High Tech in LA

Its Employment *and* Economic Contribution *in 2013*

OCTOBER 2014

LAEDC INSTITUTE FOR APPLIED ECONOMICS

High Tech in LA:

Its Employment and Economic Contribution In 2013

Christine Cooper, Ph.D.
Shannon M. Sedgwick
Somjita Mitra, Ph.D.

October 2014

Institute for Applied Economics
Los Angeles County Economic Development Corporation
444 S. Flower Street, 37th Floor ◆ Los Angeles, CA 90071
(213) 236-4840 · analysis@laedc.org

JPMorgan Chase & Co.

This research was conducted with the very generous support of JPMorgan Chase & Co.

The LAEDC Institute for Applied Economics provides objective economic and policy research for public agencies and private firms. The Institute focuses on economic impact studies, regional industry and cluster analysis and issue studies, particularly in workforce development, labor market analysis, transportation and infrastructure.

Table of Contents

This page intentionally left blank

Executive Summary

LA's high tech sector is thriving.

Los Angeles has long been the center of technology and innovation, with the nexus of its signature aerospace and entertainment industries inexorably shattering successive frontiers of knowledge and imagination. The creativity and innovative spirit of its people continues to propel Los Angeles into the future.

This report reviews the high tech sector in Los Angeles in three parts, and makes the following findings….

Technology is the single most important ingredient for building and nurturing a thriving, prosperous, and growing economy.

High tech in LA employed more than 368,500 people in 2013, more than any other metro region in the nation.

The high tech sector in LA is large and diverse, reaching across many industries.

High Tech in LA….

…accounts for 9 percent of all employment, and almost 17 percent of all payroll wages.

…supported 763,600 jobs in LA, including direct, indirect and induced jobs across a broad spectrum of industries.

…paid wages that were on average almost 70 percent higher than wages in other industries.

104,680 high tech jobs exist outside the high tech sector.

The economic contribution of high tech in LA in 2013 included $58.7 billion in labor income, and $108.3 to regional GDP.

…generated $21.8 billion in tax revenues in 2013 for federal, state and local governments.

Why High Tech Matters

High tech, low tech – the combination may determine our future.

Los Angeles has long been the center of technology and innovation, with the nexus of its signature aerospace and entertainment industries inexorably shattering successive frontiers of knowledge and imagination. From delivering cargo to space and spacecraft beyond the edges of our solar system, to delivering inhaled insulin to diabetic patients, and delivering entertainment into the hands of millions of people around the world, it is the creativity and innovative spirit of the its people that has propelled Los Angeles into the future.

While innovations of the twentieth century brought an explosion of scientific knowledge, allowing a better understanding of our resources and materials, and the computerization and digitization of virtually everything, today's innovations are bringing vast amounts of knowledge to our fingertips, instantaneous communication with anyone anywhere, and giving us access to people and knowledge and information from around the world—compressing the time to learn and innovate.

But the speed of innovation and transformational change is only possible with high tech processes. This is now a fundamentally symbiotic relationship where high tech is transformed through innovation, but the process of innovation itself needs ever higher levels of sophisticated technology and investment.

This report reviews the high tech sector in Los Angeles in three parts. First, the size of the high tech sector is estimated in terms of employment. LA's tech sector is compared to other industry sectors in Los Angeles and to high tech sectors in other regions of the nation, and comes out on top in both comparisons.

The value of wages paid by the high tech sector is reviewed as well, finding that high tech wages are on average higher than those in all other industries.

Finally, the overall economic contribution of the high tech sector is estimated, including its indirect and induced effects as it interacts with the rest of the economy, and the tax revenue generated by the activity attributable to the high tech sector.

Understanding the contribution of LA's high tech sector is critical as we chart our course for the future. In the face of globalization and lightning speed transactions, innovation and the capacity to transform our world will set the winners apart from the losers in today's global economy.

Technology is the single most important ingredient for building and nurturing a thriving, prosperous, and growing economy.

Sizing Things Up

How big is the high tech sector in LA?

The high tech sector in LA is large and diverse, reaching across many industries.

Industries of the High Tech Sector

Architectural and engineering services and R&D
NAICS 5413, 5417

Aerospace products
NAICS 3345, 3364

Biopharmaceuticals and medical devices
NAICS 3254, 3391, 6215

Computer products and electronics manufacturing
NAICS 3341, 3342, 3343, 3344, 3346, 3353, 3359

Computer software, design and services and on-line publishing
NAICS 5112, 5182, 5191, 5415

Machinery and equipment manufacturing
NAICS 3332, 3333, 3336, 3339

Management, scientific and technical consulting services
NAICS 5416

Petroleum and chemical products manufacturing
NAICS 3241, 3251, 3252

Telecommunications
NAICS 5171, 5172, 5174, 5179

Wholesale activities related to high tech
NAICS 4234, 4236, 4242, 4251

Defining the arena of high tech in a diverse economy such as that of Los Angeles County is a challenge, since high tech can be seen in every facet of work and across a spectrum of industries, with advances occurring with a frequency that appears to be accelerating, sometimes displacing earlier processes and materials while in other instances enhancing or improving existing technology.

Clearly, for an industry to be technologically advanced, it must invest in research and development, and in the human capital which embodies both the scientific and the tacit knowledge that drives innovation and efficiency. These are industries that are more likely to innovate, and indeed research shows that high tech industries are those that invest a larger proportion of their revenues in R&D. Unfortunately, detailed industry-level data on R&D investment is not readily and consistently available. A reasonable and commonly-used proxy is the share of the industry's jobs that is engaged in high tech work.

Defining High Tech Employment

The methodology used in this report is based on foundational research conducted by economists at the Bureau of Labor Statistics, which is detailed in the Appendix. At its core, it defines high tech industries as those with a larger percentage of high tech workers than other industries. The percentage threshold identifying high tech is determined using national data of the occupational composition of industries. Using this methodology, there are 34 industry groups (at the 4-digit NAICS level) that are identified as high tech industries.[1]

They are a mix of manufacturing, knowledge services, and facilitation of commerce, each of which plays an integral role in synergistically advancing innovation, building common connections and sharing supply chains.

Some industries are more involved in producing or using technology than others. For example, food processing, although becoming more highly automated, is not as technologically intensive as, say, solar panel manufacturing. The latter will have scientists, programmers, engineers and so on in their employment while these types of workers are unlikely to be working in food processing firms. Therefore, one might reasonably expect to see high tech operations across a variety of industries in the economy, and indeed, the industries of high tech are diverse, and include legacy industries such as petroleum products manufacturing and aerospace products manufacturing, and relative newcomers to the scene, such as software publishing.

