COMPUTER/ELECTRONIC MANUFACTURING IN CALIFORNIA
This report was prepared by the Center of Excellence at Los Rios Community College District and the Center for Applied Competitive Technologies (CACT) at El Camino College.

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Introduction

California has a large concentration of computer and electronic firms that excel in technological innovation, research, and development. Over the last few decades, California’s computer and electronic firms created new products that transformed business and social interactions across the world (i.e. personal computers, portable devices, network management software, etc.). Although California’s computer/electronic firms excel in the area of technological innovation and advancements, the cluster’s employment outlook is somewhat bleak due to the practice of outsourcing production to low-cost economies, such as China. Nevertheless, the cluster is significant to California’s economy, providing excellent wages for qualified, highly skilled candidates.

The purpose of this study is to assess the economic and workforce trends of the computer/electronic manufacturing cluster in California across 10 regions. This information is intended for use by the California Community College’s Centers for Applied Competitive Technologies (CACT) to determine how to best serve the industry. The CACTs offer technology education, manufacturing training, and consulting services that contribute to continuous workforce and business development, and technology deployment.¹

This study provides data comparisons for the following regions:

<table>
<thead>
<tr>
<th>Region²</th>
<th>Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay Area</td>
<td>Alameda, Contra Costa, Marin, Napa, San Francisco, Solano, Sonoma</td>
</tr>
<tr>
<td>Central Valley</td>
<td>Alpine, Amador, Calaveras, Fresno, Inyo, Kern, Kings, Madera, Mariposa, Merced, Mono, San Joaquin, Stanislaus, Tulare, Tuolumne</td>
</tr>
<tr>
<td>Far North</td>
<td>Butte, Colusa, Del Norte, Glenn, Humboldt, Lake, Lassen, Mendocino, Modoc, Plumas, Shasta, Sierra, Siskiyou, Tehama, Trinity</td>
</tr>
<tr>
<td>Greater Sacramento</td>
<td>El Dorado, Nevada, Placer, Sacramento, Sutter, Yolo, Yuba</td>
</tr>
<tr>
<td>Inland Empire</td>
<td>Riverside, San Bernardino</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>Los Angeles</td>
</tr>
<tr>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>San Diego &amp; Imperial</td>
<td>Imperial, San Diego</td>
</tr>
<tr>
<td>Silicon Valley</td>
<td>Monterey, San Benito, San Mateo, Santa Clara, Santa Cruz</td>
</tr>
<tr>
<td>South Central</td>
<td>San Luis Obispo, Santa Barbara, Ventura</td>
</tr>
</tbody>
</table>

¹ More information about the CACTs can be found in Appendix B.
² Regions are defined based on the California Community College Economic and Workforce Development (EWD) delineations.
Cluster Overview

Composition
The computer/electronic cluster consists of firms that specialize in the design, production and distribution of computers and other electronic components. Some firms in this cluster specialize in research and development, while others manufacture component parts. It is common for firms in this cluster to concentrate in a specific geographic area, such as the Silicon Valley or the Los Angeles region. Clustering allows firms to shorten their supply-chain, gain faster access to specialized information, and develop business-to-business relationships (i.e. sales/contracts). The eight major industry groups in the computer/electronic cluster include: 3

- Audio and Video Equipment – firms that manufacture electronic audio and video equipment for home entertainment, motor vehicles, and musical instrument amplifications.
- Communications Equipment – firms that manufacture data communications equipment, wireless communications equipment, radio and television broadcast equipment, and other related items.
- Computer and Peripheral Equipment – firms that manufacture and/or assemble electronic computers (such as mainframes, personal computers, workstations, laptops, and servers); storage devices; computer terminals; and other peripheral equipment.
- Electrical Equipment – firms that manufacturer switchgear, switchboard apparatus, power generators, electric motors (except internal combustion engines), motor generator sets, motor starters, relays, controllers and power, distribution and specialty transforms.
- Manufacturing and Reproducing Magnetic and Optical Media – firms that engage in mass reproduction of computer software as well as audio and video material on magnetic or optical media. Firms in this group also manufacture magnetic and optical medical such as hard drives.
- Measuring, Electromedical, and Control Instruments – firms that manufacture automatic controls, totalizing fluid meters, and instruments for measuring, displaying, indicating, recording, transmitting, and controlling industrial process variables. This group also includes firms that manufacturing instruments for measuring and testing the characteristics of electricity and electrical signals (i.e. circuit and continuity testers and semiconductor test equipment.)
- Other Electrical Equipment and Component – firms that manufacture storage batteries; dry primary batteries; fiber-optic cable; insulated wire; current-carrying wiring devices; noncurrent-carrying wiring devices; carbon and graphite electrodes, fibers and other products; porcelain electrical insulators and related parts; and electric apparatus and other equipment.

3 Appendix C provides the NAICS codes and industry descriptions for each major industry group in the computer/electronic manufacturing cluster.
Semiconductor and other electronic components is the largest industry group with about 1,860 firms and 91,750 jobs, followed by computer and peripheral equipment with 630 firms and 61,400 jobs. Exhibit 1 shows that of the 4,900 computer/electronic firms located in California, 29 percent are located in the Silicon Valley (1,440 firms), followed by the Los Angeles Region (860 firms; 18%), and Orange County (780 firms; 16%).

