leasing	22
56	Administrative and Support and Waste Management and Remediation Services	22
44	Retail Trade	20
52	Finance and Insurance	16
90	Government	13
55	Management of Companies and Enterprises	10
61	Educational Services	10
48	Transportation and Warehousing	9
71	Arts, Entertainment, and Recreation	8
51	Information	7
42	Wholesale Trade	6
11	Agriculture, Forestry, Fishing and Hunting	2
21	Mining, Quarrying, and Oil and Gas Extraction	1
22	Utilities	0
	TOTAL	647

Source(s): Lightcast MR-SAM model, 2022.

Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. The model output contains decimal points which were rounded to whole numbers. As a result, figures may not sum to the total shown in Figure 25 (page 45).

### FIGURE 34. IMPACT OF PRECISION MANUFACTURING JOB CREATION BY OCCUPATION 2-DIGIT SOC LEVEL

SOC CODE	OCCUPATION	CHANGE IN JOBS
51-0000	Production Occupations	130
11-0000	Management Occupations	69
43-0000	Office and Administrative Support Occupations	58
17-0000	Architecture and Engineering Occupations	55
13-0000	Business and Financial Operations Occupations	52
41-0000	Sales and Related Occupations	48
15-0000	Computer and Mathematical Occupations	33
53-0000	Transportation and Material Moving Occupations	29
35-0000	Food Preparation and Serving Related Occupations	25
47-0000	Construction and Extraction Occupations	20
31-0000	Healthcare Support Occupations	20
49-0000	Installation, Maintenance, and Repair Occupations	19
29-0000	Healthcare Practitioners and Technical Occupations	19
39-0000	Personal Care and Service Occupations	15
37-0000	Building and Grounds Cleaning and Maintenance Occupations	14
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	13
25-0000	Educational Instruction and Library Occupations	10
19-0000	Life, Physical, and Social Science Occupations	5
21-0000	Community and Social Service Occupations	5
33-0000	Protective Service Occupations	3
23-0000	Legal Occupations	3
45-0000	Farming, Fishing, and Forestry Occupations	2
99-0000	Unclassified Occupations	1
55-0000	Military-only Occupations	0
	TOTAL	647

Source(s): Lightcast MR-SAM model, 2022.

Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. SOC codes refer to the Standard Occupational Classification system, the framework used by federal agencies to classify workers into occupational categories for statistical purposes. The model output contains decimal points which were rounded to whole numbers. As a result, figures may not sum to the total shown in Figure 25 (page 45).

#### FIGURE 35. IMPACT OF PRECISION MANUFACTURING JOB CREATION ON INDUSTRY EARNINGS (IN MILLIONS) 2-DIGIT NAICS LEVEL

NAICS	INDUSTRY SECTOR		DIRECT			TOTAL
31	Manufacturing	\$40.38	\$0.72	\$0.03	\$0.30	\$41.43
62	Health Care and Social Assistance	\$0.00	\$0.00	\$0.00	\$3.60	\$3.61
54	Professional, Scientific, and Technical Services	\$0.00	\$0.60	\$0.22	\$1.89	\$2.71
55	Management of Companies and Enterprises	\$0.00	\$1.59	\$0.08	\$0.28	\$1.95
23	Construction	\$0.00	\$0.01	\$0.02	\$1.91	\$1.94
90	Government	\$0.00	\$0.02	\$0.01	\$1.36	\$1.39
52	Finance and Insurance	\$0.00	\$0.12	\$0.11	\$1.07	\$1.30
53	Real Estate and Rental and Leasing	\$0.00	\$0.23	\$0.14	\$0.88	\$1.26
72	Accommodation and Food Services	\$0.00	\$0.01	\$0.03	\$0.95	\$0.99
56	Administrative and Support and Waste Management and Remediation Services	\$0.00	\$0.19	\$0.15	\$0.57	\$0.92
44	Retail Trade	\$0.00	\$0.01	\$0.01	\$0.90	\$0.91
51	Information	\$0.00	\$0.11	\$0.06	\$0.66	\$0.82
81	Other Services (except Public Administration)	\$0.00	\$0.04	\$0.03	\$0.72	\$0.79
42	Wholesale Trade	\$0.00	\$0.24	\$0.02	\$0.32	\$0.57
48	Transportation and Warehousing	\$0.00	\$0.12	\$0.03	\$0.24	\$0.39
61	Educational Services	\$0.00	\$0.01	\$0.00	\$0.29	\$0.30
71	Arts, Entertainment, and Recreation	\$0.00	\$0.00	\$0.02	\$0.22	\$0.25
11	Agriculture, Forestry, Fishing and Hunting	\$0.00	\$0.00	\$0.00	\$0.09	\$0.09
22	Utilities	\$0.00	\$0.00	\$0.01	\$0.06	\$0.07
21	Mining, Quarrying, and Oil and Gas Extraction	\$0.00	\$0.00	\$0.00	\$0.05	\$0.05
	TOTAL	\$40.38	\$4.02	\$0.98	\$16.36	\$61.75

Source(s): Lightcast MR-SAM model, 2022.

Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. Initial, direct, indirect, and induced impacts may not sum to total due to rounding.

### **IN-REGION & IMPORTED PURCHASES**

In-region and imported purchases are important characteristics of the region's industry composition. In-region purchases describe the purchases a given industry makes from another industry in the region analyzed. Imported purchases describe purchases that occur outside the determined region to meet the local demand. Taken together, these purchases represent the industry's supply chain.

When looking at the Central Coast region, the top three NAICS sectors with the highest percentage of in-region purchases are Real Estate and Rental and Leasing (purchasing 92.3 percent in-region), followed by Accommodation and Food Services (90.7 percent), and Agriculture, Forestry, Fishing and Hunting (83 percent). This level of purchasing indicates the region has the ability to supply most of the demand within those industries. At the other end of the spectrum, sectors with the greatest percentage of imported purchases are Manufacturing, with 81.7 percent of purchases being imported to the region, followed by Utilities (73.9 percent), and Mining, Quarrying, Oil and Gas extraction, (73 percent).

#### FIGURE 36. IN-REGION AND IMPORTED PURCHASES BY NAICS SECTOR, 2021 (IN MILLIONS) TOP THREE INDUSTRY SECTORS BY SHARE OF IN-REGION AND IMPORTED PURCHASES ARE HIGHLIGHTED

NAICS CODE	PURCHASES FROM	IN- REGION	% IN- REGION	IMPORTED	% IMPORTED	TOTAL
90	Government	\$3,849.65	52.1%	\$3,545.00	47.9%	\$7,394.65
31	Manufacturing	\$877.00	18.3%	\$3,919.96	81.7%	\$4,796.96
53	Real Estate and Rental and Leasing	\$2,854.07	92.3%	\$239.29	7.7%	\$3,093.35
54	Professional, Scientific, and Technical Services	\$1,795.60	62.6%	\$1,072.52	37.4%	\$2,868.12
52	Finance and Insurance	\$1,586.79	56.8%	\$1,207.31	43.2%	\$2,794.10
56	Administrative and Support and Waste Management and Remediation Services	\$1,590.61	69.6%	\$693.20	30.4%	\$2,283.81
42	Wholesale Trade	\$617.53	33.0%	\$1,251.67	67.0%	\$1,869.20
51	Information	\$913.91	51.5%	\$860.52	48.5%	\$1,774.44
48	Transportation and Warehousing	\$441.10	29.6%	\$1,050.31	70.4%	\$1,491.41
23	Construction	\$1,112.68	74.8%	\$375.01	25.2%	\$1,487.68
55	Management of Companies and Enterprises	\$881.68	62.7%	\$525.01	37.3%	\$1,406.69
22	Utilities	\$185.55	26.1%	\$525.49	73.9%	\$711.04
11	Agriculture, Forestry, Fishing and Hunting	\$547.39	83.0%	\$112.10	17.0%	\$659.49
44	Retail Trade	\$241.49	40.1%	\$360.03	59.9%	\$601.52
72	Accommodation and Food Services	\$383.45	90.7%	\$39.31	9.3%	\$422.76
81	Other Services (except Public Admin.)	\$285.46	74.4%	\$98.16	25.6%	\$383.62
21	Mining, Quarrying, and Oil and Gas Extraction	\$100.41	27.0%	\$271.48	73.0%	\$371.90
71	Arts, Entertainment, and Recreation	\$96.06	61.6%	\$59.77	38.4%	\$155.83
62	Health Care and Social Assistance	\$92.42	72.8%	\$34.62	27.2%	\$127.04
61	Educational Services	\$46.86	43.6%	\$60.63	56.4%	\$107.50

Source(s): Lightcast MR-SAM model, 2022.

### **DEGREES & AWARDS DETAIL**

Figure 37 presents the distribution of degrees and awards conferred for credit by the region's institutions of higher education in all fields of study during the 2021 academic year. Roughly one in four awards (26.2 percent) were made by UC Santa Barbara. For Cal Poly, this figure was closer to one in five (19.8 percent). Taken together, the region's three community colleges accounted for nearly one-half (48.7 percent) of all awards.

