

Report:  
MANUFACTURING LANDSCAPE



Presented to:  
CENTRALINA COUNCIL OF GOVERNMENTS

# REPORT 1: Manufacturing Landscape



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Draft Report  
April, 2006

Delivered to:

**Centralina Council of Governments**

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This report, Manufacturing Landscape, presents a broad look at the manufacturing industry, with a particular focus on advanced manufacturing. We examine how the competitive environment is changing for firms operating in the United States, how the industry is adapting, and profile key niche sectors. This report provides the baseline for the project with an in depth look at manufacturing trends, which will allow us to focus on growth areas within manufacturing when evaluating regional resources and companies.

The advanced manufacturing industry presents a specific and attainable opportunity for the Centralina region. However, this is a broad industry that includes numerous sectors, requiring a careful assessment of historical performance and future potential to identify the highest impact niche industries.

*This study aims to present an unbiased profile of the U.S. manufacturing industry and determine the industry's long term potential.*

This report is part of a broader study, the *Centralina Advanced Manufacturing Feasibility Analysis*.

In January 2006, the *Centralina Council of Governments* selected the consulting team of AngelouEconomics and RTI to conduct this study. The goal of this study is to determine the need for an advanced manufacturing center in the Centralina region and, more specifically, the design and operating profile of the center.

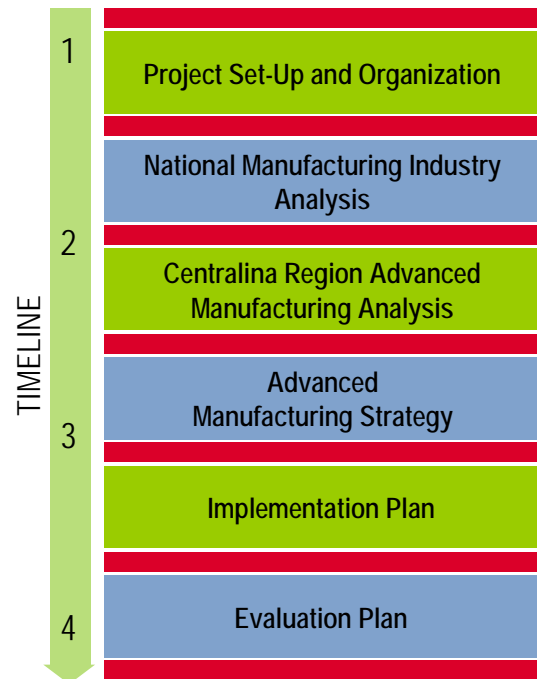
Specifically, the study was designed to:

- Identify and evaluate advanced manufacturing niche sectors and other emerging clusters that should be targeted and supported by the Center.
- Create an inventory of regional assets that can be categorized as advanced manufacturing, as well as other resources that will support current and future needs of manufacturing clusters.
- Determine the need for an Advanced Manufacturing Center in the region and the type of support that small and medium sized manufacturing enterprises and other innovative technology firms will need in the future.
- Develop strategies and action items for creating and sustaining advanced manufacturing resources in the Region through the development of an Advanced Manufacturing Center.

Four reports are being prepared for this project:

1. National Manufacturing Industry Analysis
2. Centralina Region Advanced Manufacturing Analysis
3. Strategic Recommendations
4. Implementation and Evaluation Plan

Study Process



Our goal is clear: *to identify the best course of action for further developing and supporting the advanced manufacturing cluster in Centralina.*

## 1.1: Introduction to the Manufacturing Industry

Manufacturing is a broad industry that covers an array of sectors and is specifically defined as “establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products” (NAICS codes 31-33). Manufacturing accounts for 13% of GDP and 11% of total U.S. employment. While manufacturing’s share of GDP and employment has declined in recent years, the industry remains crucial to the U.S. economy.

Manufacturing is a key component in the health and function of American commerce. The sector buys and sells goods from a wide range of businesses, creating wealth throughout the economy. This interaction creates demand across a variety of industries, requiring raw materials for production and numerous support activities like software, finance, accounting, health services, and consulting to conduct business. For every \$1 of final demand spent on manufactured goods, \$0.55 of GDP is generated in the manufacturing sector and \$0.45 is generated in non-manufacturing sectors (Bureau of Economic Analysis).

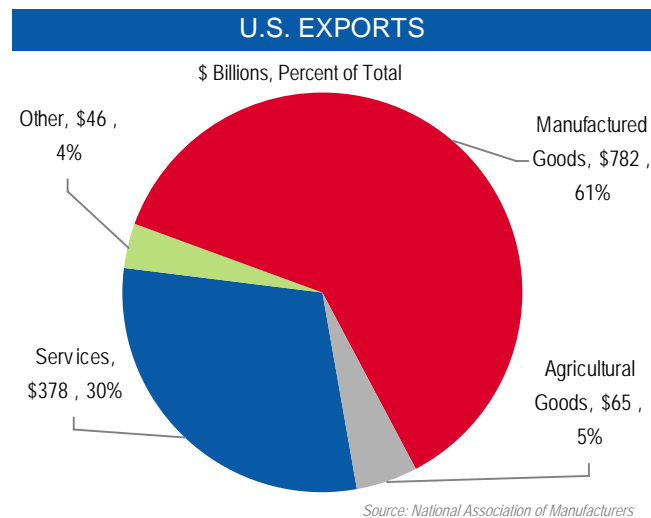
MANUFACTURING EMPLOYMENT & WAGES		
Employment	2004	14,258,191
	1995	17,235,078
Businesses	2004	370,487
	1995	402,774
Average Wage	2004	\$47,859
	1995	\$33,553

In 2004, the manufacturing industry employed 14.3 million in the U.S. or 13% of total private employment. Since 1995, the industry has lost almost 3 million jobs. Most of the job loss is due to increased productivity from computers, automation, and the movement of manufacturers offshore to low-wage areas such as China. Outsourcing is playing an increasingly important role. For example, a company may design a product in California and hire a contract manufacturer in Taiwan to assemble it using components from suppliers around the world. For many companies, offshoring is a relatively new experiment in their business model.

MANUFACTURING SHARE OF THE ECONOMY	
Gross Domestic Product (\$ billions)	\$14,258,191
Manufacturing Share of the Economy (\$ billions)	\$1,494
Manufacturing as a Percent of GDP	13%

2004

Manufacturing continues to be a major source of wealth creation in the United States. In 2005, almost two-thirds of U.S. exports were manufactured goods, compared to less than one-third for service exports. The industry also pays exceptional wages to skilled workers. The average wage in 2004 was \$48,000, which is a 20% premium relative to the national average wage.



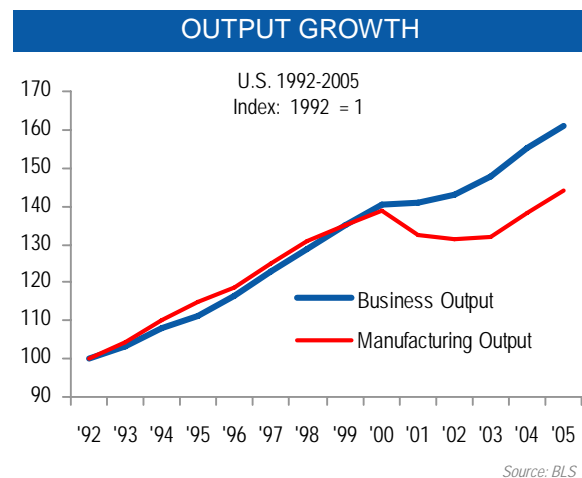
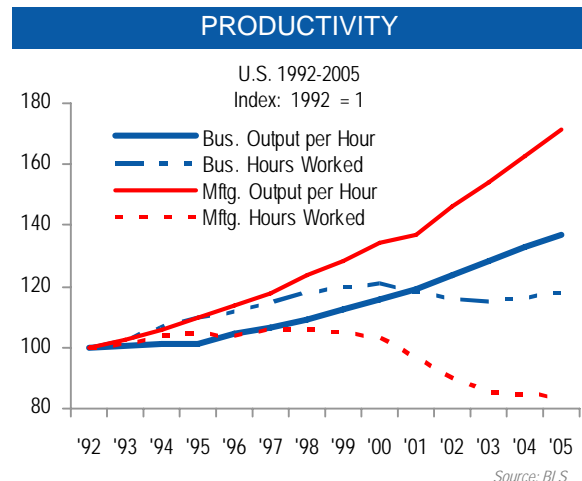
## 1.2: Changing Face of the Manufacturing Industry

### Productivity and Output

U.S. competitiveness in manufacturing will be maintained through advances in productivity, allowing American firms to maintain a labor cost advantage, despite paying higher wages and benefits. Over the course of the last quarter-century, U.S. manufacturing has experienced impressive gains in productivity. According to the U.S. Dept. of Commerce, from 1977 to 2002, productivity in the overall economy grew by 53% while productivity in the manufacturing sector grew an astounding 109%.

The comparison between the manufacturing sector and the business sector also provides a good example of the disparity in productivity. Since 1992, manufacturing has increased output per hour by 71% and decreased hours worked by 16%, whereas the business sector has only increased output per hour by 37% and increased hours worked by 17%. In other words, the manufacturing sector is decreasing the amount of hours required to produce an increasing amount of output; all at a faster rate than the business sector. Much of this productivity can be attributed to innovations in production processes, communications, computing, supply chain management, and lean manufacturing. This rapid increase in productivity has enabled the manufacturing industry to create higher-quality goods at lower costs. Over the past 25 years, prices in the overall economy have risen by 140% while prices in the manufacturing industry have risen by only 60%. This translates into a better standard of living for American consumers and higher real wages for workers.

As the overall economy continues to strengthen, manufacturing has only recently exceeded its most recent peak level of output achieved in late 2000. Manufacturing's output growth has kept pace with and, at times, exceeded the business sector, but it was hit particularly hard by the recession in late 2000. What is of most concern for manufacturing is not the sharp drop in output, but the slow pace of recovery. Since World War II, all but the most recent recession increased output by 15% in the first two years of recovery. However, from 2002 to 2004, manufacturing output increased by only 5%, well below the business sector at 8%.