Table 1: Computer/Electronic Manufacturing Firms and Jobs by Major Industry Group in California

<table>
<thead>
<tr>
<th>Industry Group</th>
<th>2011 Firms</th>
<th>2011 Share of</th>
<th>2011 Jobs</th>
<th>2011 Share of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semiconductor and Other Electronic Component</td>
<td>1,859</td>
<td>38%</td>
<td>91,747</td>
<td>38%</td>
</tr>
<tr>
<td>Computer and Peripheral Equipment</td>
<td>633</td>
<td>13%</td>
<td>61,406</td>
<td>26%</td>
</tr>
<tr>
<td>Communications Equipment</td>
<td>551</td>
<td>11%</td>
<td>28,390</td>
<td>12%</td>
</tr>
<tr>
<td>Measuring, Electromedical, and Control Instruments</td>
<td>681</td>
<td>14%</td>
<td>23,641</td>
<td>10%</td>
</tr>
<tr>
<td>Other Electrical Equipment and Component</td>
<td>429</td>
<td>9%</td>
<td>12,860</td>
<td>5%</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td>344</td>
<td>7%</td>
<td>9,323</td>
<td>4%</td>
</tr>
<tr>
<td>Manufacturing and Reproducing Magnetic and Optical Media</td>
<td>200</td>
<td>4%</td>
<td>6,623</td>
<td>3%</td>
</tr>
<tr>
<td>Audio and Video Equipment</td>
<td>181</td>
<td>4%</td>
<td>6,477</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,878</strong></td>
<td><strong>100%</strong></td>
<td><strong>240,467</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Exhibit 1: Concentration of Computer/Electronic Manufacturing Firms by Region

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4 EMSI Complete Employment - 2011.4
Map 1 displays the concentration of computer/electronic firms in California by county. As shown, there are 44 counties that have fewer than 50 firms, seven counties with 50 to 150 firms, three counties with 151 to 350 firms and three counties with more than 350 firms. Santa Clara County in the Silicon Valley, Los Angeles County, and Orange County lead the state in terms of attracting and retaining the largest concentration of computer/electronic firms.

Map 1: Computer/Electronic Manufacturing Firms in California by County

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5 EMSI Complete Employment - 2011.4
Map 2 displays the density of computer/electronic firms in proximity to the Centers for Applied Competitive Technologies (CACT). Nearly 60 percent of California’s computer/electronic firms and two out of three jobs are located in three regions: Silicon Valley, Los Angeles, and Orange County. Within these regions, 86 percent of the firms are small in size (employing fewer than 50 employees), 13 percent are medium in size (employing between 51 and 500 workers), and only one percent are large in size (employing more than 500 workers).

Map 2: Computer/Electronic Firms in California by Region

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6 InfoUSA, 2011.
Workforce Trends

In the last five years, the computer/electronic cluster declined by 9 percent, eliminating 21,730 jobs across the state. As shown in Table 2, the Silicon Valley, Bay Area, and Los Angeles Regions lost the most jobs during that timeframe. The Central Valley is the only region with a net gain in total employment, with growth of 9 percent or 345 jobs.


Table 2: Computer/Electronic Employment by Region, 2006 – 2011

<table>
<thead>
<tr>
<th>Region</th>
<th>2006</th>
<th>2011</th>
<th>Change</th>
<th>% Change</th>
<th>2011 Share of Computer/Electronic Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Valley</td>
<td>113,915</td>
<td>108,331</td>
<td>-5,584</td>
<td>-5%</td>
<td>50%</td>
</tr>
<tr>
<td>Orange County</td>
<td>28,728</td>
<td>26,243</td>
<td>-2,485</td>
<td>-9%</td>
<td>12%</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>27,268</td>
<td>23,958</td>
<td>-3,310</td>
<td>-12%</td>
<td>11%</td>
</tr>
<tr>
<td>San Diego</td>
<td>22,705</td>
<td>19,504</td>
<td>-3,201</td>
<td>-14%</td>
<td>9%</td>
</tr>
<tr>
<td>Bay Area</td>
<td>20,214</td>
<td>15,791</td>
<td>-4,423</td>
<td>-22%</td>
<td>7%</td>
</tr>
<tr>
<td>South Central</td>
<td>9,153</td>
<td>7,928</td>
<td>-1,225</td>
<td>-13%</td>
<td>4%</td>
</tr>
<tr>
<td>Greater Sacramento</td>
<td>8,354</td>
<td>7,253</td>
<td>-1,101</td>
<td>-13%</td>
<td>3%</td>
</tr>
<tr>
<td>Inland Empire</td>
<td>6,144</td>
<td>5,463</td>
<td>-681</td>
<td>-11%</td>
<td>2%</td>
</tr>
<tr>
<td>Central Valley</td>
<td>3,726</td>
<td>4,070</td>
<td>344</td>
<td>9%</td>
<td>2%</td>
</tr>
<tr>
<td>Far North</td>
<td>260</td>
<td>196</td>
<td>-64</td>
<td>-25%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>California</strong></td>
<td>240,467</td>
<td>218,737</td>
<td>-21,730</td>
<td>-9%</td>
<td>100%</td>
</tr>
</tbody>
</table>

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7 EMSI Complete Employment - 2011.4
Workforce Projections

The cluster’s employment is projected to slowly decline over the next five years. The Silicon Valley and Bay Area Regions are projected to experience the largest losses with a decline of 5,580 and 4,400 jobs respectively. The Central Valley is the only region projected to add jobs, with a growth rate similar to the previous five years.