#### FIGURE 37. TOTAL AWARDS CONFERRED BY CENTRAL COAST POSTSECONDARY INSTITUTIONS ALL FIELDS OF STUDY, 2021 ACADEMIC YEAR

INSTITUTION	INSTITUTION (GROUP)	AWARDS	
University of California, Santa Barbara	Public Universities	7,875	26.2%
California Polytechnic State University, San Luis Obispo (Cal Poly)	Public Universities	5,951	19.8%
Cuesta College	Community Colleges	5,408	18.0%
Santa Barbara City College	Community Colleges	4,676	15.5%
Allan Hancock College	Community Colleges	4,577	15.2%
Fielding Graduate University	Specialized Graduate Institutions	356	1.2%
Westmont College	Private Universities	350	1.2%
Pacifica Graduate Institute	Specialized Graduate Institutions	215	0.7%
International Sports Sciences Association	Career & Technical Institutions	142	0.5%
Laurus College	Career & Technical Institutions	129	0.4%
Antioch University-Santa Barbara	Private Universities	127	0.4%
Center for Employment Training-Santa Maria	Career & Technical Institutions	73	0.2%
Design's School of Cosmetology	Career & Technical Institutions	51	0.2%
San Joaquin Valley College-Atascadero	Career & Technical Institutions	47	0.2%
Central California School of Continuing Education	Career & Technical Institutions	41	0.1%
San Joaquin Valley College-Santa Maria	Career & Technical Institutions	38	0.1%
Santa Barbara Business College-Santa Maria	Career & Technical Institutions	32	0.1%
The Santa Barbara and Ventura Colleges of Law at Santa Barbara	Specialized Graduate Institutions	10	0.0%
	TOTAL	30,098	100.0%

Source(s): National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): Only includes general programs with at least 25 average annual completions between 2010 and 2021.

### WORKER MIGRATION

A review of migration data by metropolitan statistical area (MSA)<sup>44</sup> shows a trend toward the increased net outmigration<sup>45</sup> of workers in both Central Coast counties. In the San Luis Obispo MSA,<sup>46</sup> this trend is driven by the departure of workers under 25. While this flow is likely skewed by college students, a net flow of nearly 700 workers across education levels departed the county in the second quarter of 2021—the sharpest single-quarter decline in a decade. The overall trend in the Santa Barbara MSA is similarly downward but appears to be less tied to academic calendars. Following an upward trend in net in-migration of workers between 2017 and 2018, strong net out-migration since late 2019 has culminated in several thousand fewer workers in the region.

As shown in Figure 38 (page 60) and Figure 39 (page 61), net flows of workers by industry are fairly balanced in both counties. Industry sectors with the strongest net out-migration tend to be those with relatively low wages, such as food services, retail trade, and administrative support. Both counties have seen modest net in-migration of healthcare workers.

With regard to both the Aerospace and Defense sector and the Precision Manufacturing sector, migration trends in the Manufacturing industry sector (NAICS 31-33) are instructive. Net migration flows of Manufacturing workers over the past decade have been positive in the Central Coast, with each MSA drawing in more workers in this sector compared to the number that leave. The overall trajectory has been somewhat different between the two MSAs, however. While migration flows from quarter to quarter are volatile, the general trajectory for the net migration of Manufacturing workers has been relatively positive for the San Luis Obispo MSA over the period analyzed and slightly negative for the Santa Barbara MSA.

A look at the top destinations for out-migration (regardless of industry) reveals the Central Coast is primarily losing workers to other California locations.

- On balance, the San Luis Obispo MSA tends to lose young workers (those under 25) to San Francisco, San Jose, and San Diego, while gaining workers with less-than-bachelor's education from MSAs including Santa Barbara, Bakersfield, and Los Angeles. Looking at destinations outside California, young workers in the San Luis Obispo MSA are drawn to the Pacific Northwest, Phoenix, or Las Vegas. Young workers from the Santa Barbara MSA migrate to similar areas of California, although Austin and Dallas appear among the top destinations at different points during the period analyzed.
- + Migration patterns for young adults in both San Luis Obispo and Santa Barbara are, of course, heavily biased by the presence of Cal Poly and UC Santa Barbara. However, a more even distribution of net out-migration across education levels to San Luis Obispo and San Jose suggests that seasoned workers are leaving the Santa Barbara MSA rather than a trend driven by college-age workers leaving for opportunity, as is seen in San Luis Obispo. Santa Barbara also attracts workers of all education levels from greater Los Angeles.<sup>47</sup>

<sup>&</sup>lt;sup>44</sup> A metropolitan statistical area (MSA) is a designation of the US Office of Management and Budget used by federal statistical agencies. MSAs are composed of one or more counties (or county equivalents, such as parishes) that meet specific thresholds regarding the size of the population and the share living in urban areas, and which have strong economic ties (as illustrated by employment and commuting).

<sup>&</sup>lt;sup>45</sup> Net out-migration means more workers left jobs inside the region for jobs outside the region.