For exposition purposes, high tech industries of the defined set have been loosely aggregated into industry categories of different specialization.

[1] The full data set is provided in Exhibit A-1 in the Appendix.

Counting High Tech Employment

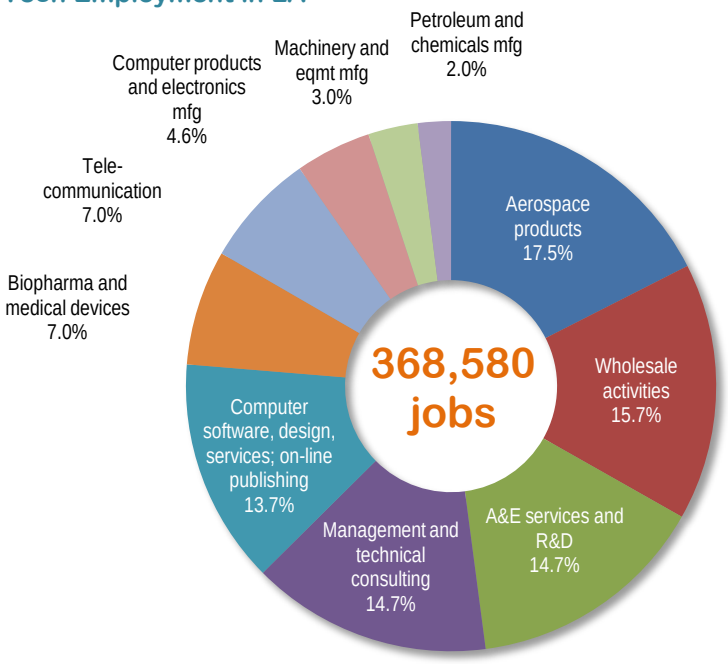
Using publicly-available data based on payroll employment within these industries, the high tech sector employs 368,580 workers in Los Angeles County in 2013 across a spectrum of industries.

The largest high tech segments are aerospace products; wholesale activities (related to high tech products); engineering services and research and development; consulting services; and computer software, design, services and on-line publishing. Together, these five segments account for more than 75 percent of LA's high tech employment (278,100 jobs together).

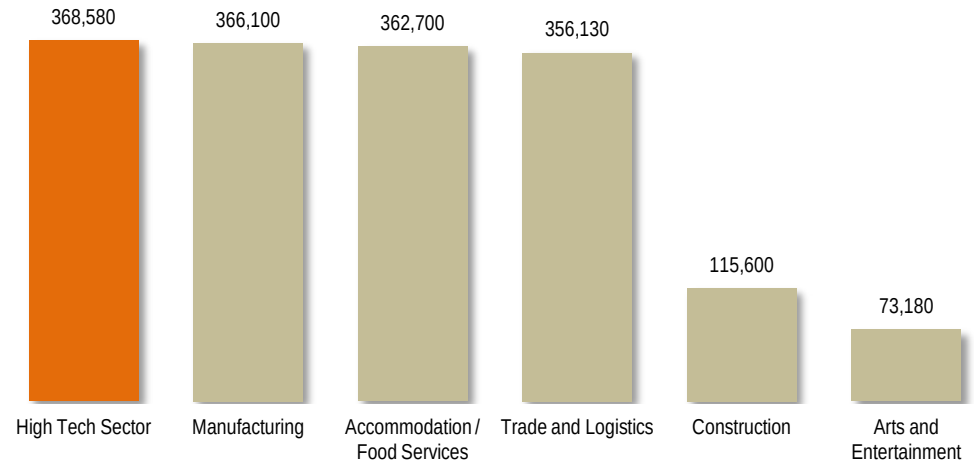
Note that there are a variety of jobs within the high tech sector, including such positions as administrative assistants, accountants, human resource professionals, shipping clerks and many others, that are not considered high tech. While these workers may not themselves be in "high tech" jobs, they do work in the high tech sector and support the growth of these industries.

By way of comparison, the high tech sector is larger than the accommodation and food services industry sector (362,700 jobs), larger than the entire manufacturing sector (366,100 jobs) and is more than three times as large as the construction industry (115,600 jobs).

High Tech Employment in LA



High Tech Employment Compared to Other Sectors in LA



The high tech sector in LA employs more than 368,500 people, more than 9 percent of all jobs in LA, and more than any other metro region in the nation.

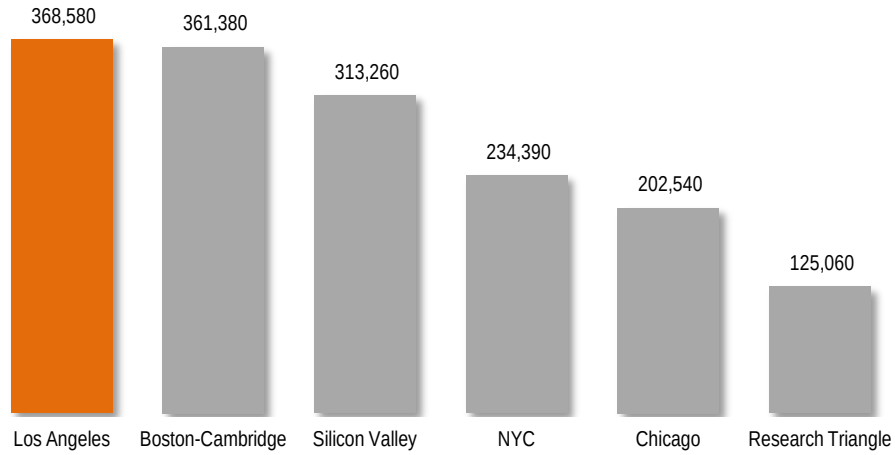
Stacking Up Against the Competition

While LA is well-known for its prowess in entertainment, fashion and aerospace, how does the high tech sector in LA compare to other centers of high tech? Using a common definition allows an apples-to-apples comparison of LA's high tech sector with other regions that may have different combinations of industries in their high tech sectors. For example, the Boston-Cambridge area is famous for its biotech industry but may have little employment in telecommunications. Still, the definition of high tech includes both of these industries. High tech is a characteristic that is not specific to a single industry but is broadly applied across industries that are on the innovation frontier.

The selection of industries included in the high tech sector is based on the proportion of high tech workers in the industry compared to the average of all industries (at the national level).[2]

The detailed employment numbers for LA's high tech sector were derived using publicly-available payroll data from the Bureau of Labor Statistics. Using this same source of payroll employment data for other regions, and the same definition of a high tech sector, employment in LA's high tech sector is shown to exceed that of Boston-Cambridge, Santa Clara County (home of "Silicon Valley"), New York City, and the Research Triangle.[3]

LA's High Tech Sector Compared to Other Regions



[2] Full methodology is provided in the Appendix
[3] Comparative employment data is provided in Exhibit A-2 in the Appendix.