Table 3: Computer/Electronic Projected Employment by Region, 2011 – 2014

<table>
<thead>
<tr>
<th>Region</th>
<th>2011 Jobs</th>
<th>2016 Jobs</th>
<th>Change</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Valley</td>
<td>113,915</td>
<td>108,331</td>
<td>-5,584</td>
<td>-5%</td>
</tr>
<tr>
<td>Orange</td>
<td>28,728</td>
<td>26,243</td>
<td>-2,485</td>
<td>-9%</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>27,268</td>
<td>23,958</td>
<td>-3,310</td>
<td>-12%</td>
</tr>
<tr>
<td>San Diego &amp; Imperial</td>
<td>22,705</td>
<td>19,504</td>
<td>-3,201</td>
<td>-14%</td>
</tr>
<tr>
<td>Bay Area</td>
<td>20,214</td>
<td>15,791</td>
<td>-4,423</td>
<td>-22%</td>
</tr>
<tr>
<td>South Central</td>
<td>9,153</td>
<td>7,928</td>
<td>-1,225</td>
<td>-13%</td>
</tr>
<tr>
<td>Greater Sacramento</td>
<td>8,354</td>
<td>7,253</td>
<td>-1,101</td>
<td>-13%</td>
</tr>
<tr>
<td>Inland Empire</td>
<td>6,144</td>
<td>5,463</td>
<td>-681</td>
<td>-11%</td>
</tr>
<tr>
<td>Central Valley</td>
<td>3,726</td>
<td>4,070</td>
<td>344</td>
<td>9%</td>
</tr>
<tr>
<td>Far North</td>
<td>260</td>
<td>196</td>
<td>-64</td>
<td>-25%</td>
</tr>
<tr>
<td>California</td>
<td>240,467</td>
<td>218,737</td>
<td>-21,730</td>
<td>-9%</td>
</tr>
</tbody>
</table>

---

8 Industry projections are based on long-term historic trends which may be skewed by the recession. Additional data is needed, such as an industry survey, to thoroughly assess projected growth or decline.

9 EMSI Complete Employment - 2011.4
Revenue & Wages

The computer/electronic cluster generated over $50 billion in sales in 2010. Silicon Valley generated 30 percent of the total revenue, followed by Orange County and Los Angeles with 18 and 17 percent respectively. The Silicon Valley also provided the highest earnings per worker (EPW) in 2011,\textsuperscript{10} while the Central Valley and South Central Region reported the lowest EPW in that year.

Exhibit 4: Computer/Electronic Revenue and Earnings Per Worker by Region\textsuperscript{11,12}

Table 4: Computer/Electronic Revenue and Earnings Per Worker (EPW) by Region\textsuperscript{11,12}

<table>
<thead>
<tr>
<th>Region</th>
<th>Revenue (thousands)</th>
<th>Revenue % of Total</th>
<th>2011 EPW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Valley</td>
<td>$15,494,817</td>
<td>30%</td>
<td>$172,389</td>
</tr>
<tr>
<td>Orange County</td>
<td>$9,180,877</td>
<td>18%</td>
<td>$78,394</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>$8,668,926</td>
<td>17%</td>
<td>$65,432</td>
</tr>
<tr>
<td>Bay Area</td>
<td>$6,812,662</td>
<td>13%</td>
<td>$102,028</td>
</tr>
<tr>
<td>San Diego</td>
<td>$3,410,086</td>
<td>7%</td>
<td>$92,798</td>
</tr>
<tr>
<td>South Central</td>
<td>$2,014,629</td>
<td>4%</td>
<td>$88,580</td>
</tr>
<tr>
<td>Inland Empire</td>
<td>$1,986,702</td>
<td>4%</td>
<td>$58,072</td>
</tr>
<tr>
<td>Greater Sacramento</td>
<td>$1,726,332</td>
<td>3%</td>
<td>$132,455</td>
</tr>
<tr>
<td>Central Valley</td>
<td>$1,332,576</td>
<td>3%</td>
<td>$56,622</td>
</tr>
<tr>
<td>Far North</td>
<td>$257,731</td>
<td>1%</td>
<td>$61,040</td>
</tr>
<tr>
<td>California</td>
<td>$50,885,338</td>
<td>100%</td>
<td>$126,189</td>
</tr>
</tbody>
</table>

\textsuperscript{10} Earnings per worker data represents payroll averages for the cluster. Payroll wages are calculated from quarterly aggregate payroll totals divided by the number of employees in a sector, regardless of occupational classification (job title).

\textsuperscript{11} EMSI Complete Employment - 2011.4 (EPW Data)

\textsuperscript{12} InfoUSA, 2011. (Revenue Data)
Map 3 displays the computer/electronic cluster’s revenue by region. This map contrasts the revenue among the Northern, Central, and Southern California regions. As shown, coastal regions with large populations generated the most revenue in 2010.