 <sup>&</sup>lt;sup>46</sup> Informal MSA names are used to improve readability. For example, the San Luis Obispo-Paso Robles, CA, MSA is referred to simply as the San Luis Obispo MSA; Santa Barbara MSA is used rather than Santa Maria-Santa Barbara, CA, MSA.
 <sup>47</sup> Including the Oxnard-Thousand Oaks-Ventura, CA, MSA; the Los Angeles-Long Beach-Anaheim, CA, MSA; and the Riverside-San Bernardino-Ontario, CA, MSA.

#### FIGURE 38. NET FLOW OF WORKERS BY INDUSTRY SECTOR, 2017 Q1 TO 2021 Q4

SAN LUIS OBISPO-PASO ROBLES, CA, MSA



Source(s): US Census Bureau, Longitudinal Employer-Household Dynamics (LEHD), Job-to-Job Flows (J2J); TIP Strategies, Inc. Note(s): Data include hires and separations of workers between establishments who experienced brief unemployment (one quarter or less). Only establishments with unemployment insurance (UI) covered employees are included. Industry sectors reflect the North American Industry Classification System (NAICS) used by federal agencies to classify businesses.

#### FIGURE 39. NET FLOW OF WORKERS BY INDUSTRY SECTOR, 2017 Q1 TO 2021 Q4 SANTA MARIA-SANTA BARBARA, CA, MSA

Outgoing Workers V Net Worker Flow (Incoming-Outgoing) Incoming Workers Health Care & Social Assistance Manufacturing Professional, Scientific, & Technical Services Wholesale Trade Construction Management of Companies & Enterprises **Public Administration** Finance & Insurance Transportation & Warehousing Information Real Estate & Rental & Leasing Utilities Mining, Quarrying, & Oil & Gas Extraction Other Services (Except Public Admin.) **Educational Services** Arts, Entertainment, & Recreation Admin. Support & Remediation Services Agriculture, Forestry, Fishing & Hunting **Retail Trade** Accommodation & Food Services 10,000 -10,000 -50.000 -30,000 30,000 50,000

-50,000 -30,000 -10,000 10,000 30,000 50,000 Source(s): US Census Bureau, Longitudinal Employer-Household Dynamics (LEHD), Job-to-Job Flows (J2J); TIP Strategies, Inc. Note(s): Data include hires and separations of workers between establishments who experienced brief unemployment (one quarter or less). Only establishments with unemployment insurance (UI) covered employees are included. Industry sectors reflect the North American Industry Classification System (NAICS) used by federal agencies to classify businesses.



## GLOSSARY

Earnings (labor income)	Income that is received as a result of labor, i.e., wages. It excludes non-work sources of income such as stock dividends or interest, rents, and Social Security.
Earnings per job	Total pre-tax industry earnings divided by the number of jobs in the industry in the same year. Industry earnings consist of two values: wages and salaries (including bonuses, stock options, and severance pay), and supplements (which consists of employer contributions to pension funds; health insurance; and federal, state, and local government programs). Because it is calculated for industries (which encompass a mix of occupations) it is not comparable to occupation-based measures, like median annual wages or median hourly earnings.
Gross state/regional product (GSP/GRP)	Measure of the final value of all goods and services produced in a state after netting out the cost of goods used in production. Alternatively, gross state product (GSP) equals the combined incomes of all factors of production, i.e., labor, land, and capital. These include wages, salaries, proprietors' incomes, profits, rents, and other. GSP is also sometimes called value added or added income. Gross regional product (GRP) represents this same measure for a region.
Imported purchases	The amount of money the selected industry spends on the goods of that industry from suppliers from outside of the selected region.
Income (industry)	Industry income is synonymous with value added gross state product (GSP). Unlike sales, income is a net measure that excludes the cost of production. For this reason, income provides a more meaningful measure of the impact of the sale. <i>Example:</i> A bakery sells a loaf of bread for \$5.00. The cost of production is \$3.00 (i.e., the amount of money spent on ingredients, labor, a portion of space rental and equipment costs, and so on needed to make the loaf of bread), meaning the income derived from the sale is \$2.00.
Initial effect	The initial change in jobs or earnings used to model economic impacts. (See page 40 for a discussion of direct, indirect, and induced impacts.)
Input-output analysis	Relationship between a given set of demands for final goods and services and the implied amounts of manufactured inputs, raw materials, and labor that this requires. When institutions pay wages and salaries and spend money for supplies in the state, they also generate earnings in all sectors of the economy, thereby increasing the demand for goods and services and jobs.
In-region purchases	The amount of money the selected industry spends on the goods of that industry from suppliers within the selected region.