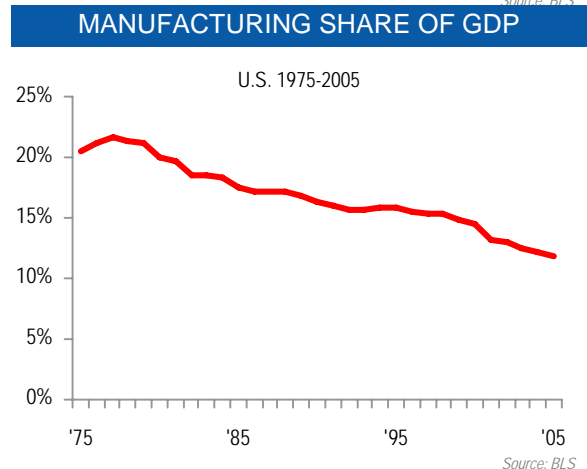
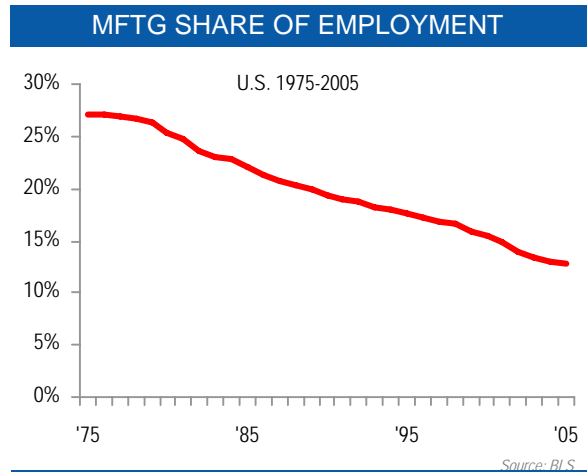
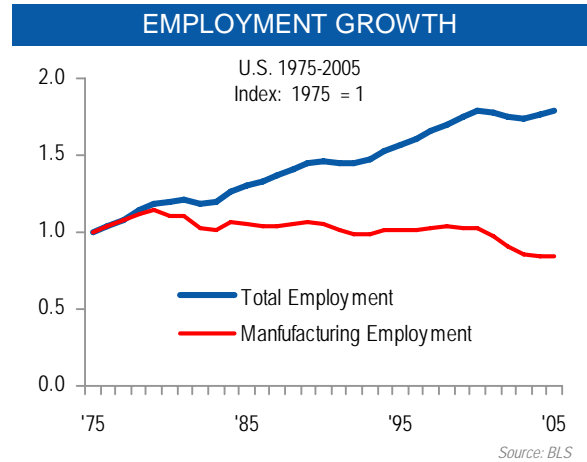


## Employment and GDP

Rising productivity is a double-edged sword. It is the key to U.S. manufacturing competitiveness in the world economy while dampening the need for increased labor. In 1979, manufacturing employment peaked at 19.6 million jobs and has been on a downward trend ever since. This trend is not exclusive to the United States. Other advanced countries have experienced the same decline in manufacturing employment. Western Europe lost as much, if not more, of a share of manufacturing employment throughout the 1990s and into the new millennium.

Considering the sizeable productivity gains, the steady decline in employment is not unexpected. Gains in productivity have outpaced growth in demand for manufactured goods, causing manufacturing employment to decline for the last three decades. Described another way, with the accelerating gains in labor productivity, manufacturing's share of total GDP would need to increase significantly to achieve historical levels of employment. As manufacturers continue to become more efficient, they will require a diminishing number of employees for production.

U.S. manufacturing employment has declined 0.6% annually since 1975. However, this statistic can be somewhat misleading as it hides larger fluctuations during business cycles. Given that manufacturing employment sharply rises and falls during each business cycle, employment during a recession falls slightly lower than the preceding trough. As the business cycle takes a positive turn and manufacturing firms begin hiring, employment does not reach the preceding peak. With each recession firms become more efficient or find alternative means to produce their goods, lowering demand for U.S. workers.



## Manufacturing Breakdown

Although manufacturing has historically kept pace with the overall economy, the composition of U.S. manufacturing has changed due to technological advances, changing demand, and global competition. While accounting for only 21% of manufacturing output fifty years ago, the three largest manufacturing industries today – motor vehicles, food, and chemical manufacturing - account for 38% of manufacturing output.

The drop off in high-tech spending, which helped trigger the recession, slowed economic activity and demand for many consumer goods. As an example, global semiconductor sales had a dramatic decline in late 2000 as businesses began to scale back on communication and computing equipment. Consequently, computer and electronic products were two of only a handful of industries that experienced a decline in output from 1999 to 2004. However, output has experienced significant gains in the last two years.

From 1999 to 2004, output increased by only 8%, compared to a 12% increase from 2002 to 2004. This is partly because of businesses' reaction to increases in inventory-to-sales ratios during 2000. Firms cut back production in late 2000 and throughout 2001 to get supply under control, causing output to slow.

Over the past five years, the manufacturing industry lost 3.1 million jobs, while employment in other sectors sustained relatively fewer losses. The decline was felt across all manufacturing industries, with machinery, computer and electronic, and transportation equipment manufacturing accounting for just over 1 million of the job losses. Low value-add industries continue their historical trend as apparel, textile, and leather products continue to shed jobs at a much faster rate than the manufacturing industry as a whole. Industries such as food and beverage manufacturing, transportation equipment, chemical products, and medical equipment provide promise as they are gaining shares of manufacturing employment, since their decline has occurred at a slower rate than the total industry for the past two years. Although these numbers look bleak, there are bright spots within these industries that are adding employment and significantly increasing output.

OUTPUT GROWTH				
NAICS	Industry	10 Year	5 Year	2 Year
31-33	Manufacturing	34%	8%	12%
311-312	Food and beverage and tobacco products	35%	16%	10%
313-314	Textile mills and textile product mills	-11%	-13%	1%
315 & 321	Apparel and leather and allied products	-44%	-39%	-8%
321	Wood products	38%	10%	22%
322	Paper products	16%	2%	4%
323	Printing and related support activities	8%	-10%	-4%
324	Petroleum and coal products	127%	101%	50%
325	Chemical products	47%	23%	14%
326	Plastics and rubber products	42%	12%	12%
331	Primary metals	17%	9%	22%
332	Fabricated metal products	34%	4%	8%
333	Machinery	31%	4%	16%
334	Computer and electronic products	24%	-14%	12%
335	Electrical equip., appliances, & components	8%	-10%	3%
336	Motor vehicles, bodies and trailers, & parts	36%	0%	7%
336	Other transportation equipment	35%	1%	7%
337	Furniture and related products	56%	13%	9%
339	Miscellaneous manufacturing	61%	26%	9%
339	Nonmetallic mineral products	42%	5%	6%

Source: Bureau of Economic Analysis; Ending in Year 2004

EMPLOYMENT GROWTH				
NAICS	Industry	10 Year	5 Year	2 Year
31-33	Manufacturing	-17%	-18%	-6%
311	Food	-4%	-5%	-3%
312	Beverage & Tobacco Products	-3%	-7%	-6%
313	Textile Mills	-49%	-40%	-18%
314	Textile Products Mills	-22%	-20%	-9%
315	Apparel	-66%	-49%	-20%
316	Leather & Allied Products	-59%	-44%	-14%
321	Wood Products	-4%	-12%	-1%
322	Paper Products	-24%	-20%	-9%
323	Printing & Related Support Activities	-20%	-20%	-7%
324	Petroleum & Coal Products	-16%	-12%	-5%
325	Chemical Products	-11%	-11%	-5%
326	Plastics & Rubber Products	-9%	-16%	-5%
327	Nonmetallic Mineral Products	-3%	-9%	-4%
331	Primary Metal	-26%	-26%	-8%
332	Fabricated Metal Products	-9%	-15%	-3%
333	Machinery	-21%	-22%	-7%
334	Computer & Electronic Products	-22%	-25%	-12%
335	Electrical Equipment, Appliance, & Components	-25%	-25%	-10%
336	Transportation Equipment	-11%	-16%	-3%
337	Furniture & Related Products	-9%	-16%	-6%
339	Miscellaneous	-9%	-12%	-5%

Source: Bureau of Labor Statistics; Ending in Year 2004

## National Manufacturing Industry Cluster Distribution 2004

Historically, the manufacturing industry has seen its most dense concentrations in the East and Midwest of the country. Metropolitan areas such as Detroit, Cleveland, Columbus, and Indianapolis have traditionally been heavily weighted with automobile manufacturers and other heavy industries.



## National Manufacturing Industry Growth Distribution 1995-2004

Growth, however, has not been occurring in the traditional regions for the overall manufacturing industry. The most noticeable growth is taking place along the west coast, the U.S.-Mexico border, and in parts of Mississippi, Alabama, Georgia, and Florida. Growth in the Southern states is attributed to reduced operating costs and lower unionization rates. This trend is expected to continue as firms continue to look for competitive advantages.

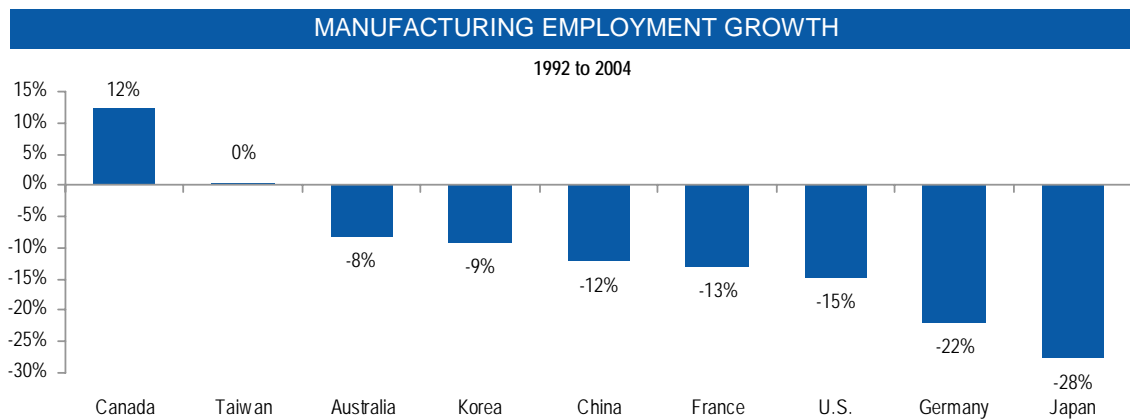


## International Pressure

In an effort to remain competitive, entire industries are moving their labor-intensive operations overseas, leaving traditional manufacturing communities with unemployed workers and few transferable skills. While manufacturing job losses accelerated during the recent recession, the industry reached its cyclical peak in April 1998 and has shed jobs ever since. This trend is driven by strong competitive forces and is likely to continue for any labor-intensive, low value-add production.