Map 3: Computer/Electronic Revenue in California by Region

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13 InfoUSA, 2011.
Occupational Analysis

Nearly every occupation in the computer/electronic cluster is projected to decline over the next five years. Of the 10 largest occupations, each is expected to lose between 300 and 1,750 jobs by 2016. Electrical and electronic equipment assemblers is projected to lose the most jobs, followed by electronics engineers and team assemblers. However, there will be demand for replacement workers due to retirements and general turnover.

Table 5 displays the median hourly earnings and education level for each occupation. Engineering managers are expected to earn the highest wages at about $64 per hour or $134,000 annually, followed by computer hardware engineers ($52 per hour; $109,000 annually) and computer software engineers ($49 per hour; $102,000 annually). Five of the 10 largest occupations require a minimum of a Bachelor’s degree, two require an Associates or other postsecondary degree, and three require short to moderate-term on-the-job training.

Table 5: Top 10 Largest Computer/Electronic Occupations in California

<table>
<thead>
<tr>
<th>Description</th>
<th>2011 Jobs</th>
<th>2016 Jobs</th>
<th>Change*</th>
<th>Percent Change</th>
<th>Median Hourly Earnings</th>
<th>Education Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer software engineers, systems software</td>
<td>16,396</td>
<td>15,964</td>
<td>(432)</td>
<td>(3%)</td>
<td>$49.16</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Electrical and electronic equipment assemblers</td>
<td>15,303</td>
<td>13,545</td>
<td>(1,758)</td>
<td>(11%)</td>
<td>$13.98</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>Computer hardware engineers</td>
<td>10,657</td>
<td>10,074</td>
<td>(583)</td>
<td>(5%)</td>
<td>$52.37</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Electronics engineers, except computer</td>
<td>9,781</td>
<td>8,822</td>
<td>(959)</td>
<td>(10%)</td>
<td>$45.95</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Team assemblers</td>
<td>9,393</td>
<td>8,518</td>
<td>(875)</td>
<td>(9%)</td>
<td>$12.20</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>Computer software engineers, applications</td>
<td>8,321</td>
<td>8,005</td>
<td>(316)</td>
<td>(4%)</td>
<td>$45.67</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Engineering managers</td>
<td>7,449</td>
<td>6,653</td>
<td>(796)</td>
<td>(11%)</td>
<td>$64.38</td>
<td>Degree plus work experience</td>
</tr>
<tr>
<td>Electrical and electronic engineering technicians</td>
<td>6,432</td>
<td>5,773</td>
<td>(659)</td>
<td>(10%)</td>
<td>$27.28</td>
<td>Associates degree</td>
</tr>
<tr>
<td>Inspectors, testers, sorters, samplers, and weighers</td>
<td>6,230</td>
<td>5,588</td>
<td>(642)</td>
<td>(10%)</td>
<td>$15.64</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>Semiconductor processors</td>
<td>5,392</td>
<td>4,891</td>
<td>(501)</td>
<td>(9%)</td>
<td>$15.73</td>
<td>Postsecondary vocational award</td>
</tr>
</tbody>
</table>

*Change outlook does not reflect replacement jobs. It only reflects new job growth or decline.

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14 Occupation projections are based on long-term historic trends which may be skewed by the recession. Additional data is needed, such as an occupational survey, to thoroughly assess projected growth or decline.
15 EMSI Complete Employment - 2011.4
16 Occupation estimates represent current and projected employment in the computer/electronic cluster, not current and projected employment across all industries/sectors.
17 Appendix D provides a profile of each occupation, including a description of the main tasks performed and top skill requirements.
Exhibit 5 displays the relationship between minimum education requirements and median hourly earnings for the top 10 largest computer/electronic occupations in California. The graphic illustrates the following:

- Engineering managers are required to have a Bachelor’s degree plus work experience. This combination awards them the highest compensation among the top 10 largest occupations.
- Occupations requiring a minimum of a Bachelor’s degree (computer software engineers, computer hardware engineers, and electronics engineers) offer earnings well above the state’s average.\(^{18}\)
- Occupations requiring an Associate or postsecondary degree (engineering technicians and semiconductor processors) provide competitive earnings when compared to the state average.
- Occupations requiring a minimum of on-the-job training (equipment assemblers, team assemblers, and inspectors/testers/weighers) offer below average earnings.

**Exhibit 5: Education Level and Median Hourly Earnings for the Top 10 Largest Computer/Electronic Occupations in California\(^ {19}\)**

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\(^{18}\) The median hourly earnings for all occupations in California is $20.35.

\(^{19}\) EMSI Complete Employment - 2011.4
Summary

The computer/electronic cluster contributes significantly to California's economy. In 2010, the cluster generated over $50 billion in sales, adding substantial tax revenue to the state's general fund. The computer/electronic cluster also provides thousands of high wage jobs for educated, skilled workers. However, in the last five years, the cluster reduced its workforce by nine percent or nearly 22,000 jobs. There are two key factors driving the cluster's decline:

- A significant number of computer/electronic firms restricted hiring or downsized their workforce in response to the national and state recession, and;

- A significant number of computer/electronic firms outsourced component production to firms outside of California to reduce operating costs.