Intermediary costs	The costs associated with producing goods and services. Examples include payroll, rent, equipment, and raw materials.
Multiplier effect (earnings)	Additional income created in the economy as employees spend money in the region. It consists of the income created by the supply chain of the industries initially affected by the spending of the employees (i.e., the direct effect), income created by the supply chain of the initial supply chain (i.e., the indirect effect), and the income created by the increased spending of the household sector (i.e., the induced effect).
Multiplier effect (jobs)	Additional employment created in the economy as a result of an initial change in jobs in the sector. It consists of employment created by the supply chain of the industries initially affected by the change in jobs (i.e., the direct effect), employment created by the supply chain of the initial supply chain (i.e., the indirect effect), and employment created by the increased spending of the household sector (i.e., the induced effect).
Net cash flow	Benefits minus costs, i.e., the sum of revenues accruing from an investment minus costs incurred.
Net present value	Net cash flow discounted to the present. All future cash flows are collapsed into one number, which, if positive, indicates feasibility. The result is expressed as a monetary measure.
Non-labor income	Income received from investments, such as rent, interest, and dividends, and other non- work sources (e.g., Social Security).
Sales (or output)	Sales include all the intermediary costs associated with producing goods and services. It differs from income, which nets out (excludes) those costs.
Taxes on production and imports (TPI)	TPI consists of state and local taxes—primarily non-personal property taxes, licenses, and sales and gross receipts taxes—and federal excise taxes on goods and services. Special assessments are also included. It is one of the four components of gross regional product (GRP); the other elements are earnings (labor income), profits/property income, and subsidies.

Source(s): Lightcast; TIP Strategies, Inc.

# **CLASSIFICATION SYSTEMS**

This section provides a brief overview of the three federal classification systems referenced in this report, along with links for more information.

+ The North American Industry Classification System (NAICS) is used by federal agencies to classify North American business establishments in order to better collect, analyze, and publish statistical data related to the business economy. The NAICS taxonomy categorizes industries into six levels using codes ranging from 2- to 6-digits as illustrated below. Visit the US Census Bureau <u>NAICS overview page</u> for more information.

#### EXAMPLE

Sector: 23 Construction Subsector: 236 Construction of Buildings Industry Group: 2362 Construction of Nonresidential Buildings NAICS Industry: 23621 Industrial Building Construction National Industry: 236210 Industrial Building Construction

+ The **Standard Occupational Classification System (SOC)** is used by federal agencies to classify workers into occupational categories for statistical purposes. The SOC system classifies occupations at four levels as illustrated in the example below. Visit the US Bureau of Labor Statistics <u>Standard Occupational Classification page</u> to learn more.

#### EXAMPLE

Major group: 51-0000 Production Occupations Minor group: 51-4000 Metal Workers and Plastic Workers Broad occupation: 51-4040 Machinists Detailed occupation: 51-4041 Machinists

+ The Classification of Instructional Programs (CIP) was developed by the National Center for Education Statistics (NCES) to categorize completions (degrees and awards granted for credit by eligible postsecondary institutions) within broad, generalized categories for tracking and analytical purposes. It consists of three levels: 1) the two-digit series, 2) the four-digit series, and 3) the six-digit series. As illustrated below, the CIP moves from broad field of study to general instructional area to detailed program area. For more information, visit the NCES <u>CIP User Site</u>.

#### EXAMPLE

#### 14. Engineering

- 14.09 Computer Engineering
  - 14.0901 Computer Engineering, General
  - 14.0902 Computer Hardware Engineering
  - 14.0903 Computer Software Engineering
  - 14.0999 Computer Engineering, Other

## RESOURCES

#### ECONOMIC IMPACT (LIGHTCAST MODEL)

- + Bureau of Economic Analysis. "Table 1.1.6. Real Gross Domestic Product, Chained Dollars." <u>https://apps.bea.gov/iTable/?reqid=19&step=2&isuri=1&categories=survey#eyJhcHBpZCI6MTksInNoZXBzJjpbMS</u> wyLDNdLCJkYXRhIjpbWyJjYXRlZ29yaWVzIiwiU3VydmV5IlosWyJOSVBBX1RhYmxlXoxpc3QiLCI2Il1dfQ==
- + Henderson, James M. and Richard E. Quant. Microeconomic Theory: A Mathematical Approach. New York: McGraw-Hill Book Company, 1971.
- + Kaeding, Nicole. "State Individual Income Tax Rates and Brackets for 2016." Tax Foundation Fiscal Fact no. 500 (February 2016). <u>https://files.taxfoundation.org/legacy/docs/TaxFoundation\_FF500.pdf</u>.
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- + Mincer, Jacob. "Investment in Human Capital and Personal Income Distribution." Journal of Political Economy 66, no. 4 (August 1958): 281–302.
- Office of Management and Budget. "Circular A-94 Appendix C." Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in Percent). Last modified December 2022. <u>https://www.whitehouse.gov/wp-</u> <u>content/uploads/2023/02/M-23-12-Appendix-C-Update\_Discount-Rates.pdf</u>.
- Walczak, Jared, Scott Drenkard. "State and Local Sales Tax Rates, Midyear 2016." Tax Foundation Fiscal Fact no. 515 (July 2016). <u>https://files.taxfoundation.org/legacy/docs/TaxFoundation\_FF515.pdf</u>.