The Changing Face of High Tech Work

With changes in technology bringing forward new products and processes, the face of high tech work is undergoing a transformation, and the composition of the high tech sector in LA has itself changed over the last ten years. In 2003, almost 40 percent of tech sector employment was in manufacturing industries. By 2013, manufacturing accounted for less than a third of high tech employment. This mirrors the national trend of falling manufacturing employment and a shift to services, which is attributed to a number of factors, including automation, globalization, technological progress and changes in consumer behavior. It may also be that many of the functions historically performed in house, such as HR functions and engineering services, are now being outsourced to specialized contracting companies. While the overall size of the high tech sector grew at a rate comparable to all employment in Los Angeles County, the distribution of those gains changed from production-based industries to service-oriented ones, with employment in high tech services growing by 13.5 percent and high tech manufacturing employment falling by more than 17 percent.

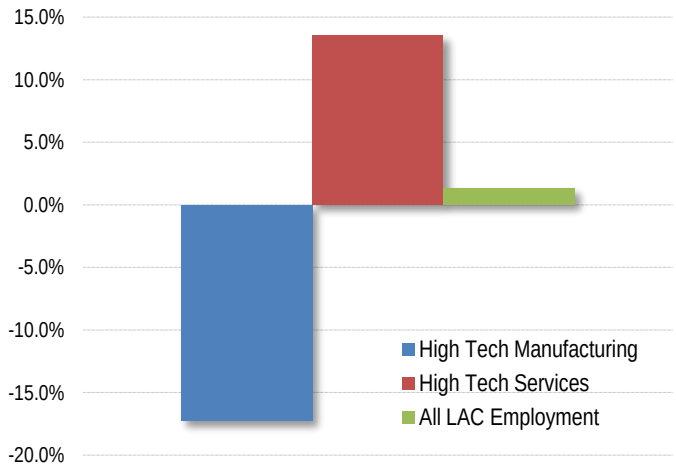
High Tech Workers outside the High Tech Sector

There are many high tech jobs in the economy that are not in the high tech sector. For example, a materials scientist in a plastics manufacturing company is involved in highly scientific and technologically-sophisticated study and application of advanced methods, but would not be counted in the high tech sector employment above since plastics manufacturing is not considered a high tech industry.

Nevertheless, this and other similarly-situated employees exist as components of the ecosystem, interacting with others in their field of study and expertise through networks, associations, academic conferences and the like, building the critical mass of the ecosystem, sharing knowledge and research, and often moving between high tech and non-high tech industries.

Occupations that are considered to be high tech occupations cross a variety of types of occupations, including management, science, design and sales occupations.[4]

Percent Change in High Tech Employment Since 2003



High Tech Occupations

Management occupations
SOC 11-3021, 11-9041, 11-9121

Computer and math occupations
SOC 15-111, 15-1131, 15-1141, 15-1142, 15-1121, 15-1122, 15-1132, 15-1133, 15-1134, 15-1143, 15-1151, 15-1152, 15-1199, 15-2031

Engineering occupations
SOC 17-2011, 17-2021, 17-2031, 17-2041, 17-2061, 17-2071, 17-2072, 17-2112, 17-212, 17-2131, 17-2141, 17-2151, 17-2161, 17-2171, 17-3012, 17-3021, 17-3023, 17-3024, 17-3026

Life and physical scientists
SOC 19-1021, 19-1022, 19-1041, 19-1042, 19-2011, 19-2012, 19-2021, 19-2031, 19-2032

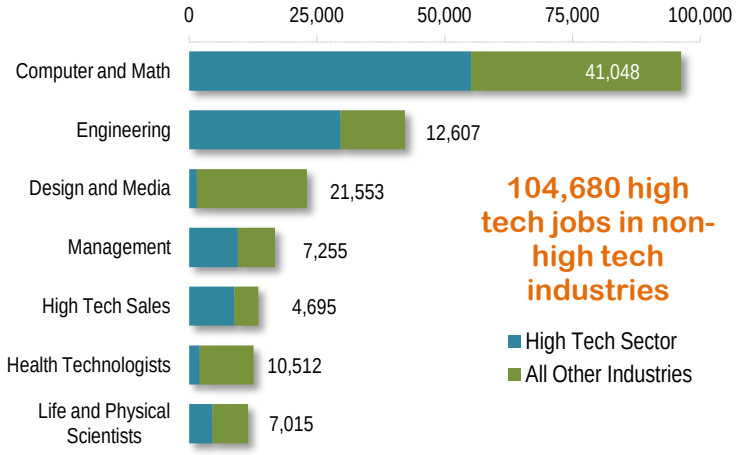
Design and media occupations
SOC 27-1014, 27-1024, 27-4032

Health technologists
SOC 29-2011, 29-2031, 29-2032, 29-2033, 29-2034, 29-2055

Sales of high tech products
SOC 41-4011, 41-9031

[4] A complete list of occupations in provided in Exhibit A-2 in the Appendix.

High Tech Workers in LA



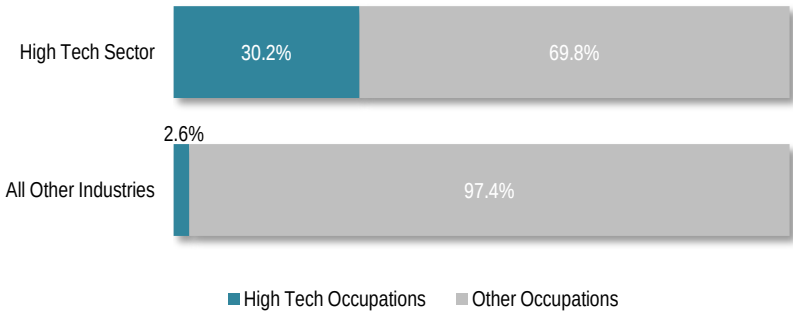
Careful examination of the occupational composition of all industries shows that there are estimated to be a total of 215,800 high tech workers, of which 111,200 are in high tech industries. The remaining 104,700 are additional high tech jobs in non-high tech industries.

Comparing high tech industries to non-high tech industries, high tech jobs accounted 30.2 percent of all employment in the high tech sector, but only 2.6 percent of employment in non-high tech industries.