More so than other manufacturing sectors, California's computer/electronic firms tend to focus on research and development of high end products while outsourcing production. This common practice is seen as a way to keep personnel and operating costs low. If the trend continues, employment in the computer/electronic manufacturing cluster may continue to decline over the next decade.

Despite the projected employment decline, California's computer/electronic cluster is a leader in new product development because of its significant investment in research and development. As such, there will continue to be a demand for engineers, scientists and managers with expertise in software, hardware, and other computer science applications. The community college system can support the cluster by: (1) training engineers for transfer to four-year universities and (2) providing customized training and consulting that assist cluster firms maintain low costs in their production facilities both locally and internationally.

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Appendix A: About the Centers for Applied Competitive Technologies

The Centers for Applied Competitive Technologies (CACT) specialize in providing workforce training and technical consultation to help businesses solve operational, personnel, and technical problems in the manufacturing environment. The CACTs offer technology education, manufacturing training, and consulting services that contribute to continuous workforce development, technology deployment and business development. Services include:

- Customized workforce training in areas such as just-in-time production, distribution cycles, and six sigma deployment.
- Consulting services in areas such as organization assessment, quality system audits, process capability, and strategic planning.
- Technical services that provide an unbiased professional evaluation of your advanced technology processes.

The CACTs are funded primarily by the California Community College Economic and Workforce Development Program. These grant funds enable Centers to offer cost-effective workforce training and consultative services for California’s advanced technology businesses. The program goal is to provide companies the technical expertise they need to compete successfully in changing markets and the global economy. The CACTs are conveniently located at community colleges across the state. In addition affiliate sites at other colleges are being established. To learn more about these Centers contact one of those listed below or visit www.makingitincalifornia.com.

CACT @ College of the Canyons
26455 Rockwell Canyon Rd.
Santa Clarita, CA 91355
(661) 362-3111

CACT @ San Diego City College
1414 Park Blvd., Room T-216
San Diego, CA 92101-8747
(619) 388-3730

CACT @ De Anza College
Foothill-De Anza Community College District
Professional & Workforce Development
12345 El Monte Road
Los Altos Hills, CA 94022
(650) 949-7795

CACT @ College of the Sequoias
915 S. Mooney Blvd.
Visalia, CA 93277
(559) 737-4838

CACT @ El Camino College
13430 Hawthorne Blvd.
Hawthorne, CA 90250
(310) 973-3170

CACT @ Sierra College
Roseville Gateway Center
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Appendix B: About the Centers of Excellence

The Centers of Excellence (COE), in partnership with business and industry, deliver regional workforce research customized for community college and workforce system decision making and resource development. The Northern California COE is one of five regional Centers of Excellence supported by the Chancellor’s Office of the California Community Colleges and is tasked with conducting environmental scanning, partnership development and technical assistance activities.

The COE’s research team represents expertise in labor market analysis, labor-management partnership projects, project management, and primary research. COE staff are experienced researchers with a focus on research design, partnership development, educational and training program mapping, and identifying skill sets for emerging occupations as well as key skill sets and geospatial analysis.

The COE maintains strategic alliances with research organizations whose relationships and technical expertise enhance COE’s research efforts. These alliances enable COE to access information from over 80 public databases using EMSI economic modeling software, GIS technology via the use of a customized geo-mapping software that ties industry codes (NAICS) to a private business database of over 1 million business records. The COE maintains robust partnerships with industry associations that assist in validating research findings, ensuring that the most recent industry and labor market conditions are captured.

COE studies are used to inform policy discussions, industry-wide legislative efforts, and regional workforce development strategies, as well as guide program and resource development efforts by the California Community Colleges. These reports can be accessed at www.coeccc.net.
Appendix C: Computer/Electronic Manufacturing Cluster, Major Industry Groups

Major Industry Group 1: Computer and Peripheral Equipment Manufacturing

334111 - Electronic Computer Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing and/or assembling electronic computers, such as mainframes, personal computers, workstations, laptops, and computer servers. The manufacture of computers includes the assembly or integration of processors, coprocessors, memory, storage, and input/output devices into a user-programmable final product.

334112 - Computer Storage Device Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing computer storage devices that allow the storage and retrieval of data from a phase change, magnetic, optical, or magnetic/optical media. Examples of products made by these establishments are CD-ROM drives, floppy disk drives, hard disk drives, and tape storage and backup units.

334113 - Computer Terminal Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing computer terminals. Computer terminals are input/output devices that connect with a central computer for processing.

334119 - Other Computer Peripheral Equipment Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing computer peripheral equipment (except storage devices and computer terminals).

Major Industry Group 2: Communications Equipment Manufacturing

334210 - Telephone Apparatus Manufacturing
This industry comprises establishments primarily engaged in manufacturing wire telephone and data communications equipment. These products may be standalone or board-level components of a larger system. Examples of products made by these establishments are central office switching equipment, cordless telephones (except cellular), PBX equipment, telephones, telephone answering machines, LAN modems, multi-user modems, and other data communications equipment, such as bridges, routers, and gateways.

334220 - Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing
This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment.

334290 - Other Communications Equipment Manufacturing
This industry comprises establishments primarily engaged in manufacturing communications equipment (except telephone apparatus, and radio and television broadcast, and wireless communications equipment).