#### **AEROSPACE & DEFENSE**

#### **Background: Trends & Directions**

- + Brukardt, Ryan, "How will the space economy change the world?," McKinsey & Company, November 2022.
- + Mazanec, Brian M., National Security Space: Actions Needed to Better Use Commercial Satellite Imagery and Analytics, US Government Accounting Office, September 2022.
- + Thomas, Troy, et al., "Satellites Are the Next Frontier for Industrial Companies," Boston Consulting Group, November 29, 2022.

#### **Background: Central Coast**

+ General resources for this section include the websites of regional postsecondary institutions (i.e., Cal Poly, UC Santa Barbara, and Cuesta College), Crunchbase, company websites, and local news sources.

#### PRECISION MANUFACTURING

#### **Background: Trends & Directions**

+ Bromberger, Jörg, Julian Ilg, and Ana Maria Miranda, "The mainstreaming of additive manufacturing," McKinsey & Company, March 2022.

- + Fusaro, Roberta, and Lucia Rahilly, "The future of US manufacturing is hiding in plain sight," The McKinsey Podcast (transcript), December 2022.
- + Heising, Wilderich, et al., "3D Printing Helps Realize the Promise of Distributed Manufacturing," Boston Consulting Group, December 5, 2022.
- + National Academies of Sciences, Engineering, and Medicine, *A Quadrennial Review of the National Nanotechnology Initiative: Nanoscience, Applications, and Commercialization*, Washington, DC: The National Academies Press, 2020.
- + Palma, Ramiro, Raj Varadarajan, Jimmy Goodrich, Thomas Lopez, and Aniket Patil, "The Growing Challenge of Semiconductor Design Leadership," Semiconductor Industry Association and Boston Consulting Group, November 2022.

#### Background: Central Coast

+ General resources for this section include the websites of regional postsecondary institutions (i.e., Cal Poly, UC Santa Barbara, and Cuesta College), Crunchbase, company websites, and local news sources.

## LIGHTCAST MR-SAM

Lightcast's Multi-Regional Social Accounting Matrix (MR-SAM) model represents the flow of all economic transactions in a given region. It replaces Lightcast's previous input-output (IO) model, which operated with some 1,000 industries, four layers of government, a single household consumption sector, and an investment sector. The old IO model was used to simulate the ripple effects (i.e., multipliers) in the regional economy as a result of industries entering or exiting the region. The MR-SAM model performs the same tasks as the old IO model, but it also does much more. Along with the same 1,000 industries, government, household and investment sectors embedded in the old IO tool, the MR-SAM exhibits much more functionality, a greater amount of data, and a higher level of detail on the demographic and occupational components of jobs (16 demographic cohorts and about 750 occupations are characterized).

This appendix presents a high-level overview of the MR-SAM. Additional documentation on the technical aspects of the model is available upon request.

### DATA SOURCES FOR THE MODEL

The Lightcast MR-SAM model relies on a number of internal and external data sources, mostly compiled by the federal government. What follows is a listing and short explanation of these sources. The use of these data will be covered in more detail later in this appendix.

Lightcast Data are produced from many data sources to produce detailed industry, occupation, and demographic jobs and earnings data at the local level. This information (especially sales-to-jobs ratios derived from jobs and earnings-to-sales ratios) is used to help regionalize the national matrices as well as to disaggregate them into more detailed industries than are normally available.

- **+** BEA Make and Use Tables (MUT) are the basis for input-output models in the US. The make table is a matrix that describes the amount of each commodity made by each industry in a given year. Industries are placed in the rows and commodities in the columns. The use table is a matrix that describes the amount of each commodity used by each industry in a given year. In the use table, commodities are placed in the rows and industries in the columns. The BEA produces two different sets of MUTs, the benchmark and the summary. The benchmark set contains about 500 sectors and is released every five years, with a five-year lag time (e.g., 2002 benchmark MUTs were released in 2007). The summary set contains about 80 sectors and is released every year, with a two-year lag (e.g., 2010 summary MUTs were released in late 2011/early 2012). The MUTs are used in the Lightcast MR-SAM model to produce an industry-by-industry matrix describing all industry purchases from all industries.
- + BEA Gross Domestic Product by State (GSP) describes gross domestic product from the value added (also known as added income) perspective. Value added is equal to employee compensation, gross operating surplus, and taxes on production and imports, less subsidies. Each of these components is reported for each state and an aggregate group of industries. This dataset is updated once per year, with a one-year lag. The Lightcast MR-SAM model makes use of this data as a control and pegs certain pieces of the model to values from this dataset.
- + BEA National Income and Product Accounts (NIPA) cover a wide variety of economic measures for the nation, including gross domestic product (GDP), sources of output, and distribution of income. This dataset is updated