The increasing global market for manufactured goods has caused the manufacturing industry all over the world to rethink the entire concept of manufacturing. Creating and delivering manufactured goods no longer requires each process to be completed by one enterprise, but rather a global supply chain where each individual process can be completed anywhere in the world. Many manufacturers must outsource for the lowest cost to remain competitive.

Rising costs are another reason why many American manufacturers are shifting abroad. Healthcare costs have been rising rapidly due to increasing medical liability costs and excessive tort claims. Some companies have seen a rise of as much as 20%. Rising energy costs is another point of concern because the manufacturing industry uses more than one-third of all energy consumed in the U.S. All of these factors make it difficult for American manufacturers to compete in the global market and has caused many to move their operations overseas.



Source: Bureau of Labor Statistics

The current decline of manufacturing jobs does not signal the end of U.S. manufacturing. Many inventions and innovations stem from the manufacturing sector's large investments in research and development. Manufacturing firms fund 60% of private sector's R&D investments each year. Several non-cost factors will drive investments in manufacturing in the U.S. long-term: access to inputs/resources, delivery-time to market, safety regulations, tariffs, security, intellectual property protection, and the customization of consumer products. U.S. manufacturing will remain competitive in capital-intensive industries with plants using advanced robotics and automated processes.

## 2.1: Introduction to Advanced Manufacturing

Advanced Manufacturing is a broad term with various interpretations. For the purpose of this report, we consider advanced manufacturing to include any manufacturing sector that employs at least twice as many research and development employees than the average industry. Advanced manufacturing is generally a high-technology industry but is not always comparable with “high-tech manufacturing.” The underlying reason being that in advanced manufacturing, the emphasis is weighted more on the high-tech processes used in production rather than on the final output of high-tech products. Some of its major industry sectors include: computer equipment, electronics, auto assembly, aerospace, biotech, machinery, pharmaceuticals, and medical equipment and instruments. Other niche sectors that are linked to advanced manufacturing include automation and manufacturing technology; chemicals and advanced materials; computer and telecommunications hardware; electronics and components; engineering, and environmental testing and measurement; and photonics, optics, and lasers. Five of these industries will be examined in specific industry profiles later in this report.

Fundamentally, advanced manufacturing involves the implementation of innovative and revolutionary manufacturing techniques, while using highly automated manufacturing equipment that combines the very latest advancements in information technology, semiconductors, advanced materials, and new and more efficient organizational manufacturing processes. For example, accuracy and speed have remarkably improved due to computer numeric controls that have been installed to oversee the machining, forming, cutting, and molding phases of the manufacturing process. As a result, the use of highly automated machines and robots are being used for welding, painting, and material handling applications. Computer-aided Design (CAD), Computer-integrated Manufacturing (CIM), and optical monitoring are just a few of the processes that have revolutionized the industry, each improving quality control, lowering costs, reducing development timelines, and creating precision oriented assembly.

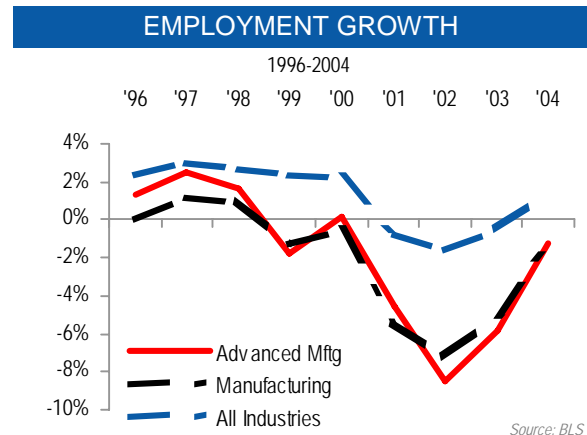
The advanced manufacturing industry was born from the ever-intensifying movement towards heightened global competitiveness and the battle for market share. With added countries opting for liberal international trade standards, advanced manufacturing processes are continuously becoming highly sophisticated and refined. Other major factors influencing the rapid pace of change in the industry are the increased demands for improved customer service, diversity of product offerings, improved product quality, quicker time-to-market new product cycles, and increased corporate profit margins. The specific 4-digit NAICS codes used to define Advanced Manufacturing are listed below.

NAICS DEFINITION OF ADVANCED MANUFACTURING			
NAICS	NAICS Description	NAICS	NAICS Description
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers Mfg.	3343	Audio and Video Equipment Mfg.
3254	Pharmaceutical and Medicine Mfg.	3344	Semiconductor and Other Electronic Component Mfg.
3256	Soap, Cleaning Compound, and Toilet Preparation Mfg.	3345	Navigational, Measuring, Electromedical, and Optical Media
3259	Other Chemical Product and Preparation Mfg.	3346	Mfg. And Reproducing Magnetic and Optical Media
3331	Agriculture, Construction, and Mining Machinery Mfg.	3353	Electrical Equipment Mfg.
3332	Industrial Machinery Mfg.	33599	All Other Electrical Equipment and Component Mfg.
3333	Commercial and Service Industry Machinery Mfg.	3361	Motor Vehicle Mfg.
332994	Ordnance & Accessories Mfg. - Small Arms Mfg.	3362	Motor Vehicle Body and Trailer
3336	Engine, Turbine, and Power Transmission Equipment Mfg.	3363	Motor Vehicle Parts Mfg.
3339	Other General Purpose Machinery Mfg.	3364	Aerospace Product and Parts Mfg.
3341	Computer and Peripheral Equipment Mfg.	3391	Medical Equipment and Supplies Mfg.
3342	Communications Equipment Mfg.		

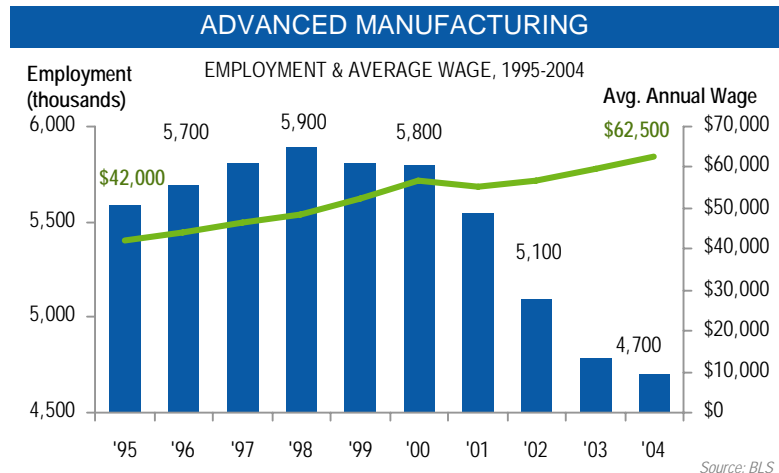
Source: Department of Commerce

## Historical Growth Trends

Employment growth in the advanced manufacturing industry has closely followed the manufacturing sector, as well as total industry employment, over the past 10 years. A modest decline in employment growth was seen from 1997 to 1999. In 2000, employment growth in advanced manufacturing experienced a brief upswing before embarking on a 2-year crash that coincided with the 2002 recession. However, the advanced manufacturing sector and the overall manufacturing industry have both rebounded nicely since the 2002 low. As of 2004, employment growth in the advanced manufacturing industry has returned to near 2000 levels. Employment growth should slow over the next few years; however, a less volatile, positive trend should emerge that will bring greater predictability and overall strength to the industry.



Despite the fluctuations in employment for the industry, average wages for advanced manufacturing have proved more resilient in variable economic environments. In the past decade, average wages for the industry have increased a substantial 49%. More importantly, as employment declined 19% from 2000 to 2004, average wages increased 10% during the same time period.



## 2.2: Trends in Advanced Manufacturing

### National Advanced Manufacturing Industry Cluster Distribution 2004

Similar to the overall manufacturing industry, the advanced manufacturing has also seen the majority of its concentration located in traditional manufacturing areas such as Detroit, parts of Ohio, Indiana, and along the east coast. Additionally, Denver, Dallas, and the Bay Area also have strong advanced manufacturing clusters due to the recent boom in high-technology manufacturing, such as pharmaceuticals and medical devices.



### National Advanced Manufacturing Industry Growth Distribution 1995-2004

However, growth in the advanced manufacturing industry is not emerging from the regions with the heaviest cluster concentrations, indicating a migration in the industry. Metropolitan areas such as Houston, Jacksonville, Southern California, parts of Kentucky, and Missouri are experiencing more substantial industry growth, most of which have a significantly reduced cost of business environment.