Major Industry Group 3: Audio and Video Equipment Manufacturing

334310 - Audio and Video Equipment Manufacturing
This industry comprises establishments primarily engaged in manufacturing electronic audio and video equipment for home entertainment, motor vehicles, and public address and musical instrument amplification. Examples of products made by these establishments are video cassette recorders, televisions, stereo...
equipment, speaker systems, household-type video cameras, jukeboxes, and amplifiers for musical instruments and public address systems.

**Major Industry Group 4: Semiconductor and Other Electronic Component Manufacturing**

334411 - Electron Tube Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing electron tubes and parts (except glass blanks). Examples of products made by these establishments are cathode ray tubes (i.e., picture tubes), klystron tubes, magnetron tubes, and traveling wave tubes.

334412 - Bare Printed Circuit Board Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing bare (i.e., rigid or flexible) printed circuit boards without mounted electronic components. These establishments print, perforate, plate, screen, etch, or photoprint interconnecting pathways for electric current on laminates.

334413 - Semiconductor and Related Device Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing semiconductors and related solid state devices. Examples of products made by these establishments are integrated circuits, memory chips, microprocessors, diodes, transistors, solar cells and other optoelectronic devices.

334414 - Electronic Capacitor Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing electronic fixed and variable capacitors and condensers.

334415 - Electronic Resistor Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing electronic resistors, such as fixed and variable resistors, resistor networks, thermistors, and varistors.

334416 - Electronic Coil, Transformer, and Other Inductor Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing electronic inductors, such as coils and transformers.

334417 - Electronic Connector Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing electronic connectors, such as coaxial, cylindrical, rack and panel, pin and sleeve, printed circuit and fiber optic.

334418 - Printed Circuit Assembly (Electronic Assembly) Manufacturing
This U.S. industry comprises establishments primarily engaged in loading components onto printed circuit boards or who manufacture and ship loaded printed circuit boards. Also known as printed circuit assemblies, electronics assemblies, or modules, these products are printed circuit boards that have some or all of the semiconductor and electronic components inserted or mounted and are inputs to a wide variety of electronic systems and devices.

334419 - Other Electronic Component Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing electronic components (except electron tubes; bare printed circuit boards; semiconductors and related devices; electronic capacitors; electronic resistors; coils, transformers and other inductors; connectors; and loaded printed circuit boards).

**Major Industry Group 5: Measuring, Electromedical, and Control Instruments Manufacturing**

334512 - Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use
This U.S. industry comprises establishments primarily engaged in manufacturing automatic controls and regulators for applications, such as heating, air-conditioning, refrigeration and appliances.
334513 - Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
This U.S. industry comprises establishments primarily engaged in manufacturing instruments and related devices for measuring, displaying, indicating, recording, transmitting, and controlling industrial process variables. These instruments measure, display or control (monitor, analyze, and so forth) industrial process variables, such as temperature, humidity, pressure, vacuum, combustion, flow, level, viscosity, density, acidity, concentration, and rotation.

334514 - Totalizing Fluid Meter and Counting Device Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing totalizing (i.e., registering) fluid meters and counting devices. Examples of products made by these establishments are gas consumption meters, water consumption meters, parking meters, taxi meters, motor vehicle gauges, and fare collection equipment.

334515 - Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
This U.S. industry comprises establishments primarily engaged in manufacturing instruments for measuring and testing the characteristics of electricity and electrical signals. Examples of products made by these establishments are circuit and continuity testers, voltmeters, ohm meters, wattmeters, multimeters, and semiconductor test equipment.

Major Industry Group 6: Manufacturing and Reproducing Magnetic and Optical Media

334611 - Software Reproducing
This U.S. industry comprises establishments primarily engaged in mass reproducing computer software. These establishments do not generally develop any software. They mass reproduce data and programs on magnetic or optical media, such as CD-ROMs, diskettes, tapes, or cartridges. This industry includes establishments that mass reproduce game cartridges.

334612 - Prerecorded Compact Disc (except Software), Tape, and Record Reproducing
This U.S. industry comprises establishments primarily engaged in mass reproducing audio and video material on magnetic or optical media. Examples of products mass reproduced by these establishments are prerecorded audio compact discs, audio and video cassettes, and digital video discs (DVDs).

334613 - Magnetic and Optical Recording Media Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing magnetic and optical recording media, such as blank magnetic tape, blank diskettes, blank optical discs, hard drive media, and blank magnetic tape cassettes.

Major Industry Group 7: Electrical Equipment Manufacturing

335311 - Power, Distribution, and Specialty Transformer Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing power, distribution, and specialty transformers (except electronic components). Industrial-type and consumer-type transformers in this industry vary (e.g., step up or step down) voltage but do not convert alternating to direct or direct to alternating current.

335312 - Motor and Generator Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing electric motors (except internal combustion engine starting motors), power generators (except battery charging alternators for internal combustion engines), and motor generator sets (except turbine generator set units). This industry includes establishments rewinding armatures on a factory basis.
335313 - Switchgear and Switchboard Apparatus Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing switchgear and switchboard apparatus.

335314 - Relay and Industrial Control Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing relays, motor starters and controllers, and other industrial controls and control accessories.