periodically throughout the year and can be between a month and several years old depending on the specific account. NIPA data are used in many of the Lightcast MR-SAM processes as both controls and seeds.

- + BEA Local Area Income (LPI) encapsulates multiple tables with geographies down to the county level. The following two tables are specifically used: CA05 (Personal income and earnings by industry) and CA91 (Gross flow of earnings). CA91 is used when creating the commuting submodel and CA05 is used in several processes to help with place-of-work and place-of-residence differences, as well as to calculate personal income, transfers, dividends, interest, and rent.
- + Bureau of Labor Statistics Consumer Expenditure Survey (CEX) reports on the buying habits of consumers along with some information as to their income, consumer unit, and demographics. Lightcast utilizes this data heavily in the creation of the national demographic by income type consumption on industries.
- + Census of Government's (CoG) state and local government finance dataset is used specifically to aid breaking out state and local data that is reported in the MUTs. This allows Lightcast to have unique production functions for each of its state and local government sectors.
- Census' OnTheMap (OTM) is a collection of three datasets for the census block level for multiple years. All three of
  these are used in the commuting submodel to gain better estimates of earnings by industry that may be counted as
  commuting. This dataset has holes for specific years and regions. These holes are filled with Census' Journey-toWork described later.
  - + Origin-Destination (OD) offers job totals associated with both home census blocks and a work census block.
  - + Residence Area Characteristics (RAC) offers jobs totaled by home census block.
  - + Workplace Area Characteristics (WAC) offers jobs totaled by work census block.
- + Census' Current Population Survey (CPS) is used as the basis for the demographic breakout data of the MR-SAM model. This set is used to estimate the ratios of demographic cohorts and their income for the three different income categories (i.e., wages, property income, and transfers).
- + Census' Journey-to-Work (JtW) is part of the 2000 Census and describes the amount of commuting jobs between counties. This set is used to fill in the areas where OTM does not have data.
- + Census' American Community Survey (ACS) Public Use Microdata Sample (PUMS) is the replacement for Census' long form and is used by Lightcast to fill the holes in the CPS data.
- + Oak Ridge National Lab (ORNL) County-to-County Distance Matrix (Skim Tree) contains a matrix of distances and network impedances between each county via various modes of transportation such as highway, railroad, water, and combined highway-rail. Also included in this set are minimum impedances utilizing the best combination of paths. The ORNL distance matrix is used in Lightcast's gravitational flows model that estimates the amount of trade between counties in the country.

### OVERVIEW OF THE MR-SAM MODEL

Lightcast's MR-SAM modeling system is a comparative static model in the same general class as RIMS II (Bureau of Economic Analysis) and IMPLAN (Minnesota Implan Group). The MR-SAM model is thus not an econometric model, the primary example of which is PolicyInsight by REMI. It relies on a matrix representation of industry-to-industry purchasing patterns originally based on national data which are regionalized with the use of local data and mathematical

manipulation (i.e., non-survey methods). Models of this type estimate the ripple effects of changes in jobs, earnings, or sales in one or more industries upon other industries in a region.

The Lightcast MR-SAM model shows final equilibrium impacts—that is, the user enters a change that perturbs the economy, and the model shows the changes required to establish a new equilibrium. As such, it is not a dynamic model that shows year-by-year changes over time (as REMI's does).

### NATIONAL SAM

Following standard practice, the SAM model appears as a square matrix, with each row sum exactly equaling the corresponding column sum. Reflecting its kinship with the standard Leontief input-output framework, individual SAM elements show accounting flows between row and column sectors during a chosen base year. Read across rows, SAM entries show the flow of funds into column accounts (also known as receipts or the appropriation of funds by those column accounts). Read down columns, SAM entries show the flow of funds into row accounts (also known as expenditures or the dispersal of funds to those row accounts).

The SAM may be broken into three different aggregation layers: broad accounts, sub-accounts, and detailed accounts. The broad layer is the most aggregate and will be covered first. Broad accounts cover between one and four sub-accounts, which in turn cover many detailed accounts. This appendix will not discuss detailed accounts directly because of their number. For example, in the industry broad account, there are two sub-accounts and over 1,000 detailed accounts.