## MANUFACTURING SECTOR COMPARISON

NAICS	Description	2004 Ouput (\$Bil)	02 to 04 Output Growth	2004 VA (\$Bil)	02 to 04 VA Growth	2004 Emp. (Thou.)	02 to 04 Emp. Growth	2004 Cap Ex (\$Bil)	02 to 04 Cap Ex Growth	2004 VA/Emp (\$Thou)	04 to 14 Emp. Growth	04 to 14 Output Growth
31-33	Manufacturing	\$4,312	12%	\$2,031	8%	14,258	-6%	\$115.11	-8%	\$142	-5%	41%
3111	Animal Food Mftg.	\$29	10%	\$12	18%	49	-3%	\$0.61	6%	\$254	-6%	30%
3112	Grain & Oilseed Milling	\$41	-11%	\$22	23%	61	-2%	\$1.16	14%	\$356	-7%	31%
3113	Sugar & Confectionery Product Mftg.	\$28	10%	\$14	5%	81	-6%	\$0.87	18%	\$175	-5%	12%
3114	Fruit & Vegetable Preserving & Specialty Food Mftg.	\$56	5%	\$28	-6%	181	-5%	\$1.95	7%	\$153	-2%	15%
3115	Dairy Product Mftg.	\$75	20%	\$24	10%	131	-4%	\$1.62	-7%	\$186	-11%	16%
3116	Animal Slaughtering & Processing	\$144	22%	\$48	18%	506	-2%	\$2.19	7%	\$94	13%	17%
3117	Seafood Product Preparation & Packaging	\$9	15%	\$4	8%	43	-1%	\$0.17	-18%	\$82	-5%	20%
3118	Bakeries & Tortilla Mftg.	\$50	6%	\$34	6%	284	-4%	\$1.29	-6%	\$120	4%	21%
3119	Other Food Mftg.	\$64	12%	\$37	11%	154	3%	\$1.41	0%	\$242	6%	16%
3121	Beverage Mftg.	\$78	8%	\$38	16%	166	-4%	\$2.53	-18%	\$231	-1%	19%
3122	Tobacco Mftg.	\$53	-6%	\$33	-1%	28	-14%	\$0.35	22%	\$1,206	-41%	-40%
3131	Fiber, Yarn, & Thread Mills	\$11	2%	\$4	-1%	54	-16%	\$0.21	-26%	\$66	-54%	-20%
3132	Fabric Mills	\$21	-4%	\$9	-14%	115	-21%	\$0.53	-41%	\$76	-48%	-30%
3133	Textile & Fabric Finishing & Fabric Coating Mills	\$11	-6%	\$4	-24%	69	-16%	\$0.20	-12%	\$58	-49%	-27%
3141	Textile Furnishings Mills	\$22	8%	\$9	13%	101	-13%	\$0.29	29%	\$93	-13%	40%
3149	Other Textile Product Mills	\$10	1%	\$5	7%	75	-4%	\$0.22	-16%	\$68	-27%	0%
3151	Apparel Knitting Mills	\$5	-13%	\$2	-26%	42	-17%	\$0.08	-27%	\$50	-52%	-25%
3152	Cut & Sew Apparel Mftg.	\$30	-6%	\$13	-17%	221	-21%	\$0.25	-16%	\$61	-64%	-25%
3159	Apparel Accessories & Other Apparel Mftg.	\$3	1%	\$1	-12%	23	-15%	\$0.02	-53%	\$52	-35%	-25%
3161	Leather & Hide Tanning & Finishing	\$2	-22%	\$1	-11%	7	-15%	\$0.02	-7%	\$86	-14%	0%
3162	Footwear Mftg.	\$2	-8%	\$1	-9%	19	-9%	\$0.03	-11%	\$52	-32%	0%
3169	Other Leather & Allied Product Mftg.	\$2	-13%	\$1	5%	16	-20%	\$0.03	41%	\$67	-13%	0%
3211	Sawmills & Wood Preservation	\$32	24%	\$11	40%	117	-2%	\$0.90	10%	\$92	-19%	27%
3212	Veneer, Plywood, & Eng. Wood Product Mftg.	\$25	28%	\$11	33%	118	2%	\$0.69	22%	\$92	7%	29%
3219	Other Wood Product Mftg.	\$49	18%	\$22	14%	313	-2%	\$1.13	9%	\$70	17%	20%
3221	Pulp, Paper, & Paperboard Mills	\$70	-2%	\$37	-3%	145	-12%	\$3.14	-17%	\$255	-16%	5%
3222	Converted Paper Product Mftg.	\$88	9%	\$37	-1%	348	-8%	\$2.02	-19%	\$106	3%	10%
3231	Printing & Related Support Activities	\$91	-4%	\$57	-3%	659	-7%	\$4.09	6%	\$87	NA	NA
3241	Petroleum & Coal Products Mftg.	\$320	50%	\$62	67%	112	-5%	\$7.15	-13%	\$551	NA	NA
3251	Basic Chemical Mftg.	\$131	26%	\$59	28%	155	-8%	\$4.56	-6%	\$377	-29%	-1%
3252	Resin, Synthetic Rubber, Fibers & Filaments Mftg.	\$73	19%	\$29	26%	107	-6%	\$2.19	-15%	\$268	-21%	18%
3253	Pesticide, Fertilizer, & Agricultural Chemical Mftg.	\$22	20%	\$12	28%	42	-5%	\$0.69	10%	\$284	-17%	-5%
3254	Pharmaceutical & Medicine Mftg.	\$144	4%	\$121	17%	287	-2%	\$7.09	23%	\$421	26%	38%
3255	Paint, Coating, & Adhesive Mftg.	\$29	11%	\$16	20%	69	-3%	\$0.38	-39%	\$231	-6%	12%
3256	Soap & Cleaning Compound Mftg.	\$66	9%	\$40	-1%	115	-4%	\$1.26	-39%	\$351	5%	22%
3259	Other Chemical Product & Preparation Mftg.	\$41	14%	\$19	-6%	106	-6%	\$0.94	-28%	\$179	-10%	26%
3261	Plastics Product Mftg.	\$154	12%	\$74	-1%	632	-5%	\$5.49	-14%	\$118	-5%	52%
3262	Rubber Product Mftg.	\$35	8%	\$17	0%	172	-6%	\$1.16	6%	\$100	-23%	-7%
3271	Clay Product & Refractory Mftg.	\$8	1%	\$6	2%	65	-10%	\$0.35	-4%	\$86	5%	25%
3272	Glass & Glass Product Mftg.	\$23	3%	\$13	-2%	112	-10%	\$1.26	16%	\$115	-13%	23%

*Source: Bureau of Labor Statistics; Census, Bureau of Economic Analysis; AngelouEconomics*

Red text is below Average Manufacturing Value; Blue text is equal to or above Average Manufacturing Value

VA= Value Add; Emp=Employment; Cap Ex=Capital Expenditure

Continued...

MANUFACTURING SECTOR COMPARISON (continued)												
NAICS	Description	2004 Output (\$Bil)	02 to 04 Output Growth	2004 VA (\$Bil)	02 to 04 VA Growth	2004 Emp. (Thou.)	02 to 04 Emp. Growth	2004 Cap Ex (\$Bil)	02 to 04 Cap Ex Growth	2004 VA/Emp (\$Thou)	04 to 14 Emp. Growth	04 to 14 Output Growth
31-33	Manufacturing	\$4,312	12%	\$2,031	8%	14,258	-6%	\$115.11	-8%	\$142	-5%	41%
3273	Cement & Concrete Product Mftg.	\$47	6%	\$26	8%	230	0%	\$2.23	-22%	\$115	11%	14%
3279	Other Nonmetallic Mineral Product Mftg.	\$16	9%	\$11	13%	73	2%	\$0.78	12%	\$144	3%	15%
3311	Iron & Steel Mills & Ferroalloy Mftg.	\$61	28%	\$31	67%	95	-11%	\$1.45	8%	\$329	-16%	18%
3312	Steel Product Mftg. from Purchased Steel	\$18	19%	\$7	25%	60	-3%	\$0.48	16%	\$117	-10%	14%
3313	Alumina & Aluminum Production & Processing	\$34	22%	\$9	0%	73	-7%	\$0.53	-26%	\$128	-22%	-9%
3314	Nonferrous Metal (except Aluminum) Prod.& Proc.	\$27	29%	\$10	22%	72	-11%	\$0.40	-38%	\$134	-15%	4%
3315	Foundries	\$29	8%	\$15	1%	165	-7%	\$1.10	-6%	\$94	-22%	-7%
3321	Forging & Stamping	\$26	21%	\$12	14%	109	-3%	\$0.77	1%	\$111	-9%	4%
3322	Cutlery & H&tool Mftg.	\$9	-25%	\$6	-6%	58	-10%	\$0.33	6%	\$109	-7%	25%
3323	Architectural & Structural Metals Mftg.	\$64	10%	\$32	2%	386	-2%	\$1.36	-16%	\$83	2%	23%
3324	Boiler, Tank, & Shipping Container Mftg.	\$22	-2%	\$10	0%	91	-5%	\$0.56	5%	\$112	-8%	4%
3325	Hardware Mftg.	\$11	9%	\$6	-5%	38	-10%	\$0.19	-27%	\$151	-8%	18%
3327	Mach. Shops; Turned Prod.; & Screw, & Bolt Mftg.	\$46	9%	\$29	2%	326	3%	\$2.02	-1%	\$88	4%	42%
3328	Coating, Engrav., Heat Treating, & Allied Act.	\$20	10%	\$12	7%	143	-4%	\$0.71	2%	\$83	6%	40%
3329	Other Fabricated Metal Product Mftg.	\$56	11%	\$32	8%	276	-7%	\$1.27	-13%	\$116	-8%	11%
3331	Agriculture, Construction, & Mining Machinery Mftg.	\$63	40%	\$27	31%	193	-3%	\$0.96	-14%	\$139	-3%	8%
3332	Industrial Machinery Mftg.	\$31	11%	\$19	4%	120	-8%	\$0.81	-23%	\$157	-13%	9%
3333	Commercial & Service Industry Machinery Mftg.	\$22	5%	\$11	1%	115	-11%	\$0.55	-8%	\$98	-26%	-15%
3335	Metalworking Machinery Mftg.	\$29	20%	\$15	-3%	200	-7%	\$0.85	-6%	\$77	-16%	4%
3336	Engine, Turbine, & Power Transmission Equip. Mftg.	\$40	9%	\$14	-22%	93	-7%	\$0.74	-31%	\$146	-16%	16%
3339	Other General Purpose Machinery Mftg.	\$60	10%	\$31	4%	264	-7%	\$1.23	-8%	\$117	-14%	15%
3341	Computer & Peripheral Equipment Mftg.	\$75	8%	\$32	-6%	210	-15%	\$1.25	-48%	\$154	-17%	695%
3342	Communications Equipment Mftg.	\$67	3%	\$30	-6%	145	-21%	\$0.98	-41%	\$209	-11%	247%
3343	Audio & Video Equipment Mftg.	\$9	-1%	\$3	3%	33	-22%	\$0.17	25%	\$105	-22%	0%
3344	Semiconductor & Other Electronic Component Mftg.	\$131	18%	\$78	13%	450	-14%	\$6.36	0%	\$173	-12%	59%
3345	Navig., Measuring, Electromedical, & Control Instr. Mftg.	\$103	14%	\$66	18%	430	-4%	\$2.76	4%	\$155	4%	43%
3346	Mftg. & Reproducing Magnetic & Optical Media	\$7	1%	\$4	-10%	47	-15%	\$0.44	7%	\$88	0%	36%
3351	Electric Lighting Equipment Mftg.	\$12	-4%	\$7	-5%	64	-11%	\$0.23	-16%	\$106	-15%	17%
3352	Household Appliance Mftg.	\$24	9%	\$10	1%	89	-8%	\$0.45	-25%	\$112	-27%	32%
3353	Electrical Equipment Mftg.	\$31	3%	\$17	1%	154	-12%	\$0.64	-6%	\$109	-24%	3%
3359	Other Electrical Equipment & Component Mftg.	\$36	1%	\$19	-1%	137	-9%	\$0.87	-23%	\$140	-10%	36%
3361	Motor Vehicle Mftg.	\$270	13%	\$71	-2%	256	-4%	\$4.69	-2%	\$276	2%	29%
3362	Motor Vehicle Body & Trailer Mftg.	\$29	10%	\$11	21%	165	7%	\$0.44	33%	\$65	8%	50%
3363	Motor Vehicle Parts Mftg.	\$197	-1%	\$85	-2%	691	-5%	\$6.27	-17%	\$123	6%	44%
3364	Aerospace Product & Parts Mftg.	\$130	6%	\$68	5%	438	-6%	\$2.29	-19%	\$154	8%	61%
3365	Railroad Rolling Stock Mftg.	\$9	24%	\$3	-15%	24	11%	\$0.11	-11%	\$132	-24%	17%
3366	Ship & Boat Building	\$24	14%	\$13	8%	150	5%	\$0.36	-19%	\$87	-2%	37%
3369	Other Transportation Equipment Mftg.	\$13	-2%	\$6	-1%	38	-4%	\$0.30	-42%	\$150	16%	42%
3371	HH & Institutional Furniture & Kitchen Cab. Mftg.	\$48	8%	\$27	5%	383	-4%	\$0.83	-19%	\$69	-2%	24%
3372	Office Furniture (including Fixtures) Mftg.	\$25	8%	\$14	3%	133	-11%	\$0.37	-31%	\$107	1%	39%
3391	Medical Equipment & Supplies Mftg.	\$68	14%	\$48	12%	302	-2%	\$2.25	1%	\$158	3%	58%
3399	Other Miscellaneous Mftg.	\$71	5%	\$36	1%	352	-7%	\$1.83	4%	\$103	-8%	29%

