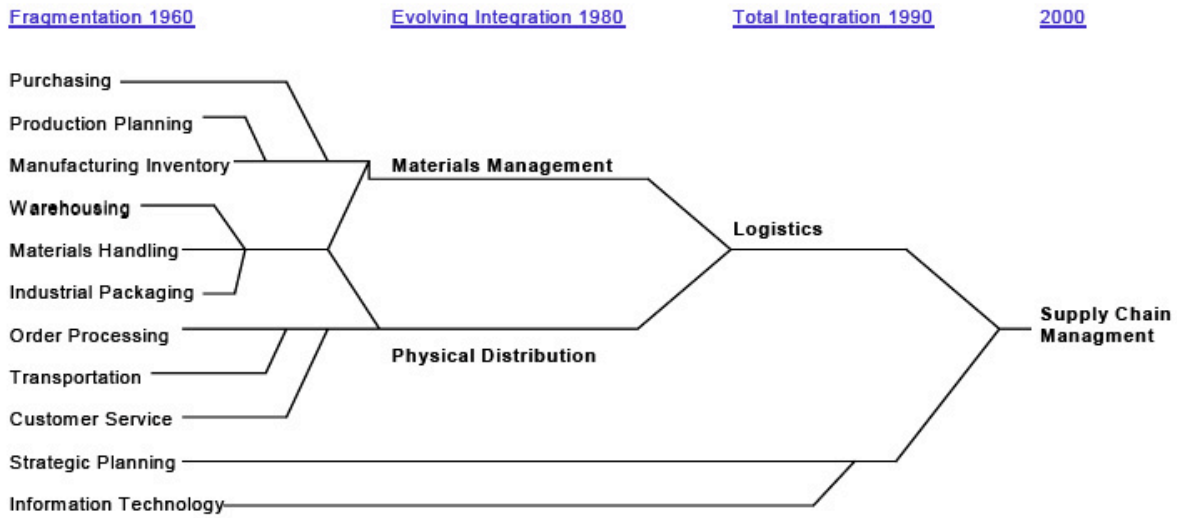
What is it?

Advanced manufacturing involves the simultaneous digital integration using information technology, of design, of innovative materials, enterprise management, logistical systems, and marketing activities over highly flexible regional and/or global supply, financial (including payment), and research networks. Digital manufacturing also permits "additive manufacturing" where small components, including those at the nano or molecular scale (including biological) are added together to create a product. Advanced manufacturing includes biomanufacturing involving the application of biological process to produce, for example, medical devices, plastics, and fuels. Products are individually tracked (RFID tags)[1] delivered in "real time" directly to the customer anywhere in the world. Less inventory is maintained but more timely market appropriate design is incorporated into product.

The Evolution of Supply Chain Management



Source: Collaborative Economics

There were 47,174 manufacturing firms in California in 2005. Of these, 72 percent have fewer than nineteen employees. Even so, manufacturing firms tend to be larger than the typical California firm (88 percent had fewer than 19 employees). Over 59 percent are employed in firms with 100 employees or more (41 percent are in firms with less than 99 employees). There were 41,900 high-tech establishments in 2004, leading California to

[1] Radio Frequency Identification Tags placed on a container that can be scanned to identify its contents. This data is used to track its progress.

be ranked 1st nationwide.[23] In 2006, California was the number one state for manufacturing with 1.5 million employees in the sector. Of these, 904,920 employees can be classified as high-technology employees.[4] The six counties that form Southern California rank as the nation's top manufacturing "state."

Which industries are likely to be affected by Improvement in Advanced Manufacturing?

Globally manufactured goods, including food and clothing, are deeply embedded in California's and the rest of the world's markets. The 50 largest multinational manufacturing companies had 55% of their employees and 59% of their sales outside of the home countries.

Revenue growth is coming from overseas, not domestically. (This is increasingly so for small manufacturers too). In 1988, 38 of the 64 largest food processing firms owned a total of 682 food processing plants in foreign countries. These plants accounted for 26 percent of the 38 firms' sales of $154 billion in 1988. In contrast, exports of processed food from these firms amounted to only 2.6 percent of their U.S. sales. These developments suggest that virtually all manufacturing products are likely to be affected by global competition. Competition with imports have also outpaced export opportunities. Current and emerging multinational firm competitive characteristics are those of advanced manufacturing, including: product quality and excellent design, product technology, advanced management techniques, excellent logistics, rapid response to changing markets, company acquisitions, sustained edge in use of IT, high level of innovation, and flexible role in supply chains being either a competitor or partner.