Major Industry Group 8: Other Electrical Equipment and Component Manufacturing

335911 - Storage Battery Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing storage batteries.

335912 - Primary Battery Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing wet or dry primary batteries.

335921 - Fiber Optic Cable Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing insulated fiber-optic cable from purchased fiber-optic strand.

335929 - Other Communication and Energy Wire Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing insulated wire and cable of nonferrous metals from purchased wire.

335931 - Current-Carrying Wiring Device Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing current-carrying wiring devices.

335932 - Noncurrent-Carrying Wiring Device Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing noncurrent-carrying wiring devices.

335991 - Carbon and Graphite Product Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing carbon, graphite, and metal-graphite brushes and brush stock; carbon or graphite electrodes for thermal and electrolytic uses; carbon and graphite fibers; and other carbon, graphite, and metal-graphite products.

335999 - All Other Miscellaneous Electrical Equipment and Component Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing industrial and commercial electric apparatus and other equipment (except lighting equipment, household appliances, transformers, motors, generators, switchgear, relays, industrial controls, batteries, communication and energy wire and cable, wiring devices, and carbon and graphite products). This industry includes power converters (i.e., AC to DC and DC to AC), power supplies, surge suppressors, and similar equipment for industrial-type and consumer-type equipment.

327113 - Porcelain Electrical Supply Manufacturing
This U.S. industry comprises establishments primarily engaged in manufacturing porcelain electrical insulators, molded porcelain parts for electrical devices, ferrite or ceramic magnets, and electronic and electrical supplies from nonmetallic minerals, such as clay and ceramic materials.

Appendix D: Occupation Profiles

Below are the occupational profiles for the top 10 largest occupations in the computer/electronic cluster. Each occupational profile includes a description of the main tasks performed and top skill requirements as defined by O*NET Online.

Software Developers, Systems Software (15-1133)
Software Developers research, design, develop, and test operating systems-level software, compilers, and network distribution software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications. The top skills for this occupation include:

- Ability to modify existing software to correct errors, to adapt it to new hardware, or to upgrade interfaces and improve performance.
- Ability to direct software programming and development of documentation.
- Ability to Store, retrieves, and manipulate data for analysis of system capabilities and requirements.
- Ability to analyze information to determine, recommend, and plan installation of a new system or modification of an existing system.
- Ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

Electrical and electronic equipment assemblers (51-2022)
Electrical and electronic equipment assemblers assemble or modify electrical or electronic equipment, such as computers, test equipment telemetering systems, electric motors, and batteries. The top skills for this occupation include:

- Watching gauges, dials, or other indicators to make sure a machine is working properly.
- Controlling operations of equipment or systems.
- Ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
- Ability to listen to and understand information and ideas presented through spoken words and sentences.
- Ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.

Computer hardware engineers (17-2061)
Computer hardware engineers research, design, develop, or test computer or computer-related equipment for commercial, industrial, military, or scientific use. They may supervise the manufacturing and installation of computer or computer-related equipment and components. The top skills for this occupation include:

- Ability to Test and verify hardware and support peripherals to ensure that they meet specifications and requirements, by recording and analyzing test data.
- Ability to Build, test, and modify product prototypes using working models or theoretical models constructed with computer simulation.
- Ability to monitor functioning of equipment and make necessary modifications to ensure system operates in conformance with specifications.
- Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Understanding the implications of new information for both current and future problem-solving and decision-making.
- Managing one's own time and the time of others.
- Analyzing needs and product requirements to create a design.
Electronics engineers, except computer (17-2072)
Electronics engineers research, design, develop, or test electronic components and systems for commercial, industrial, military, or scientific use employing knowledge of electronic theory and materials properties. They design electronic circuits and components for use in fields such as telecommunications, aerospace guidance and propulsion control, acoustics, or instruments and controls. The top skills for this occupation include:

- Ability to prepare engineering sketches or specifications for construction, relocation, or installation of equipment, facilities, products, or systems.
- Ability to develop or perform operational, maintenance, or testing procedures for electronic products, components, equipment, or systems.
- Ability to inspect electronic equipment, instruments, products, or systems to ensure conformance to specifications, safety standards, or applicable codes or regulations.
- Ability to choose the right mathematical methods or formulas to solve a problem.
- Ability to see details at close range (within a few feet of the observer).
- Ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
- Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.

Team assemblers (51-2092)
Team assemblers work as part of a team having responsibility for assembling an entire product or component of a product. The top skills for this occupation include:

- Ability to perform quality checks on products and parts.
- Ability to review work orders and blueprints to ensure work is performed according to specifications.
- Ability to maintain production equipment and machinery.
- Ability to adjust actions in relation to others' actions.
- Ability to talk to others to convey information effectively.

Computer software engineers, applications (15-1031)
Computer software engineers develop, create, and modify general computer applications software or specialized utility programs; analyze user needs and develop software solutions; and design software or customize software for client use with the aim of optimizing operational efficiency. The top skills for this occupation include:

- Ability to modify existing software to correct errors, allow it to adapt to new hardware, or to improve its performance.
- Ability to design, develop and modify software systems, using scientific analysis and mathematical models to predict and measure outcome and consequences of design.
- Ability to coordinate software system installation and monitor equipment functioning to ensure specifications are met.
- Ability to considering the relative costs and benefits of potential actions to choose the most appropriate one.