It is worth noting that while overall employment has been stagnant since 2003, employment in high tech *occupations* has been growing. In the high tech sector, high tech occupations have grown by 10 percent in ten years (from 100,800 to 111,200), but as shown above this sector has seen increased employment growth overall. In all other industries, which together experienced *no* employment growth over the years, high tech jobs have grown by a whopping 20 percent (from 87,100 to 104,700).

This is an indication that many, if not all, industries are becoming more technology-oriented.

Share of Employment that is High Tech Occupations



Counting the Self-Employed

In addition to payroll employment, there is a segment of the workforce that is self-employed, either working through contractual arrangements directly for employers, or selling goods and services to other customers. Many people do work on the side, perhaps earning a supplemental income in addition to their salary earnings. Others may be intrepid entrepreneurs that have not yet formalized their business operations. The reporting of this data is somewhat different as it is reported on the tax returns of the individuals earning this additional income, and as such it is lagged by a year so the data is only available through 2012.

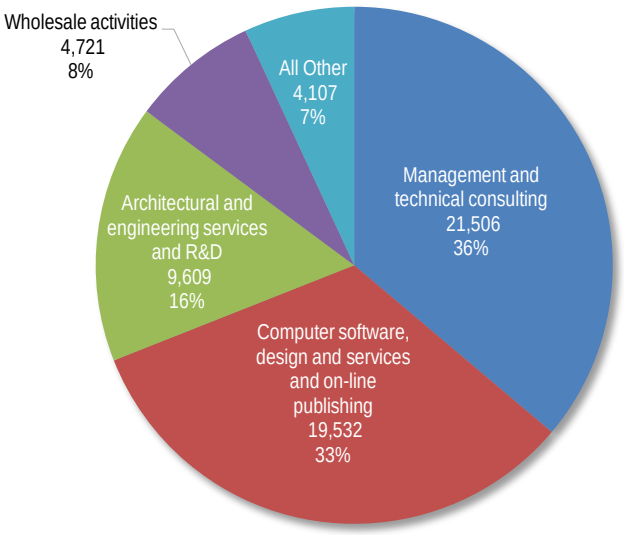
There were 59,500 self-employed in high tech industries in 2012, accounting for approximately 6 percent of all self-employed in Los Angeles County. This is an increase of more than 18 percent since 2002.

Not surprisingly, almost all of these people were service-providers, either computer services, consulting services, or engineering services. A large number reported income from wholesaling activities, such as for example, online marketing.

While these are counted as individuals, they cannot be added to the jobs reported above since there is no way of knowing whether or not the self-employed are moonlighting or doing work on the side in addition to their payroll employment. Still, it is a data set to monitor as it is often considered to be an indicator of entrepreneurship and start-up activity. It is also possible that both the earnings and the number of self-employed are under-reported since there is threshold requirement for reporting self-employment, and such earnings are more easily hidden than payroll earnings.

Self-employed high tech workers numbered 59,500 in 2012, claiming $3 million in earnings.

Self-Employed Workers in High Tech Occupations



Measuring Value

Jobs are valuable – but how valuable?

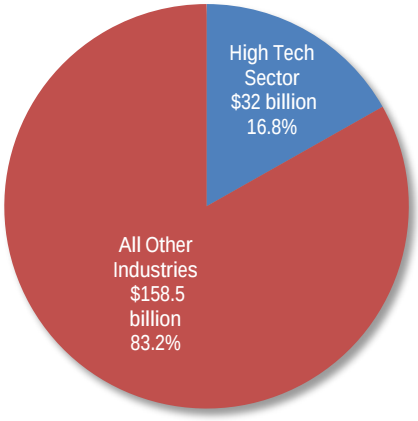
On average, wages in the high tech sector are almost 70 percent more than wages in other industries.

Workers in the high tech sector are likely to be more highly-educated, more highly-skilled and more technologically-capable than workers elsewhere. The reward for these higher levels of human capital is reflected in the wages paid for their labor.

While employment in the high tech sector accounted for 9 percent of all employment in Los Angeles County, the high tech sector paid almost 17 percent of all wages in the county ($32 billion) in 2013.

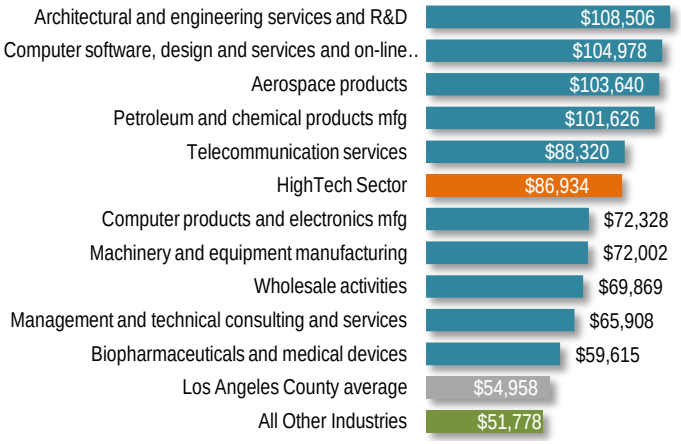
On average, annual wages in high tech industries are higher than in all other industries. Overall, the annual average wage paid to all employees in the high tech sector was $86,934, almost 68 percent higher than the average paid to workers in non high tech industries ($51,778).

Share of All Wages Paid in LA



The segment paying the highest average annual wage to its workers is architectural and engineering services and R&D, with an annual average of $108,506.

Average Wages in HighTech Sector

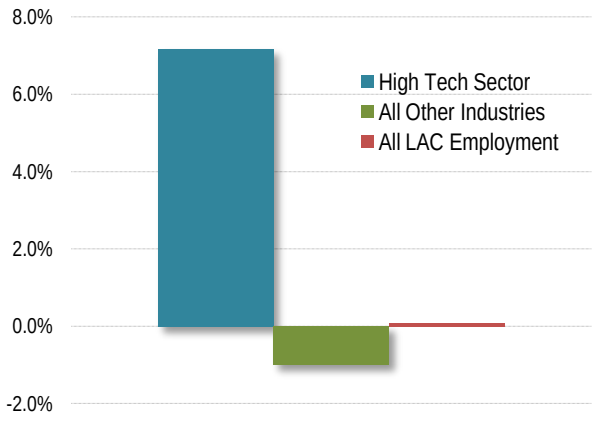


The past ten years have been marked by stagnant real wage growth. In fact, inflation-adjusted wages in Los Angeles County grew by less than 0.1 percent between 2003 and 2013. However, real wages have grown in the high tech sector by 7.2 percent, while real wages have fallen in all other industries. As a result, the average wage premium for high tech workers has grown from a 55 percent premium in 2003 to today's 68 percent wage premium.