### MULTI-REGIONAL ASPECT OF THE MR-SAM

Multi-regional (MR) describes a non-survey model that has the ability to analyze the transactions and ripple effects (i.e., multipliers) of not just a single region, but multiple regions interacting with each other. Regions in this case are made up of a collection of counties.

Lightcast's multi-regional model is built off of gravitational flows, assuming that the larger a county's economy, the more influence it will have on the surrounding counties' purchases and sales. The equation behind this model is essentially the same that Isaac Newton used to calculate the gravitational pull between planets and stars. In Newton's equation, the masses of both objects are multiplied, then divided by the distance separating them and multiplied by a constant. In Lightcast's model, the masses are replaced with the supply of a sector for one county and the demand for that same sector from another county. The distance is replaced with an impedance value that takes into account the distance, type of roads, rail lines, and other modes of transportation. Once this is calculated for every county-to-county pair, a set of mathematical operations is performed to make sure all counties absorb the correct amount of supply from every county and the correct amount of demand from every county. These operations produce more than 200 million data points.

### COMPONENTS OF THE LIGHTCAST MR-SAM MODEL

The Lightcast MR-SAM is built from a number of different components that are gathered together to display information whenever a user selects a region. What follows is a description of each of these components and how each is created. Lightcast's internally created data are used to a great extent throughout the processes described below, but its creation is not described in this appendix.
## COUNTY EARNINGS DISTRIBUTION MATRIX

The county earnings distribution matrices describe the earnings spent by every industry on every occupation for a year i.e., earnings by occupation. The matrices are built utilizing Lightcast's industry earnings, occupational average earnings, and staffing patterns.

Each matrix starts with a region's staffing pattern matrix which is multiplied by the industry jobs vector. This produces the number of occupational jobs in each industry for the region. Next, the occupational average hourly earnings per job are multiplied by 2,080 hours, which converts the average hourly earnings into a yearly estimate. Then the matrix of occupational jobs is multiplied by the occupational annual earnings per job, converting it into earnings values. Last, all earnings are adjusted to match the known industry totals. This is a fairly simple process, but one that is very important. These matrices describe the place-of-work earnings used by the MR-SAM.

## COMMUTING MODEL

The commuting sub-model is an integral part of Lightcast's MR-SAM model. It allows the regional and multi-regional models to know what amount of the earnings can be attributed to place-of-residence vs. place-of-work. The commuting data describe the flow of earnings from any county to any other county (including within the counties themselves). For this situation, the commuted earnings are not just a single value describing total earnings flows over a complete year but are broken out by occupation and demographic. Breaking out the earnings allows for analysis of place-of-residence and place-of-work earnings. These data are created using Bureau of Labor Statistics' OnTheMap dataset, Census' Journey-to-Work, BEA's LPI CA91 and CA05 tables, and some of Lightcast's data. The process incorporates the cleanup and disaggregation of the OnTheMap data, the estimation of a closed system of county inflows and outflows of earnings, and the creation of finalized commuting data.

## NATIONAL SAM

The national SAM as described above is made up of several different components. Many of the elements discussed are filled in with values from the national Z matrix—or industry-to-industry transaction matrix. This matrix is built from BEA data that describe which industries make and use what commodities at the national level. These data are manipulated with some industry standard equations to produce the national Z matrix. The data in the Z matrix act as the basis for the majority of the data in the national SAM. The rest of the values are filled in with data from the county earnings distribution matrices, the commuting data, and the BEA's National Income and Product Accounts.

One of the major issues that affect any SAM project is the combination of data from multiple sources that may not be consistent with one another. Matrix balancing is the broad name for the techniques used to correct this problem. Lightcast uses a modification of the "diagonal similarity scaling" algorithm to balance the national SAM.

## **GRAVITATIONAL FLOWS MODEL**

The most important piece of the Lightcast MR-SAM model is the gravitational flows model that produces county-bycounty regional purchasing coefficients (RPCs). RPCs estimate how much an industry purchases from other industries inside and outside of the defined region. This information is critical for calculating all IO models. Gravity modeling starts with the creation of an impedance matrix that values the difficulty of moving a product from county to county. For each sector, an impedance matrix is created based on a set of distance impedance methods for that sector. A distance impedance method is one of the measurements reported in the Oak Ridge National Laboratory's County-to-County Distance Matrix. In this matrix, every county-to-county relationship is accounted for in six measures: great-circle distance, highway impedance, rail miles, rail impedance, water impedance, and highway-rail-highway impedance. Next, using the impedance information, the trade flows for each industry in every county are solved for. The result is an estimate of multi-regional flows from every county to every county. These flows are divided by each respective county's demand to produce multi-regional RPCs.