Engineering managers (11-9041)
Engineering managers plan, direct, or coordinate engineering activities or engage in research and development. The top skills for this occupation include:

- Ability to coordinate and direct projects, making detailed plans to accomplish goals and directing the integration of technical activities.
- Ability to consult or negotiate with clients to prepare project specifications.
- Ability to recruit employees, assign, direct, and evaluate their work, and oversee the development and maintenance of staff competence.
• Ability to analyze technology, resource needs, and market demand, to plan and assess the feasibility of projects.

**Electrical and electronic engineering technicians (17-3023)**

Electrical and electronic engineering technicians apply electrical and electronic theory and related knowledge, usually under the direction of engineering staff, to design, build, repair, calibrate, and modify electrical components, circuitry, controls, and machinery for subsequent evaluation and use by engineering staff in making engineering design decisions. The top skills for this occupation include:

• Ability to Read blueprints, wiring diagrams, schematic drawings, or engineering instructions for assembling electronics units, applying knowledge of electronic theory and components.

• Ability to perform preventative maintenance or calibration of equipment or systems.

• Ability to maintain system logs or manuals to document testing or operation of equipment.

• Ability to provide customer support and education, working with users to identify needs, determine sources of problems, or to provide information on product use.

**Inspectors, testers, sorters, samplers, and weighers (51-9061)**

Inspectors, testers, sorters, samplers, and weighers inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications. The top skills for this occupation include:

• Ability to Analyze and interpret blueprints, data, manuals, and other materials to determine specifications, inspection and testing procedures, adjustment and certification methods, formulas, and measuring instruments required.

• Ability to Inspect, test, or measure materials, products, installations, or work for conformance to specifications.

• Ability to Observe and monitor production operations and equipment to ensure conformance to specifications and make or order necessary process or assembly adjustments.

• Ability to Analyze test data, making computations as necessary, to determine test results.

**Semiconductor processors (51-9141)**

Semiconductor processors perform any or all of the following functions in the manufacture of electronic semiconductors: load semiconductor material into furnace; saw formed ingots into segments; load individual segment into crystal growing chamber and monitor controls; locate crystal axis in ingot using x-ray equipment and saw ingots into wafers; and clean, polish, and load wafers into series of special purpose furnaces, chemical baths, and equipment used to form circuitry and change conductive properties. The top skills for this occupation include:

• Ability to manipulate valves, switches, and buttons, or key commands into control panels to start semiconductor processing cycles.

• Ability to Inspect materials, components, or products for surface defects and measure circuitry, using electronic test equipment, precision measuring instruments, microscope, and standard procedures.

• Ability to Study work orders, instructions, formulas, and processing charts to determine specifications and sequence of operations.

• Ability to Set, adjust, and readjust computerized or mechanical equipment controls to regulate power level, temperature, vacuum, and rotation speed of furnace, according to crystal growing specifications.

• Ability to Etch, lap, polish, or grind wafers or ingots to form circuitry and change conductive properties, using etching, lapping, polishing, or grinding equipment.

Appendix E: Locating Computer/Electronic Manufacturing Related Degree & Certificate Programs

The California Community Colleges offer a range of instructional programs that support computer/electronic manufacturing. To locate the programs use the Taxonomy of Programs (TOP) list below with the searchable data base found on the California Community College Chancellor's Office website. The URL is: https://misweb.cccco.edu/webproginv/prod/topcodelist_n.cfm. Using these codes you can find which colleges have programs.

For example if one puts in the TOP Code 0934.10 (Computer Electronics) these colleges will be identified as having programs: Cerritos College, El Camino College, Fullerton College, Glendale College, Los Angeles City College, Los Angeles Harbor College, Los Angeles Trade-Technical, Los Angeles Valley College, Merced College, Mission College, Modesto Junior College, Mount San Antonio College, Orange Coast College, Palomar College, Pasadena City College, Riverside City College, Saddleback College, San Bernardino Valley College, San Diego City College, Sierra College, Solano Community College, Southwestern College, and Victor Valley Community College.

While not every program found will be oriented to computer/electronic manufacturing, the following TOP codes are those most closely associated with it:

- 0934.10 Computer Electronics
- 0702.00 Computer Information Systems
- 0708.00 Computer Infrastructure and Support
- 0708.10 Computer Networking
- 0707.10 Computer Programming
- 0706.00 Computer Science (transfer)
- 0707.00 Computer Software Development
- 0708.20 Computer Support
- 0707.30 Computer Systems Analysis
- 0707.20 Database Design and Administration
- 0953.30 Electrical, Electronic, and Electro-Mechanical Drafting
- 0935.00 Electro-Mechanical Technology
- 0934.00 Electronics and Electric Technology
- 0924.00 Engineering Technology, General
- 0901.00 Engineering, General (Transfer)
- 0934.20 Industrial Electronics
- 0956.80 Industrial Quality Control
- 0945.00 Industrial Systems Technology and Maintenance
- 0701.00 Information Technology, General
- 0943.00 Instrumentation Technology
- 0956.30 Machining and Machine Tools
- 0956.00 Manufacturing and Industrial Technology
- 0999.00 Other Engineering and Industrial Technologies