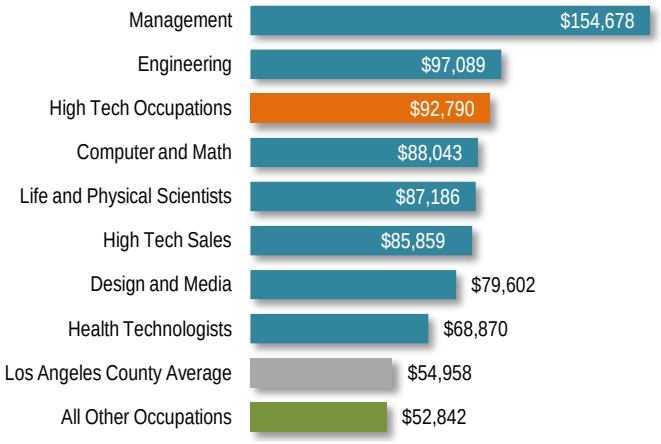
Note that this is an average of all wages paid to all employees in high tech industries, including those that are not necessarily high tech workers, such as administrative assistants and bookkeepers. While all these workers are engaged in high tech industries, one would expect that those in high tech occupations would be compensated higher than the average in that industry.

The average wage of all high tech occupations regardless of the industry in which they work was $92,790 in 2013, compared to $50,313 in all other occupations, a wage premium of more than 84 percent. High tech management positions secured the highest average wages, followed by engineering occupations and computer and math occupations.

Percent Change in Inflation-Adjusted Wages Since 2003



Average Wages of High Tech Occupations



Spreading the Wealth

The economic impact of the high tech sector is felt across the economy.

High tech supported 763,600 jobs in LA, including direct, indirect and induced jobs across a broad spectrum of industries.

While the high tech sector is large, its total economic contribution to the LA economy multiplies through its supply chain and payroll spending throughout the region. The concept of economic contribution answers the question, "what contribution does this sector make?" and measures not only the direct activity but also indirect and induced activity.

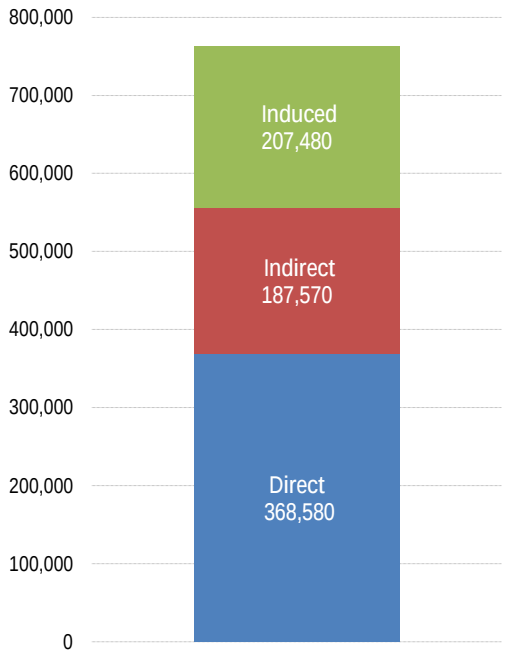
In addition to the 368,580 direct jobs in high tech industries, an additional 187,570 jobs are supported by high tech industries through their purchase of goods and services from local businesses that are not within the high tech ecosystem. Additionally, another 207,480 jobs are supported by the high tech ecosystem through the household spending of employees in high tech industries and their supply chain.

These overall impacts are widely distributed across the economy. Indirect impacts are those that occur in the supply chain of the high tech sector but only those that are outside the high tech sector.

Induced impacts are those that are generated by the household spending of employees of the tech sector (or of its supply chain). Most of these jobs are related to personal consumption, such as education, health care, retail services, real estate, and restaurant meals. These impacts also exclude any spending on high tech industries.

Of the 187,570 jobs supported in the supply chain of the high tech sector, and the 207,480 jobs generated by household spending of high tech workers.

Composition of Total Employment Contribution of the High Tech Sector



Other Economic Contributions

The total labor income earned by the total employment in LA that the high tech sector contributed in 2013 was $58.7 billion, which includes wages and benefits for all direct, indirect and induced workers.

The overall activity produced $108.3 billion in value-added, which is the sector's contribution to regional GDP.

The total fiscal impact as a result of all the economic activity in 2013 attributable to the high tech sector includes direct, indirect and induced activity. For example, high tech workers pay property taxes on their homes, sales taxes on their consumption purchases, and income taxes on their earnings. The tax revenues generated by this activity reached $21.8 billion overall, of which $4.7 billion was collected by the state government, $2.6 billion was collected by the County, and city governments in the county collected $1.1 billion.

Total Fiscal Impacts by Type

	$ millions
By Type of Tax:	
Personal income taxes	$ 5,760
Social insurance	5,760
Sales and excise taxes	3,272
Property taxes	2,465
Corporate profits taxes	3,509
Motor vehicle license	124
Other taxes and fees paid by businesses	710
Other taxes and fees paid by households	225
Total	$ 21,825
By Type of Government:	
Federal	$ 13,448
State	4,732
County	2,558
Cities	1,087
Total	$ 21,825

Employment Impacts across Industries

NAICS	Industry Sector	Direct Jobs	Indirect Jobs	Induced Jobs
11	Agriculture, forestry and fishing		30	40
21	Mining		11,520	50
22	Utilities		630	330
23	Construction		7,520	1,110
31-33	Manufacturing	119,450	3,870	1,520
42	Wholesale trade	57,160	11,240	5,130
44-45	Retail trade		1,890	38,620
48-49	Transportation and warehousing		11,910	4,460
51	Information	46,700	5,040	1,290
52	Finance and insurance		10,910	13,820
53	Real estate and rental		9,270	9,910
54	Profession and technical services	135,860	22,260	5,320
55	Management of companies		12,820	590
56	Administrative and waste services		53,810	9,940
61	Educational services		290	10,030
62	Health and social services	9,410	0	46,710
71	Arts, entertainment and recreation		4,160	6,490
72	Accommodation and food services		10,370	28,110
81	Other services		7,250	21,410
92	Government		2,780	2,590
	TOTAL Indirect Jobs	368,580	187,570	207,480

The economic contribution of high tech in LA in 2013 included $58.7 billion in labor income, $108.3 to regional GDP, and $21.8 billion in tax revenues in 2013 for federal, state and local governments.

Appendix

Details matter. All is revealed here.

Definitions are important. High tech industries encompass the gamut of NAICS industries from manufacturing to service sectors. However, there is no universal definition of what constitutes high tech.