Source: Bureau of Labor Statistics; Census, Bureau of Economic Analysis; AngelouEconomics

Red text is below Average Manufacturing Value; Blue text is equal to or above Average Manufacturing Value

VA= Value Add; Emp=Employment; Cap Ex=Capital Expenditure

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When comparing niche targets such as Aerospace Product and Parts Manufacturing, Motor Vehicle Manufacturing, Medical Equipment and Supplies Manufacturing, and Pharmaceutical and Medicine Manufacturing to the overall national manufacturing industry, a clearer understanding of the value of the advanced manufacturing industry begins to emerge.

The Aerospace Product and Parts Manufacturing Industry outperforms the overall manufacturing industry in categories such as value-add per employee, projected employment growth, and projected output growth. In 2004, the aerospace industry produced \$154,000 in value-add per employee while the overall manufacturing industry only produced \$142,000. The projected employment growth for the aerospace industry for the 2004 to 2014 time period is 8%, while the overall manufacturing industry is expected to lose 5% during the same time period. The projected output growth for the aerospace industry from 2004 to 2014 is a significant 61% while the overall manufacturing industry is only anticipated to grow output by a respectable 41%.

The Motor Vehicle Manufacturing Industry produced \$276,000 worth of value-add per employee in 2004, which far exceeded that of the overall industry. Projected employment growth for the motor vehicle industry is expected to be on the order of 2%, which is above the industry average. Also, capital expenditure growth for 2004 declined by only 2% compared to the an overall decline of 8%.

The Medical Equipment and Supplies Manufacturing Industry outperformed the overall industry in 2004 value-add per employee with \$158,000 produced. Projected 2004 to 2014 employment growth will be 58% compared to an overall industry growth average of 41%.

The Pharmaceutical and Medicine Manufacturing Industry substantially outperformed the overall industry in 2004 value-add per employee with \$421,000 produced. The '04 value-add came in at 17%, compared to only 8% for the industry, and the projected 2004 to 2014 employment growth will far exceed the overall industry with a growth rate of 26%.

All of the preceding niche industries are considered to be highly attractive prospective advanced manufacturing sectors that show great promise for stimulating job creation and creating a positive economic impact for a region. Traditionally, niche sectors such as Textile and Fabric Manufacturing along with Apparel and Accessories Manufacturing were considered to be attractive new additions to a region's industry cluster mix. However, when compared to the overall manufacturing industry, low-end manufacturing like Textile and Fabric Manufacturing is expected to underperform the overall manufacturing industry in several categories such as projected 2004 to 2014 employment and output growth. In 2004 alone, the Textile and Fabric Manufacturing Industry fell short of the overall industry in output growth, value-add growth, employment growth, capital expenditure growth, and value-add per employee. The niche industry grew output from 2002 to 2004 by a negative 6% while the overall industry increased by 12%. The niche industry grew value-add by a negative 24% while the overall industry increased 8%. 2004 value-add per employee only registered \$58,000 compared to the overall industry's \$142,000. Projected 2004 to 2014 employment growth is expected to decline an incredible 49%, and output is expected to decline a substantial 27% during the same time period.

A similar pattern unfolds for the Apparel and Accessories Manufacturing Industry. 2002 to 2004 output declined 1% while the overall industry increased 12%. '02 to '04 value-add growth declined 12%, compared to the overall industry's 8% increase. '02 to '04 employment decreased a significant 15%. The niche industry's capital expenditure also declined a devastating 53%. Finally, 2004 value-add per employee only registered \$52,000, projected 2004 to 2014 employment growth is expected to decline by 35%, and 2004 to 2014 output will decrease 25% for the niche industry.

MANUFACTURING SECTOR COMPARISON										
NAICS	Description	2004 Ouput (\$Bil)	02 to 04 Output Growth	2004 VA (\$Bil)	02 to 04 VA Growth	2004 Emp. (Thou.)	02 to 04 Emp. Growth	2004 Cap Ex (\$Bil)	02 to 04 Cap Ex Growth	2004 VA/Emp (\$Thou)
31-33	Manufacturing	\$4,312	12%	\$2,031	8%	14,258	-6%	\$115.11	-8%	\$142
313210	Broadwoven Fabric Mills	\$10.6	-5%	\$4.1	-20%	69.0	-24%	\$0.24	-28%	\$59
313230	Nonwoven Fabric Mills	\$5.8	1%	\$2.5	-5%	17.1	-5%	\$0.21	-50%	\$148
321991	Manufactured Home (Mobile Home) Mftg	\$6.3	-5%	\$2.8	-4%	45.0	-12%	\$0.06	-14%	\$61
333314	Optical Instrument & Lens Mftg	\$3.4	12%	\$1.9	10%	21.7	-11%	\$0.11	-12%	\$90
333611	Turbine & Turbine Generator Set Units Mftg	\$9.4	-31%	\$3.1	-60%	18.0	-23%	\$0.13	-37%	\$171
333991	Power-Driven H&tool Mftg	\$3.2	-10%	\$1.2	-30%	12.8	-20%	\$0.04	-22%	\$97
333993	Packaging Machinery Mftg	\$4.3	11%	\$2.3	-5%	18.0	-5%	\$0.04	-46%	\$129
334111	Electronic Computer Mftg	\$52.4	12%	\$21.7	4%	114.0	-18%	\$0.53	-60%	\$191
334411	Electron Tube Mftg	\$2.0	-19%	\$0.6	-38%	9.8	-38%	\$0.02	-48%	\$57
334510	Electromedical & Electrotherapeutic Apparatus Mftg	\$18.5	21%	\$11.6	19%	54.5	1%	\$0.45	-4%	\$212
334511	Nav., Guidance, Aero., & Nautical Sys. & Inst. Mftg	\$36.9	13%	\$27.2	28%	148.6	1%	\$1.07	15%	\$183
334514	Totalizing Fluid Meter & Counting Device Mftg	\$5.1	10%	\$2.1	7%	14.3	-15%	\$0.07	-23%	\$147
335311	Power, Distribution, & Specialty Transformer Mftg	\$4.6	-5%	\$1.8	-10%	25.4	-16%	\$0.04	-49%	\$73
336120	Heavy Duty Truck Mftg	\$18.2	14%	\$3.7	24%	35.0	8%	\$0.16	5%	\$106
336411	Aircraft Mftg	\$64.7	3%	\$30.2	2%	206.8	-5%	\$0.89	-2%	\$146
336412	Aircraft Engine & Engine Parts Mftg	\$25.6	11%	\$13.0	11%	78.4	-10%	\$0.44	-45%	\$166
336413	Other Aircraft Parts & Auxiliary Equipment Mftg	\$23.0	12%	\$14.3	8%	81.9	-7%	\$0.56	-14%	\$174
336414	Guided Missile & Space Vehicle Mftg	\$13.0	7%	\$7.7	6%	51.5	-4%	\$0.32	-13%	\$149
339111	Laboratory Apparatus & Furniture Mftg	\$4.7	10%	\$3.3	9%	14.4	-2%	\$0.10	-26%	\$230
339112	Surgical & Medical Instrument Mftg	\$23.9	13%	\$17.0	13%	104.4	-2%	\$0.83	-10%	\$163
325411	Medicinal & Botanical Mftg	NA	NA	\$7.1	-11%	22.9	-3%	\$0.6	-20%	\$309
325412	Pharmaceutical Preparation Mftg	NA	NA	\$99.4	19%	225.5	-2%	\$5.7	36%	\$441
325413	In-Vitro Diagnostic Substance Mftg	NA	NA	\$6.9	21%	14.5	7%	\$0.2	-12%	\$477
325414	Biological Product (except Diagnostic) Mftg	NA	NA	\$7.4	24%	24.3	-5%	\$0.5	-2%	\$306
336111	Automobile Mftg	NA	NA	\$23.1	-19%	146.7	-8%	\$2.4	17%	\$158
336112	Light Truck & Utility Vehicle Mftg	NA	NA	\$44.0	8%	74.8	1%	\$2.1	-18%	\$588
336120	Heavy Duty Truck Mftg	\$18.1	14%	\$3.7	24%	35.0	8%	\$0.2	5%	\$106
336211	Motor Vehicle Body Mftg	\$9.5	-10%	\$3.5	25%	64.5	-7%	\$0.2	1%	\$54
336212	Truck Trailer Mftg	\$4.8	24%	\$1.8	23%	33.8	19%	\$0.1	135%	\$54
336214	Travel Trailer & Camper Mftg	\$7.7	17%	\$3.3	24%	45.1	18%	\$0.1	6%	\$72
336350	Motor Vehicle Trans. & Power Train Parts Mftg	NA	NA	\$13.6	-5%	84.6	-5%	\$1.3	-18%	\$161
336370	Motor Vehicle Metal Stamping	NA	NA	\$13.0	4%	100.5	-5%	\$1.0	-1%	\$130

A closer look at advanced manufacturing, through 6-digit NAICS, reveals many of the same patterns. Since the high-tech industry was affected most by the recent recession, it is no surprise that advanced manufacturing industries lost employment and output over the past several years. However, long-term prospects for growth in advanced manufacturing remain promising, as employment is stabilizing, and output is forecasted to improve. The U.S. will continue to lose manufacturing that is not-time sensitive, has low barriers to entry, and does not require a skilled labor force. The opportunity for recruitment lies in manufacturing industries that are high value-add, utilize complex production processes, are time-sensitive, need ready access to markets, and are located in high cost metros.