What products are on the market today or are expected to be in the near future?

Today, the United States is the world's leading manufacturer, producing 75 percent of what it consumes. Venture capital investment in start ups is very high in California, concentrating for example, on software, semiconductors, medical devices, biotechnology, networking equipment, and industrial energy.

Even so, California, the U.S. and Europe are competing for global market position with the rest of the world. For example, China's middle class in 2004 was 52 million strong or twice Canada's population and larger than California's population of 37 million. Projections are that within 10 years, there will be 400 to 500 million middle class Chinese. They, like the equally large Indian middle class will be trend-setters, updating their cell phones, buying foreign brand-name (Asian and other) apparel, and computers

[2] AeA, (2006). Cyberstates. http://sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2006/04/19/BUGGPIB7TR1.DTL&type=business

[4] AeA (2006). Cyberstates. http://sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2006/04/19/BUGGPIB7TR1.DTL&type=business

and high-speed Internet links. In 2003 there were 12.4 million privately owned vehicles, up 25% from 2002. 4.5 million cars will be sold to them annually by 2010. Emerging global companies in China and the rest of Asia, in South America, India, and Eastern Europe and Russia will compete with California to serve these markets. Clearly, the capacity to link to local markets and to produce culturally appealing products will be key. Small and medium sized manufacturers are already making this move with significantly more companies saying that exports are more than 25 percent of their sales.

What is California's Competitive Position?

California lost jobs due to productivity improvements just like other nations around the world. Six developments account for the most recent changes in the number of manufacturers and employment: 1) prime manufacturers increasing their dependence on suppliers and pressuring them to reduce costs; 2) the integration of design-production-logistics into global supply chains tied to prime contractor demands leading to a reduction in the number of US parts suppliers; 3) the adoption of new advanced digital manufacturing technologies producing productivity improvements; 4) the convergence of multiple technologies such as nanotechnology, MEMS, and biotechnology to create new manufacturing and product hybrids; 5) the ability to offer value such as proprietary, high-technology products; a willingness to customize; extraordinary service and parts support; short production runs; and fast turnaround time;[5] and 6) globalization of markets including the adoption of advanced technologies.

Global Loss of Manufacturing Jobs to Productivity Increases: California is Not Alone

Country	1990	2004	1992-2003 productivity growth	1992-2003 change in manufacturing jobs
United States	18.0%	11.8%	57%*	-13.6
Japan	24.3%	18.3%	54.3%	-25.7%
China (estimates - see paper)			60.0%	-18.0%
Germany	31.6%	22.7%	35.1%	-21%
United Kingdom	22.3%	14.9%	35.9%	-18.1%
France	21.0%	16.3%	58.0%	-10.9%

William A. Ward Clemson, Manufacturing Productivity and the Shifting US, China, and Global Job Scenes—1990 to 2005, University Center for International Trade Working Paper 052507, (August 4, 2005)

[5] Manufacturing Institute (2006). *The Future Success of Small and Medium Sized Manufacturers: Challenges and Policy Issues.* The Manufacturing Institute.

The core of California's ability to sustain and expand its competitive manufacturing advantage in the future is the use of new materials, applied through advanced manufacturing techniques to produce innovative products that are moved across global electronic and surface logistics, just-in-time, to closely tied customers anywhere in the world. Information technology penetrates and ties together every element of this process. An innovative, highly trained workforce working with advanced manufacturing and the new materials technologies invents and applies the proprietary knowledge that generates a firm's competitive advantage. Increasing productivity in the manufacturing value chain requires streamlining the supply chain by integrating logistics tasks and managing complex supplier relationships among many partners around the globe.

From 1990 through 2002 California's smaller manufacturing firms grew in number and in number of employees, while larger firms declined. These smaller and medium sized firms are California's future and are the ones to benefit most from improved competitive advantage. Ethnic entrepreneurs have been a primary source of high-technology start-ups, and the establishment of new markets, and of supply chains with South East Asia, China, and Mexico. The number of manufacturing firms owned by Latinos and other ethnical minorities – while small now compared to white-owned firms – will increase in the future given future demographic projections.