Defining High Tech Employment

There have been several attempts at identifying high tech industries. The seminal method is based upon work done by Daniel E. Hecker with the Office of Occupational Statistics and Employment Projections at the Bureau of Labor Statistics, who has been studying this issue for decades, and whose work is frequently cited by other researchers attempting to measure high technology employment across the nation.[5] Hecker cites a Congressional Office of Technology document that states that high technology industries are "engaged in the design, development and introduction of new products and/or innovative manufacturing processes through the systematic application of scientific and technical knowledge."

Such industries typically employ more scientific, technical and engineering professionals as a share of their workforce than less technology-intensive industries. These workers are identified as technology-oriented workers, often engaged in research and development activities, applying newer technology to existing products and processes, and increasing overall scientific knowledge.

Hecker's definition of a high tech industry is one in which technology-oriented occupations account for a larger proportion of the industry's overall employment than the average for all industries.

Technology-Oriented Occupations

Since the occupational composition of an industry is at the core of this definition of high tech industries, specific identification of these technology-oriented occupations is first needed. However, there is no universal definition of what constitutes technology-oriented job.

Hecker's definition includes all workers in scientific, engineering and technician occupations, according to the Standard Occupational Classification system, which he identifies as workers that need "in-depth knowledge of the theories and principles of science, engineering and mathematics underlying technology, a knowledge that is generally acquired through specialized post-high school education in some field of technology leading up to an award from a vocational certificate or an associate's degree to a doctorate."

Since Hecker's work was completed in 1995, much has changed, particularly in the technology field. Occupational definitions have also changed several times since the

[5] Daniel E. Hecker, "High-technology employment: A NAICS-based update," *Monthly Labor Review*, July 2005

classification used in Hecker's work. Industries evolve over time, and new industries (and occupations) emerge.

Using the same general guidelines, however, seems reasonable. The list of occupations identified as technology-oriented in 2013 is similar to Hecker's list, with the addition of some scientific and engineering management positions, a few highly-technical digital and media occupations, a number of medical technologists, and two occupations representing sales functions of highly-specialized products which require a highly technical background

Exhibit A-3 presents the complete list of technology-oriented occupations, the estimated number of jobs in these occupations in Los Angeles County, and the percentage of those jobs that are in high tech industries in Los Angeles County. Overall, approximately 51.5 percent of these technology-oriented workers are employed in high tech industries.

High Tech Industries

For most purposes, it is reasonable to consider firms that employ large numbers of workers in technology-oriented occupations would be considered high tech firms, even though many of their employees may not be in technology-oriented occupations. For example, a firm engaged in software design certainly employs a number of programmers, systems software engineers, computer technicians and managers of these functions. However, the firm is also likely to employ a receptionist, administrative assistants, accountants, program managers, and so on. While young firms may focus on their core needs and outsource overhead and administrative functions, older and larger firms are more likely to add layers of administrative functions that provide jobs for many in occupations that would not be considered high tech occupations.

However, since all employment in such firms are contingent upon the nature of the firm (which in this case is a high technology function), all employees and jobs should be included in the definition of the high tech sector.

Still, there needs to be a criterion for measuring what constitutes "large numbers of workers in high technology occupations." A small firm may not hire many people at all, but would still be a high tech firm, while a large company may hire many technology-oriented employees but not be performing a high tech function, such as, for example, an insurance company or a university.

The criterion used in this report follows the guidelines set forth by Hecker; that is, an industry is considered high tech if employment in technology-oriented occupations is at least twice the average for all industries. Since this is a relatively low threshold for defining a high tech industry, Hecker further qualifies high technology industries into three levels using thresholds of twice, three times and five times the average for all industries.

At the national level, the average percentage of technology-oriented occupations employed by each industry was 5.3 percent in 2013 (at the four-digit NAICS industry group level). Thus industries with more than 26.5 percent of all jobs in technology-oriented occupations are classified as Level I high tech industries, those with more than 10.6 percent but less than

26.5 percent are classified as Level II high tech industries, and those with between 5.3 percent and 10.6 percent are classified as Level III high tech industries.

Exhibit A-1 presents the complete list of industry groups which reach these criteria, showing the share of employment that is in high tech occupations.

The same criterion is used to estimate employment in the high tech sectors of other regions reported in this report. The metro areas used for comparison were: Boston-Cambridge-Newton, MA MSA ("Boston-Cambridge"); Cook County ("Chicago"); Santa Clara County, CA ("Silicon Valley"); the aggregation of Raleigh, NC MSA and Durham-Chapel Hill, NC MSA ("Research Triangle"); and the aggregation of Richmond County, Kings County, New York County, Queens County and Bronx County (together, "New York City").

High Tech Workers in non-High Tech Industries

Still, as noted there are many technology-oriented jobs in the economy that are not within high tech industries. For example, a materials scientist in a plastics manufacturing company is involved in highly scientific and technologically sophisticated study and application of advanced methods but would not be counted since plastics manufacturing is not considered a high tech industry (on average, approximately 3.8 percent of jobs in plastics manufacturing are technology-oriented occupations).

Estimates for the number of technology-oriented workers in non-high tech industries were produced by applying the national occupation composition of non-tech industries (produced by the Occupational Employment Statistics program) to annual industry employment values (produced by the CEW program) for Los Angeles County.

Data Sources

All data was obtained from the Bureau of Labor Statistics and the Census Bureau. Annual employment and payroll data are from the Census of Employment and Wages series. Estimates for non-disclosed employment and payroll data were produced using proportional shares for the prior year's data or using midpoint estimates from the County Business Patterns program. Occupational data are from the Occupational Employment Statistics program. Unless noted otherwise, all data is for the 2013 calendar year.

Economic Contribution Analysis

Economic contribution analysis is used to estimate that portion of a region's economic activity that can be attributed to an existing industry sector.

The primary economic contribution to the Los Angeles economy of high tech industries is the expenditure of billions of dollars towards goods and services from regional vendors. This continuing injection of funds circulates from the initial recipients to the owners and employees of establishments that help supply the goods and services that the sector purchases.

The sector also spends billions of dollars every year for the wages and

benefits of its employees and contract workers. These workers, as well as the employees of all suppliers, spend a portion of their incomes on groceries, rent, vehicle expenses, healthcare, entertainment, and so on. The recirculation of the original expenditures multiplies the initial spending through these indirect and induced effects.

The extent to which the initial expenditures multiply is estimated using economic models that depict the relationships between industries (such as computer products manufacturing and its suppliers) and among different economic agents (such as industries and their employees).