Following this section is an in-depth view of five preliminary advanced manufacturing niches from the national level. In our next report we will supplement our selection process and incorporate a detailed analysis of the advanced manufacturing industry in Centralina.

## 3.1: Aerospace

### Industry Overview

Aerospace is a broad industry that consists of civilian and military aircraft, space vehicles, and missiles. Aircraft suppliers provide parts and machinery for aircraft assembly and maintenance. These parts include engines, interior components, avionics, and aircraft hardware such as landing gear. Suppliers are important for both the assembly and maintenance of aircraft. The aerospace industry's customers include the military, commercial airlines, and general aviation.

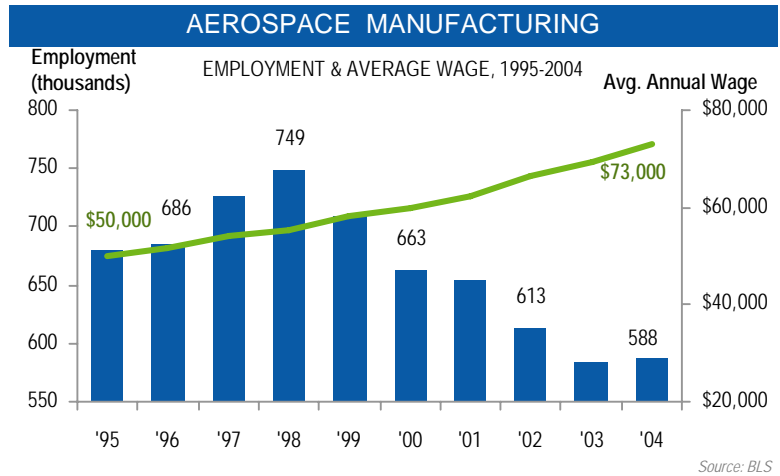
### Historical Growth Trends

The industry has suffered in recent years due to falling orders for new aircraft, but growth has returned in 2005 and is expected to continue into 2006.

Aerospace industry employment fell every year from 1998 to 2003. In 2003 alone, the industry shed over 40,000 jobs to end the year with 575,000 employees but added just over 10,000 jobs in 2004. Sales experienced a healthy rebound in 2005, adding 9% to close the year at \$170 billion, according to the Aerospace Industries Association (AIA). The government is the largest customer segment of the aerospace industry (about 60% of all sales), and increased sales to the Pentagon are offsetting declines in the commercial aircraft market.

Civilian aircraft sales fell sharply following September 11, 2001. Pent up demand and a growing economy will lift civil aircraft sales over the next several years. Military aircraft was the fastest growing segment in terms of sales from 2003 to 2005, adding 24%.

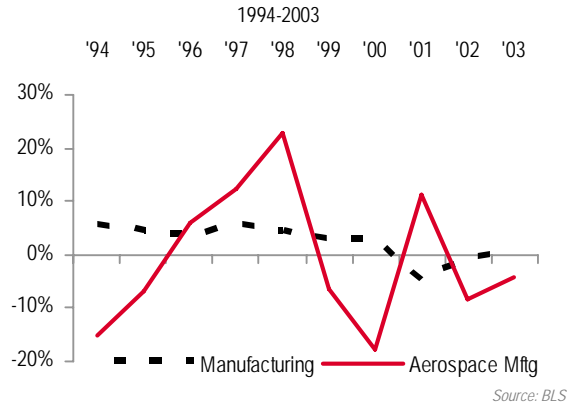
AEROSPACE MANUFACTURING	
<b>NAICS Description</b>	
3364	Aerospace Product and Parts Mftg
336411	Aircraft Mftg
336412	Aircraft Engine and Engine Parts Mftg
336413	Other Aircraft Parts and Auxiliary Equipment Mftg
336414	Guided Missile (GM) and Space Vehicle Mftg
336415	Space Vehicle Propulsion (SVP), Propulsion Unit Parts Mftg
336419	Other GM and SVP and Auxiliary Equipment Mftg
334511	Search, Navigation, Guidance, Aeronautical, Instrument Mftg
<b>U.S. Industry Employment</b>	
587,000	
<b>Average Wage</b>	
\$73,000	
<b>Location Criteria</b>	
Educated Workforce	
Research Institutions	
High Tech Cluster	
Access to Capital	



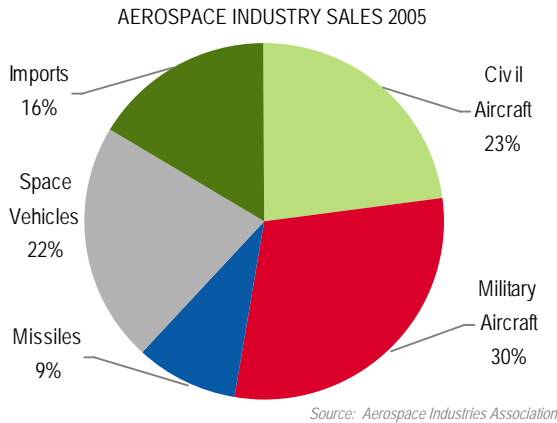
The aerospace industry offers some of the highest salaries in the manufacturing sector. The Bureau of Labor Statistics reported that aerospace products and parts manufacturing workers earned an average annual salary of \$73,000 in 2004, an increase of 46% since 1995. The leading geographic centers of aircraft and parts manufacturing in the U.S. are Washington, California, Kansas, Texas, and Connecticut.

Output in the Aerospace industry is extremely erratic as commercial and military orders occur in bulk. Historical output data shows output with a negative growth rate in 2003, the latest year available, but sales data indicates that output will be positive for the next several years.

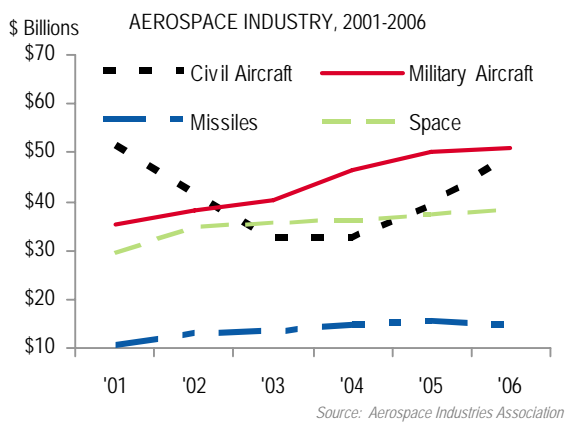
### GROWTH IN OUTPUT



### U.S. AEROSPACE INDUSTRY



### AEROSPACE SALES



## Industry Forecast

### Civilian Aircraft

Civilian aircraft sales account for nearly one-quarter of the U.S. aerospace industry. Civilian aircraft sales increased nearly \$7 billion in 2005 and are forecast to add another \$10 billion in 2006. The civilian jetliner market is split nearly 50-50 between Boeing and Europe's Airbus. Both companies delivered a combined 570 aircraft in 2004. Meanwhile, Boeing is introducing its 200-seat **7E7**, its first new airliner in 10 years. The 7E7 is expected to enter service in 2008. An emerging bright spot is civilian helicopters whose sales have experienced a rapid increase in recent years.

Civilian Aircraft Growth Sectors
Light Jets
Helicopters
Maintenance Repair, and Overhaul (MRO)
Software
Cargo aircraft

Another bright spot in the industry is the **maintenance, repair, and overhaul (MRO)** segment. The nearly \$40 billion MRO landscape is evolving rapidly and is **expected to grow by \$11 billion** over the next 5 years. MRO consists of independent service providers, airline technical services departments, and OEMs. Airlines are striving to avoid large capital outlays for new aircraft purchases through improved maintenance and repair of their existing fleet. Civilian carriers and cargo companies are outsourcing their maintenance and repair. Revenues for MRO organizations are expected to grow over 5% per year over the next several years.

### Military Aircraft

Military aircraft accounts for over one-third of the U.S. aerospace industry. The outlook for the sector is good, and defense budgets are expected to raise 4-6% until the end of the decade. Defense contractors should expect roughly the same single-digit growth of recent years. Sales of military aircraft, engines, parts, and services increased 7% to \$49 billion in 2005.

Military Growth Sectors
Unmanned Aircraft (UAVs)
Missile Defense
Homeland Security
Infrared counter measures
Network-Centric warfare

The U.S. military is continuing to reduce the size of its units as it transitions to a smaller, more mobile force to combat terrorism and respond globally to small conflicts. Technology is playing an increasingly important role. **Network-centric warfare** involves complex integration of data from computers, satellites, and sensors to provide fighting forces with accurate, real-time information about the battlefield. Recent conflicts in Afghanistan and Iraq showcased **Unmanned Aerial Vehicles (UAVs)**. As the technology improves, UAVs will replace human pilots in dangerous roles in both military and civilian use.