Where are Advanced Manufacturing related companies located in the Innovation Corridor?

Los Angeles County retained its title of the nation's largest manufacturing center as measured by employment with a 2005 average of 470,400 jobs. If the six major Southern California counties (San Diego, Orange, Riverside, San Bernardino and Ventura), are added together the 2005 annual manufacturing employment was 915,900 jobs. This leaves an estimated 600,000 jobs in the Northern portion of Innovation Corridor, with the vast majority concentrated in the San Francisco Bay area. By the definition of advanced manufacturing used here, the Los Angeles and the Bay Area are top ranked innovation corridor growth areas followed by the San Joaquin Valley.

Innovation can be measured by patent production, which is indirectly related to the establishment of new high technology firms in the Innovation Corridor. The nationally top ranked cites are: San Jose (1), San Diego (4), Sunnyvale (5), Palo Alto (6), Fremont (7), Cupertino (9), and Mountain View (10). Santa Clara and San Mateo Counties have consistently out paced the rest of the nation in value added per employee, increasing at the rate of 4.1 percent vs. 1.9 percent nationally.[6]

[6] Joint Venture Silicon Valley (2007). Index of Silicon Valley. http://www.jointventure.org/publicatons/index/2007%20Index/The%202007%20Index%20of%20Silicon%20Valley.pdf

Manufacturing Jobs Across the State

Change in Logistics Employment as Portion of Total Manufacturing Employment										
Sector	Bay Area		Greater Sacramento		Southern Border		San Joaquin		Southern California	
	1990	2002	1990	2002	1990	2002	1990	2002	1990	2002
Design	13 %	19 %	15 %	22 %	15 %	25 %	8 %	8 %	10 %	13 %
Logistics	12 %	13 %	22 %	25 %	14 %	18 %	16 %	24 %	11 %	18 %
Production	75 %	69 %	62 %	54 %	71 %	57 %	77 %	68 %	79 %	69 %
Logistics (x 1,000) Jobs	66	68	13	20	20	27	20	35	142	193
Total (x1,000)	547	523	61	80	139	148	127	145	1,286	1,074

Source: Collaborative Economics (2004). Manufacturing in Transfo rmation: Economic Change and Employment Opportunities in the Des ign, Production, and Logistics Value Chain. California Regional Economies Project, California Employment Dev elopment Department. http://www.labor.ca.gov/panel/espcrepcrmit.pdf

Time Structures

How many new jobs will be created or affected by the new technology?

It is difficult to project the number of new jobs that will be created by the adoption of new technologies and markets. For example, manufacturers of all sizes increasingly use temporary help services for their workforce as
they strive to cut labor costs and maintain a lean and flexible operation. This shift of employer-of-record to the employment services industry skews manufacturing industry employment data, making it appear to have declined more than it actually has. It is unlikely that this trend will slow.

During the recent recession, small manufactures created more jobs than larger manufacturers. A significant number of these firms are exporters, and they display more innovations per employee than large manufacturers. It is also likely that they will create the new biotechnology, nanotechnology, and other technologies and jobs that will accompany them.

Major manufacturing employers in the Innovation Corridor can be identified at: http://www.labormarketinfo.edd.ca.gov/article.asp?articleId=656.

Industry Conversion and New Jobs

New Technology:	2002	2004 or 2005	2006 to 2008	2010 or 2012	2015	Total Job Growth	Percent +
Existing Manufacturing Sectors (LMID)	1,638,200			1,665,000		26,800	1.6%
ATTi: ITS & Logistics		660,000	766,000	905,000	1,000,000	340,000	51.5%
Life-Sciences		116,100	121,100	154,800		38,700	33.3%
MEMS		18,000		22,000	30,000	12,000	66.7%
Nanotechnology						226,800	95%

Source: Time Structures

Job growth will occur in established high-technology Industries such as computer programming and related sciences, biotech/biomed, aerospace (including autonomous vehicles), computer and peripherals, and telecommunications. Manufacturing jobs forecasted to decline over the next decade include manufacturing production in old line industries such as apparel, plastics, converted paper, machinery, printing, and petroleum and coal manufacturing. California is showing strong growth in the design and logistics components. The greatest growth between 2004 and 2014 expected for traditional industries which will have to improve their competitive position include manufacturing jobs in California will be for production workers, production helpers, and assemblers, with nearly half of these new jobs hired through temporary help agencies rather than directly by the manufacturing industry.