These models are built upon actual data of expenditure patterns that are reported to the U.S. Bureau of Labor Statistics, the U.S. Census Bureau and the Bureau of Economic Analysis of the U.S. Department of Commerce. Data is regionalized so that it reflects and incorporates local conditions such as prevailing wages rates, commuting patterns, and resource availability and costs.

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

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

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

Estimates are developed using software and data from IMPLAN Group, LLC which traces inter-industry transactions resulting from an increase in demand in a given region. The economic region of interest is the Los Angeles County, and the activity is reported for 2013, the most recent year for which a complete set of data is available. Estimates for labor income and output are expressed in

2013 dollars to maintain consistency with the reported industry activity.

The total estimated economic contribution includes *direct*, *indirect* and *induced* effects.

Direct activity includes the materials purchased and the employees hired by the industry itself. *Indirect effects* are those which stem from the employment and business revenues motivated by the purchases made by the industry and any of its suppliers. *Induced effects* are those generated by the household spending of employees whose wages are sustained by both direct and indirect spending.

Contribution analysis differs from economic impact analysis in that linkages between the individual component industries are removed so that indirect activity is not double-counted as also part of direct activity. For example, the value of a contract computer programming service that is paid by an aerospace firm would be included as both direct revenue and as an expense of the aerospace company, resulting in a double-counting of this revenue. Breaking these inter-industry linkages eliminates this double-counting and is a more accurate method of estimating the economic contribution of the industry sector.

Exhibit A-1
Industries of the High Tech Sector

NAICS	Industry Group Name	2013 LAC Jobs	% of which High Tech Workers	Average Annual Wages
3241	Petroleum and coal products manufacturing	4,780	11.0	$ 119,362
3251	Basic chemical manufacturing	1,200	13.1	74,647
3252	Resin, synthetic rubber and artificial and synthetic fibers and filaments	1,370	12.1	63,288
3254	Pharmaceutical and medicine manufacturing	7,420	24.1	62,118
3332	Industrial machinery manufacturing	1,900	18.4	61,990
3333	Commercial and service industry machinery manufacturing	3,670	17.0	78,734
3336	Engine, turbine, power transmission equipment manufacturing	1,030	16.3	79,194
3339	Other general purpose machinery manufacturing	4,440	12.4	69,068
3341	Computer and peripheral equipment manufacturing	1,580	58.2	103,170
3342	Communications equipment manufacturing	3,240	41.3	93,639
3343	Audio and video equipment manufacturing	670	19.0	77,786
3344	Semiconductor and other electronic component manufacturing	8,330	36.0	63,271
3345	Electronic instrument manufacturing	24,310	35.3	114,773
3346	Magnetic media manufacturing and reproducing	1,050	12.5	55,003
3353	Electrical equipment manufacturing	2,000	15.8	53,809
3359	Other electrical equipment and components	4,150		74,522
3364	Aerospace product and parts manufacturing	39,520	29.5	96,792
3391	Medical equipment and supplies manufacturing	8,800	11.4	63,402
4234	Commercial goods merchant wholesalers	15,850	26.2	73,439
4236	Electric goods merchant wholesalers	12,780	17.5	67,230
4242	Druggists' goods merchant wholesalers	6,830	20.9	71,778
4251	Electronic shopping and mail-order houses	21,700	12.7	68,216
5112	Software publishers	5,820	63.3	151,601
5171	Wired telecommunications carriers	18,400	19.5	93,606
5172	Wireless telecommunications carriers	4,580	19.9	65,596
5174	Satellite telecommunications	800	12.1	78,520
5179	Other telecommunications	1,670	26.2	97,077
5182	Data processing, hosting and related services	5,580	45.4	94,068
5191	Other information services	9,850	31.8	98,029
5413	Architectural, engineering and related services	37,150	25.8	109,189
5415	Computer systems design and related services	28,840	67.0	100,057
5416	Management, scientific and technical consulting services	53,390	14.3	65,908
5417	Scientific R&D services	16,480	41.9	106,968
6215	Medical and diagnostic laboratories	9,410	25.8	54,102
	TOTAL	368,580	30.2	$ 86,934

Exhibit A-2
Comparative High Tech Employment

Industry Group Name	LAC	Boston-Cambridge	Santa Clara County	NYC	Research Triangle
Aerospace products	63,830	33,700	18,880	1,570	6,810
Architectural and engineering services and R&D	53,630	76,150	34,570	42,570	25,560
Biopharmaceuticals and medical devices	25,630	15,690	7,440	6,810	11,760
Computer products and electronics manufacturing	21,020	32,440	97,210	2,170	17,300
Computer software, design, services and on-line publishing	50,090	103,530	105,990	87,830	29,120
Machinery and equipment manufacturing	11,040	10,060	7,480	1,080	1,220
Management and technical consulting and services	53,390	35,190	10,840	37,900	7,730
Petroleum and chemical products manufacturing	7,350	1,930	450	450	1,500
Telecommunications	25,440	14,050	5,340	21,580	7,500
Wholesale activities related to high tech	57,160	38,650	25,060	32,430	16,540
TOTAL High Tech Sector Employment	368,580	361,380	313,260	234,390	125,060