### Space Vehicles and Missiles

The smallest segment of the aerospace industry includes firms producing guided missiles and spacecraft. Most sales are to the military and government. The chief commercial application of missiles is to launch satellites into orbit. Space sector sales increased to \$37 billion in 2005, up 4%. NASA and non-defense department federal agencies accounted for most of the increase. Suppliers in the U.S. and Europe dominate the aircraft parts industry, although Asian firms are quickly increasing their

Space and Missile Growth Sectors
Missile Defense
Earth imagery
Military satellites
Space Station
Mar's mission

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competitiveness. Missile sales were up nearly 4% to \$15 billion, the highest level since the end of the Cold War. The Bush Administration committed to develop the **National Missile Defense (NMD)** system to protect the U.S. against ballistic missile attack. The project consists of five elements: group-based interceptors, command, control and communication; radar; upgraded early-warning radar; and satellites for detection. The project's first phase is to cost \$30 billion.

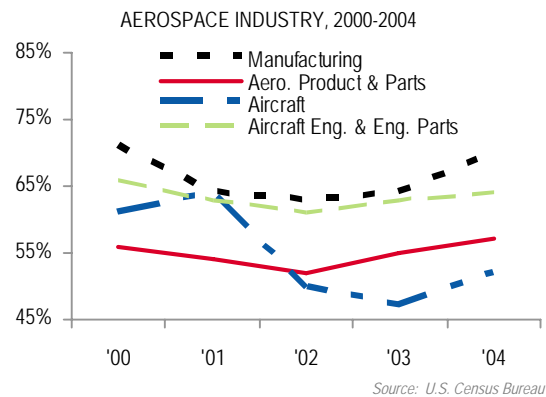
#### **Aerospace Industry Sub-Niche Sectors**

- Light Aircraft OEMs
- Suppliers to Light Aircraft Assemblers
- Unmanned Aerial Vehicles (UAVs)
- Optics/Photonics
- Aviation Software
- Space Vehicles and Missiles

## Capacity

Capacity utilization rates for the aerospace industry have closely followed the U.S. manufacturing industry from 2000 to 2004. Sub-niche sectors such as Aerospace Product and Parts Manufacturing saw its percentage of total production capacity at 56% in 2000, down to 52% in 2002, and then back to 57% in 2004, following an increase in military and commercial aircraft orders. Aircraft Manufacturing experienced an increase in 2001 and then a rapid decline through 2002 and 2003 in the wake of 9/11. Most industries and sub-industries will follow the cycles of the national economy. Generally speaking, capacity utilization rates will follow the business cycle, which is why we see a peak in 2000, followed by a sharp decline that bottoms out in 2002, and finally a recovery through 2004. However, there will always be exceptions to the rule. The Aerospace industry, for example, experienced increases in production capacity rates during the recent recession due to global conflicts and increases in the national defense budget.

### PRODUCTION CAPACITY UTILIZATION RATE



## Breakdown of Production Inputs

Total production inputs for aircraft manufacturing decreased 4.7% between 1997 and 2002. However, production inputs of aircraft engine parts ballooned 869% during the same time period. Increases in engine part inputs can be largely attributed to the increase in sophistication of aircraft engines and the complexity of servicing and maintaining the engines. Overall, aircraft manufacturing has not become more expensive over the years due to cost savings in other facets of the production process. This is largely due to an increase in automation, which reduces worker error and increases quality and efficiency.

### AIRCRAFT MANUFACTURING INPUTS

Input	Delivered Costs (\$1,000)	
	1997	2002
Total Materials	\$34,268,528	\$32,659,425
Materials, ingredients, containers, and supplies, nsk	21.4%	27.4%
Aircraft engines	ND	20.7%
All other materials/components/parts/containers/supplies	16.4%	8.9%
Resistors/capacitors/transformers/other electronic components	0.3%	2.9%
Aircraft engine parts (excluding instruments)	0.2%	2.2%
Flight/navigational/airframe/eng. indicators/instrum./clusters	ND	2.0%
Radio communication systems/equip. (microwave, UHF, etc.)	ND	1.8%
Navigational systems and equipment (NAVAIDS)	0.4%	0.8%
Other fabricated metal products (exc. fluid power and forgings)	0.5%	0.5%
Metal bolts/nuts/screws/other screw machine products	ND	0.4%

Source: Census; Top ten inputs for Aircraft Manufacturing, 336411

## Geographic Concentration

### National Aerospace Manufacturing Industry Cluster Distribution 2004

The aerospace industry has historically been anchored in metropolitan areas such as Seattle, Cape Canaveral, Dallas, and Southern California, primarily due to the presence of both commercial and military aircraft manufacturing firms like Boeing and Lockheed Martin. The industry is also concentrated in areas that are heavily dependent on government agencies and bases such as NASA in Florida and Edwards Air Force Base in Southern California.



### National Aerospace Manufacturing Industry Growth Distribution 1995-2004

Employment growth in the aerospace industry, however, has for the most part avoided the heavy aerospace clusters and has been lackluster over the past ten years. Regions surrounding San Francisco, parts of Alabama, Jacksonville, and Dallas have seen reasonable growth in recent years, which is impressive during a time of consolidation.



## 3.2: Automotive Manufacturing

### Industry Overview

The automotive manufacturing industry has a long history of producing equipment such as engines, interior components, and electrical systems. The industry's primary functions include design, assembly, and distribution of transportation vehicles.

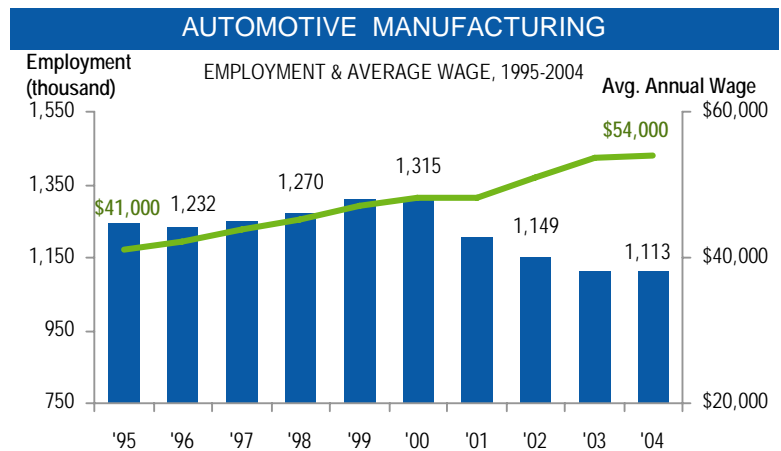
The auto manufacturing industry in the U.S. employs more than 1.1 million people domestically. However, with precision and efficiency of utmost importance, the industry continually develops ways to streamline production through automation, reducing automotive employment. Competitive market forces often cause auto manufacturers to develop new designs and technologies to remain competitive, further pressing the need for efficiency. Such developments include the new electric and hybrid powered automobiles.

Despite recent events, such as the rising price of oil and the encroaching of foreign automotive companies in the domestic market, optimism is still present in the long-term viability of the industry. Emerging global economies and markets, such as China and India, have developed a strong interest in developing larger volumes of exports in the industry. However, of all OEM's, General Motors dominates the growing Chinese Market.

AUTOMOTIVE MANUFACTURING	
<b>NAICS Description</b>	
3361	Motor Vehicle Manufacturing
336111	Automobile Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing
336120	Heavy Duty Truck Manufacturing
3362	Motor Vehicle Body and Trailer Manufacturing
336211	Motor Vehicle Body Manufacturing
336212	Truck Trailer Manufacturing
336213	Motor Home Manufacturing
3363	Motor Vehicle Parts Manufacturing
<b>U.S. Industry Employment</b>	
1,113,000	
<b>Average Wage</b>	
\$54,000	
<b>Location Criteria</b>	
Low Labor Unionization Rate	
Reliable and Affordable Power Supply	
Low Cost Business Climate	
Proximity to Technical Training Institutions	

### Historical Growth Trends

While employment has dropped in recent years, wages have continually increased. Along with domestic companies, foreign companies have also moved manufacturing development from foreign countries to the U.S., accounting for improved employment forecasts. Foreign companies accounted for 43% of sales this year (Brookings Institute). In 2005, Toyota became the third largest seller of automobiles in the U.S. The company expects their U.S. production to exceed 2 million vehicles by 2008, due in large part to new plants in Texas, Indiana, and Kentucky. Similarly, Honda has



Source: BLS

established plants in Ohio and Alabama, Mitsubishi has created a plant in Illinois, and Nissan has plants in Tennessee and Mississippi. Currently, foreign automotive manufacturers employ more than 55,000 assembly plant personnel, produce over 3.6 million vehicles a year, and have invested \$22.6 billion in their U.S. operations. Since the 1980's, foreign manufacturers have tended to locate in the South and Midwest due to cheaper operating and labor costs (Automotive Digest and Center for Automotive Research).

## Industry Forecast

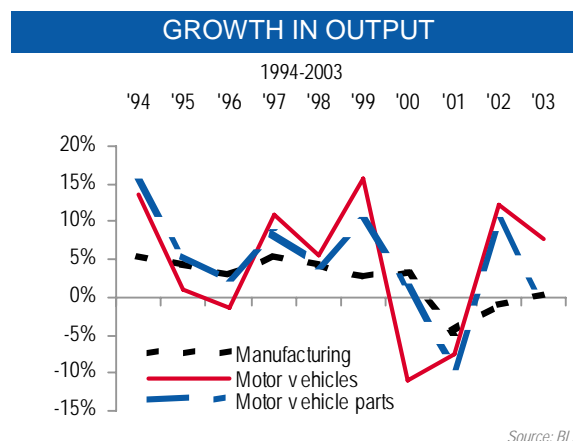
Though outlook might appear grim in the short-term, long-term growth in auto manufacturing is on the rise; motor vehicle growth in output increased 7.6% in 2003 and is expected to continue. Over the next ten years, overall automotive manufacturing output is expected to increase 36%. Additionally, employment is forecasted to increase almost 6% over the same time period. The development of new technologies and more efficient automobiles will insure growth in the foreseeable future.

The demand for automobiles that consume less energy in order to augment the current fuel price has also risen. While hardships might seem prevalent for domestic automotive manufacturers, several fields of research and development in certain alternative sectors of production have given rise to optimism.