Newly emerging industries such as nanotechnology, biotechnology, energy, and Intelligent Transportation systems could see the most growth, generating more than 644,300 jobs by 2015.

The California Employment Development Department, Labor Market Information Division, lists manufacturing occupations likely to grow at: http://www.labormarketinfo.edd.ca.gov/cgi/career/?PageID=3&SubID=144 .

What skills will the new workforce require?

Today, the Innovation Corridor does not lack for innovation, well trained workers or high-technology companies. However, given the aging population and changing demographics, this may be a serious problem in the future. This is particularly so given the expected national gap or 14 million by 2020 between skilled workers and the larger number of jobs that require will require them. The Southern portion of the Innovation Corridor is most at risk given the large number workers lacking a high school diploma, ironically the are with greatest manufacturing concentration. The San Francisco Bay area is also at risk.

Of the 20 manufacturing occupations with the largest expected employment growth, over half require less than an associate degree, with most requiring on-the-job training or work experience. Forty percent of the high-growth occupations require a bachelor's degree or higher, and one requires an associate degree.

The future workforce literacy skills required for the Innovation Corridor will require a higher level than those of the past. Time Structures has surveyed advanced manufacturers anticipated training needs for the Economic and Workforce Development Program, California Community Colleges. The results are available from their office.

20th vs. 21st Century Literacy Skills

- **General literacy** vs. ***Science literacy***
- **Arithmetic literacy** vs. ***Math literacy***
- **No computer literacy** vs. ***Advanced computer literacy***
- **Basic shop equipment** vs. ***Scientific laboratory equipment***
- **Conversational English** vs. ***Specialized technical English***
- **Follow instructions** vs. ***Innovation and problem solving***
- **No writing and analysis** vs. ***Technical report preparation and interpretation***
- **Individual job responsibility** vs. ***Capacity to form and innovate in mixed groups***
- **One-time learning of advanced competencies** vs. ***Life-long learning of different advanced competencies***

California Six Largest Manufacturing Segments by Business Size and Number of Employees (2005) (Source: LMID)

NAICS Code	Industry	Total	Size of Firm by Number of Employees: 0-4	5-9	10-19	20-49	50-99	100-249	250-499	500-999	1000+
315	Apparel Manufacturing # Businesses	4,218	1,709	869	771	569	180	88	20	9	3
315	Apparel Manufacturing # Employees	78,877	2,602	5,798	10,476	16,889	12,525	12,640	6,710	5,796	5,441
334	Computer and Electronic Products # Businesses	4,579	1,493	636	655	769	446	332	131	67	50
334	Computer and Electronic Products # Employees	319,595	2,377	4,355	9,112	24,286	30,930	50,542	44,636	45,500	107,857
332	Fabricated Metal Products # Businesses	7,154	2,636	1,437	1,308	1,150	385	192	39	7	0
332	Fabricated Metal Products # Employees	140,287	4,786	9,641	17,830	34,836	26,461	28,840	13,569	4,324	0
311	Food Manufacturing # Businesses	3,510	1,185	612	542	559	241	222	91	44	14
311	Food Manufacturing # Employees	164,173	2,124	4,197	7,475	17,204	17,103	33,988	30,843	29,975	21,264
333	Machinery # Businesses	2,988	1,112	590	523	448	165	109	27	9	5
333	Machinery # Employees	79,480	1,936	3,938	7,179	13,675	11,542	16,506	8,548	6,924	9,232
339	Misc Manufacturing # Businesses	4,373	2,218	752	633	433	168	122	31	11	5
339	Misc Manufacturing # Employees	87,928	4,091	4,968	8,448	13,161	11,646	18,265	12,273	7,099	7,977

Labor Market Information Division (EDD): California Industry Employment Projections 2002 – 2012