Exhibit A-3
Technology-Oriented Occupations

SOC	Occupation Title	2013 LAC Jobs	% in HighTech Industries	Average Annual Wages	# that Work Outside High Tech Sector
11-3021	Computer and information systems managers	9,370	50.8%	147,360	4,610
11-9041	Architectural and engineering managers	6,420	60.8%	163,680	2,520
11-9121	Natural sciences managers	990	87.5%	165,560	120
15-1111	Computer and information research scientists	300	100.0%	120,570	940
15-1131	Computer programmers	8,300	55.7%	91,990	3,680
15-1141	Database administrators	2,260	65.8%	97,100	770
15-1142	Network and computer systems administrators	9,950	44.3%	91,630	5,540
15-1121	Computer systems analysts	11,950	61.8%	99,800	4,560
15-1122	Information security analysts	1,810	62.4%	117,160	680
15-1132	Software developers, applications	15,660	76.8%	68,030	3,640
15-1133	Software developers, systems software	13,030	65.2%	90,470	4,540
15-1134	Web developers	4,490	35.3%	81,460	2,910
15-1143	Computer network architects	4,510	55.8%	96,690	1,990
15-1151	Computer user support specialists	14,820	42.0%	54,660	8,600
15-1152	Computer network support specialists	3,540	63.8%	70,980	1,280
15-1199	Computer occupations, all other	3,180	53.8%	77,920	1,470
15-2031	Operations research analysts	1,460	69.6%	88,820	440
17-2011	Aerospace engineers	4,920	66.6%	120,750	1,640
17-2021	Agricultural engineers	0	-		0
17-2031	Biomedical engineers	580	87.8%	94,420	70
17-2041	Chemical engineers	780	78.0%	91,100	170
17-2061	Computer hardware engineers	1,665	100.0%	98,570	1,010
17-2071	Electrical engineers	4,620	82.9%	110,620	790
17-2072	Electronics engineers, except computer	7,240	47.5%	103,230	3,800
17-2112	Industrial engineers	6,110	75.5%	98,450	1,500
17-2121	Marine engineers and naval architects	0	-		0
17-2131	Materials engineers	1,150	55.2%	105,820	520
17-2141	Mechanical engineers	5,890	88.2%	98,330	700
17-2151	Mining and geological engineers	0	-		0
17-2161	Nuclear engineers	0	-		0
17-2171	Petroleum engineers	800	37.4%	122,150	500
17-3012	Electrical and electronics drafters	1,470	41.0%	55,840	870
17-3021	Aerospace engineering and operations technicians	820	62.0%	71,870	310
17-3023	Electrical and electronics engineering technicians	3,510	79.5%	61,530	720
17-3024	Electro-mechanical technicians	360	93.5%	55,480	20
17-3026	Industrial engineering technicians	1,300	100.0%	61,910	0
19-1021	Biochemists and biophysicists	790	75.0%	102,240	200
19-1022	Microbiologists	550	57.5%	85,080	230
19-1041	Epidemiologists	10	100.0%	57,980	300
19-1042	Medical scientists, except epidemiologists	5,630	28.7%	93,270	4,020
19-2011	Astronomers	0	-		0
19-2012	Physicists	480	50.2%	108,850	240
19-2021	Atmospheric and space scientists	80	100.0%	98,050	510
19-2031	Chemists	2,840	52.8%	67,200	1,340
19-2032	Materials scientists	320	44.2%	99,710	180
27-1014	Multimedia artists and animators	6,660	3.4%	92,730	6,430
27-1024	Graphic designers	9,530	12.8%	57,100	6,310
27-4032	Film and video editors	6,840	0.4%	98,170	6,810
29-2011	Medical and clinical laboratory technologists	3,020	38.6%	75,850	1,860
29-2031	Cardiovascular technologists and technicians	1,090	3.9%	62,780	1,050
29-2032	Diagnostic medical sonographers	1,130	19.4%	82,530	910
29-2033	Nuclear medicine technologists	390	13.8%	94,500	340
29-2034	Radiologic technologists	4,270	14.1%	68,290	3,670
29-2055	Surgical technicians	2,700	0.1%	55,020	2,700
41-4011	Sales reps, technical and scientific products	10,590	70.2%	80,780	3,150
41-9031	Sales engineers	2,920	47.2%	104,280	1,540
		215,850	51.5%	$ 92,790	104,680

About the Authors

The IAE team

Christine Cooper, Ph.D.

Vice President
Institute for Applied Economics

Dr. Cooper leads the LAEDC Institute for Applied Economics whose work involves research in regional issues such as economic impact studies, regional industry analysis and forecasts, workforce development analysis and policy studies. Her fields of expertise include development economics, environmental economics, regional analysis and urban sustainability.

Prior to joining the LAEDC, Dr. Cooper was co-founder of a start-up company in Hong Kong concentrating on equity transactions software and computer accessories manufacturing, which expanded production into the special economic zone of Shenzhen, China and distributed products throughout the United States and Asia. With her business partner, she established the first authorized Apple Computer retailer in China. She has been a lecturer at California State University, Long Beach and at the Pepperdine Graziadio School of Business and Management.

Dr. Cooper is a citizen of the United States and Canada. She earned a Bachelor of Arts in Economics from Carleton University in Ottawa, Canada, and a Ph.D. in Economics from the University of Southern California. With funding from the National Science Foundation, she earned a Graduate Certificate in Environmental Sciences, Policy and Engineering. Her current research includes industry cluster performance in the regional economy, commuting and job allocation patterns and workforce development issues.

Shannon M. Sedgwick

Economist

In her current capacity as an Economist at the LAEDC, Ms. Sedgwick develops subject-specific information and data interpretation for economic impact, demographic, transportation, industry and issue studies. She performs research, data collection and organization, analysis and report preparation. Her work focuses on demographics, industry clusters and occupational analysis. Ms. Sedgwick is also proficient at conducting geospatial analysis and has experience working with IMPLAN.

Ms. Sedgwick joined the LAEDC team in June of 2008 as an Economic Research Assistant with the Kyser Center for Economic Research. In that role she assisted both Economic Research and the Consulting Practice of the LAEDC with data collection and research, managing multiple data sets covering the State of California, Southern California and its counties. She was responsible for the *Business Scan* a collection of Los Angeles County economic indicators; the annual *L.A. Stats*, the most frequently requested statistics for Los Angeles region; and was a regular contributor to the weekly economic newsletter, *e-Edge.*

Before joining the LAEDC, Ms. Sedgwick managed an industrial and steel supply company located in the Inland Empire. There she identified and targeted a diverse customer base, and analyzed product and customer patterns in the local industrial market to successfully increase revenues.

A Southern California native, Ms. Sedgwick received her Bachelor of Arts in Economics from the University of Southern California (USC) with a minor in Architecture. She has been a member of the national and the Los Angeles Chapter of the National Association for Business Economics (NABE) since 2008.

Somjita Mitra, Ph.D.

Economist

Somjita Mitra joined the LAEDC Institute for Applied Economics as an Economist in June 2013. She is involved in planning, designing and conducting research and analysis for consulting clients and local businesses and governments, as well as for LAEDC's internal departments. Her focus is in regional analysis, economic impact studies and the industrial and occupational structure of local economies.

Before joining the LAEDC, Dr. Mitra was an Economist for a local economic research and litigation consulting company evaluating economic damages, estimating lost profits, identifying key economic issues and developing necessary analytical and empirical frameworks. Prior to this, Dr. Mitra was Project Director for a consumer research firm in Los Angeles where she managed projects that identified and analyzed key market issues for local firms as well as multinational corporations.

Dr. Mitra received her Bachelor of Arts in Economics and Political Science from the University of California, Los Angeles and her Master of Arts in Politics, Economics and Business as well as her Ph.D. in Economics from Claremont Graduate University. Dr. Mitra enjoys volunteering in the local community and is actively involved in both women's welfare and animal rescue organizations.

INSTITUTE FOR APPLIED ECONOMICS
Los Angeles County Economic Development Corporation
444 S. Flower Street, 37th Floor ◆ Los Angeles, CA 90071
www.LAEDC.org