	Employment		Numerical	Percent
Industry	2002	2012	Change	Change
Manufacturing	1,638,200	1,665,000	26,800	1.6%
Durable Manufacturing	1,053,300	1,076,000	22,700	2.2%
Wood Product Manufacturing	40,400	42,500	2,100	5.2%
Sawmills and Wood Preservation	7,900	7,300	-600	-7.6%
Veneer, Plywood, and Engineered Wood Product Manufacturing	6,800	8,000	1,200	17.6%
Other Wood Product Manufacturing	25,700	27,200	1,500	5.8%
Nonmetallic Mineral Product Manufacturing	46,000	50,300	4,300	9.3%
Cement and Concrete Product Manufacturing	20,800	24,400	3,600	17.3%
Other Nonmetallic Mineral Product Manufacturing	25,200	25,900	700	2.8%
Primary Metal Manufacturing	26,900	26,600	-300	-1.1%
Fabricated Metal Product Manufacturing	147,000	151,100	4,100	2.8%
Forging and Stamping	10,200	11,700	1,500	14.7%
Architectural and Structural Metals	35,400	39,800	4,400	12.4%
Boilers, Cutlery, Hardware and Wire Product Manufacturing	21,200	20,900	-300	-1.4%
Machine Shops and Threaded Product Manufacturing	39,100	39,800	700	1.8%
Coating, Engraving, and Heat Treating Metals	20,500	20,100	-400	-2.0%
Other Fabricated Metal Product Manufacturing	20,600	18,800	-1,800	-8.7%
Machinery Manufacturing	92,700	91,900	-800	-0.9%
Agriculture, Construction, and Mining Manufacturing	5,500	5,600	100	1.8%
Industrial Machinery Manufacturing	18,600	16,900	-1,700	-9.1%
Commercial and Service Industry Machinery Manufacturing	20,800	21,100	300	1.4%
HVAC and Commercial Refrigeration Equipment	6,800	7,000	200	2.9%
Metalworking Machinery Manufacturing	13,600	13,600	0	0.0%
Turbine and Power Transmission Equipment Manufacturing	6,400	6,900	500	7.8%
Other General Purpose Machinery Manufacturing	21,100	20,800	-300	-1.4%
Computer and Electronic Product Manufacturing	360,100	365,100	5,000	1.4%
Computer and Peripheral Equipment Manufacturing	71,700	67,200	-4,500	-6.3%
Communications Equipment Manufacturing	33,900	35,700	1,800	5.3%
Audio and Video Equipment Manufacturing	8,800	9,400	600	6.8%
Semiconductor and Other Electronic Component Manufacturing	122,800	126,400	3,600	2.9%
Electronic Instrument Manufacturing	112,000	115,100	3,100	2.8%
Magnetic Media Manufacturing and Reproducing	10,900	11,300	400	3.7%
Electrical Equipment, Appliance, and Component Manufacturing	39,900	39,100	-800	-2.0%
Electric Lighting Equipment Manufacturing	13,100	13,700	600	4.6%
Electrical Equipment Manufacturing	10,700	9,900	-800	-7.5%
Other Electrical Equipment and Component Manufacturing	16,100	15,500	-600	-3.7%
Transportation Equipment Manufacturing	137,600	141,500	3,900	2.8%
Motor Vehicle Manufacturing	8,500	9,300	800	9.4%
Motor Vehicle Body and Trailer Manufacturing	9,900	11,000	1,100	11.1%

Motor Vehicle Parts Manufacturing	24,500	23,900	-600	-2.4%
Aerospace Product and Parts Manufacturing	79,600	79,600	0	0.0%
Ship and Boat Building	9,000	10,800	1,800	20.0%
Other Transportation Equipment Manufacturing	6,100	6,900	800	13.1%
Furniture and Related Product Manufacturing	68,400	69,800	1,400	2.0%
Household and Institutional Furniture Manufacturing	45,400	45,500	100	0.2%
Office Furniture and Fixtures Manufacturing	15,700	16,400	700	4.5%
Other Furniture and Related Product Manufacturing	7,400	7,900	500	6.8%
Miscellaneous Manufacturing	94,400	98,100	3,700	3.9%
Medical Equipment and Supplies Manufacturing	50,200	52,100	1,900	3.8%
Other Miscellaneous Manufacturing	44,200	46,000	1,800	4.1%