- **Hybrid Electric/Gas Powered Vehicles:** This new technology is the first significant move away from the internal combustion engine in 100 years. These highly fuel-efficient models have begun to change the face and philosophy of the automotive industry for the near future. Toyota is currently the largest producer of hybrid-powered cars; however, General Motors has produced a similar product and plans to introduce it in mass production within a year.
- **Fuel Cell Vehicles:** These systems function by compressing hydrogen made from natural gas and gasoline and then converting it with on-board systems. The OEM's have invested substantial capital and energy into hydrogen fuel cell technology and development. Domestic companies GM, Ford, and Daimler-Chrysler have recently combined resources to collaborate in research and development in an unprecedented industry alliance.

Growth is expected in the auto manufacturing industry for several reasons:

1. The development of new energy-efficient technologies provide consumers with a more diverse variety from which to choose. A greater diversity of automobiles that consume energy more efficiently and cost consumers less money to operate will be beneficial. These new automobiles are also less harmful to the environment, thus creating another incentive for customers.
2. With the developing Chinese market, several million potential consumers await products to purchase in the future. The Chinese market is highly coveted by domestic auto manufacturers. As foreign competitors are thriving in U.S. markets, U.S. companies are also beginning to flourish in China and other Asian markets.
3. Streamlined production has allowed for a more efficient and effective production process of automobiles. Automation has allowed large auto manufacturers to create a higher quality product. As well as improving quality, automation has provided auto manufacturers the opportunity to relocate to other locations in more efficient and cost effective ways.



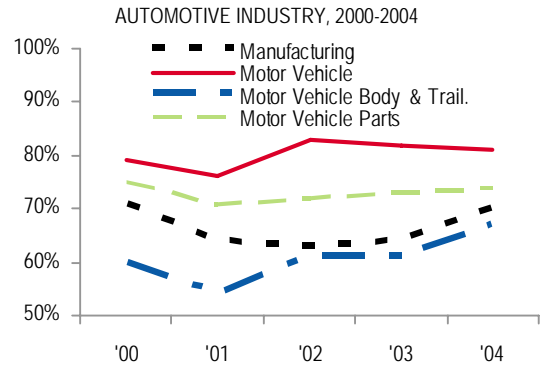
## Capacity

Full production capacity in the automotive industry has remained relatively high compared to the overall national manufacturing industry, indicating future growth. In particular, the motor vehicle manufacturing sector has maintained an aggressive production pace at well over 80% of total production capacity. This proves that demand for automobiles is still very high in the U.S. despite lackluster earnings performance from the Big 3 automakers. Much of the domestic demand for automobiles is being driven by new, higher quality product offerings from foreign competitors.

Interestingly, the sub-niche sectors in the automobile industry have not followed the traditional pattern of the national manufacturing industry. Instead of demand for automobiles and parts falling during the recent

recession, demand actually increased, causing an increase in production from 2001 to 2002. Much of the demand increase for each sub-niche sector can be linked to the aggressive marketing campaign during the recession. Sales offers that included 0% financing options were instrumental in boosting demand during the national economy's weakest years.

### PRODUCTION CAPACITY UTILIZATION RATE



## Breakdown of Industry Inputs

Total costs of inputs for the automotive industry declined 7.5% from 1997 to 2002. The only production input that saw an increase in cost was the automotive trimmings, textile (panels, headliners, etc.) segment due mainly to an increase in demand for luxury options by consumers.

Despite increasing profit margins on automobiles, the Big 3 automakers are experiencing dwindling earnings as the industry's aging workforce begins to retire and cash in on employee pension plans. The decrease in costs of inputs is due in part because an increase in efficiency and production processes.

### MOTOR VEHICLE MANUFACTURING INPUTS

Input	Delivered Costs (\$1,000)	
	1997	2002
Total Materials	\$65,491,083	\$60,584,704
Gasoline engines/parts specially designed for gasoline engines	16.1%	16.4%
All other materials/components/parts/containers/supplies	20.0%	16.1%
Drive train components and parts	11.6%	9.9%
Automotive stampings (inc. body parts, hubcaps, fenders, etc.)	10.9%	6.9%
Automotive trimmings, textile (panels, headliners, etc.)	3.0%	6.2%
Shocks, struts, and other suspension equipment and parts	3.6%	5.7%
Seats (purchased separately) for automobiles, trucks, & buses	3.9%	4.2%
Materials, ingredients, containers, and supplies, nsk	0.9%	3.6%
Exhaust systems and parts	1.7%	3.0%
Glass and glass products (including windows and mirrors)	1.6%	2.8%

Source: Census; Top Ten Costs of Inputs; NAICS 336111

## Geographic Concentration

### National Automotive Manufacturing Industry Cluster Distribution 2004

Automotive manufacturing in the U.S. is heavily concentrated in the eastern half of the nation, with the exception of the Upper Northwest. Large portions of Kentucky, Tennessee, Ohio, North and South Carolina, and Alabama are home to some of the nation's largest automotive manufacturing centers.



### National Automotive Manufacturing Industry Growth Distribution 1995-2004

Growth for the industry continues to occur more strongly in the regions where cluster concentrations are high. Parts of Florida, Mississippi, and Oklahoma enjoy healthy growth in the automotive manufacturing sectors within their respective states. However, the Northeastern part of the U.S., where cluster strength is still high, has experienced almost no growth over the past ten years; this is mainly due to the high operating costs and labor unions.



## 3.3: Medical Devices

### Industry Overview

Medical devices manufacturing serves a variety of needs in the medical profession. From development of diagnostic products to new devices, physicians and engineers have developed a highly innovative and collaborative relationship that has fueled the momentum of this growing and vital industry. Sub-niche sectors in the industry include surgical instruments, microscopy, diagnostics, and service devices associated with all fields of healthcare including dentistry and ophthalmology.

The medical devices market covers a wide variety of categories. Products include furniture to assist with surgery, diagnostic equipment, medicine delivery products, sanitized gloves and clothing, and surgical lasers. However, medical devices manufacturers produce mainly adhesives, electronic components, motors and motion control equipment, software, sterilization solutions, inspection and testing equipment, and tubing products.

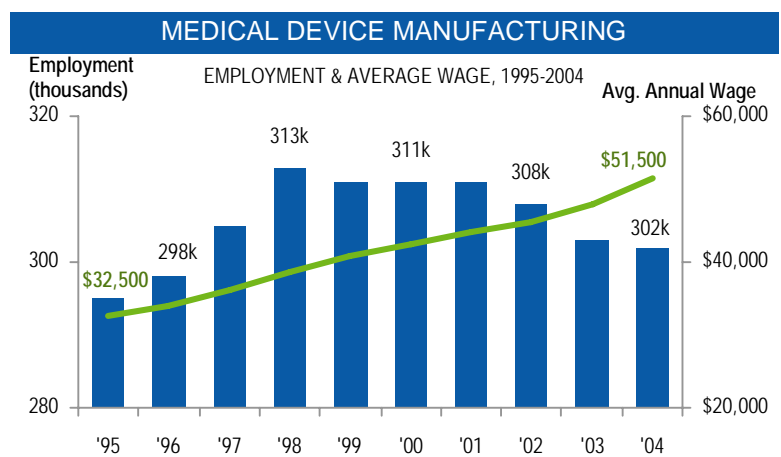
Luxury items such as beds and seating for examination and surgical applications are included in medical devices manufacturing, as well as all other essential tools.

The industry's goal of servicing human well-being with greater efficiency, sterility, and precision creates an atmosphere for growth and development. Patient care and recovery improves with each new discovery, and the process of engineering new equipment based on physicians' desires and patients' needs promotes an environment of continuous innovation and cooperation between two different professions. Physicians and engineers often collaborate to bring new and innovative products to market.

### Historical Growth Trends

Though employment has recently declined in the industry, the long-term trends in growth and wages are excellent. Wages increased by 7.4% in 2004 and by 21.1% since 2000. Initial employment figures for 2005 indicate that employment will increase, albeit marginally. Output growth has declined marginally since 2000, but the medical devices industry still remains well ahead the growth trend of the overall national manufacturing industry.

MEDICAL DEVICE MANUFACTURING	
<b>NAICS Description</b>	
3391	Medical Equipment and Supplies Manufacturing
339111	Laboratory Apparatus and Furniture Manufacturing
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Appliance and Supplies Manufacturing
339114	Dental Equipment and Supplies Manufacturing
339115	Ophthalmic Goods Manufacturing
339116	Dental Laboratories
<b>U.S. Industry Employment</b>	
301,700	
<b>Average Wage</b>	
\$51,500	
<b>Location Criteria</b>	
Educated Workforce	
Access to Venture Capital	
Research Presence	
Affordable Lab Space	



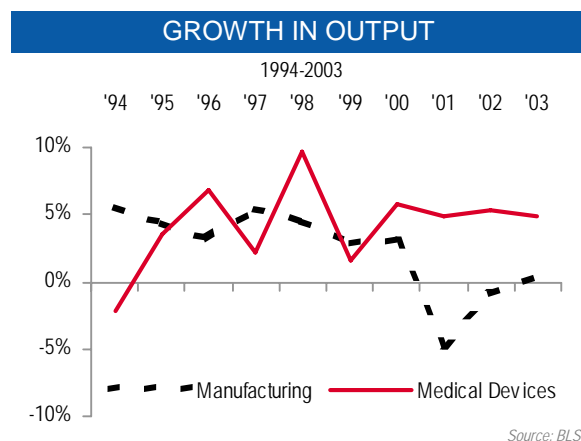
## Industry Forecast

Despite the recent standstill in employment growth, the industry is forecasted to add jobs. The employment growth trend is projected to continue for the next ten years at a rate of about 3%. This steady growth in the industry demonstrates the capability for long-term confidence and development. The output for chained dollar? (adjusted for inflation and purchasing behavior) for the past ten years has seen steady growth as well. Output in 1994 reached \$39 billion and \$69 billion in 2004. The Bureau of Labor Statistics expects output to total \$109 billion in 2014, making the average rate of change over this period just over an increase of 5%. Demand for these products should increase with the aging population of the U.S. As the baby-boomers retire and age, the need for a larger quantity and higher quality of medical devices is expected to increase. By 2020, the U.S. Census Bureau expects more than 54 million people to be over the age of 65. The steady growth in the industry is directly linked to the age and size of the population.

The medical devices manufacturing industry is highly regulated, yet the demand for products is rising. The medical devices market requires a cluster of other medical or high-tech companies for support and knowledge capital. Such industries include microelectronics, telecommunications, instrumentation, biotechnology, and software development.

A few of the components that are driving growth in the industry are as follows:

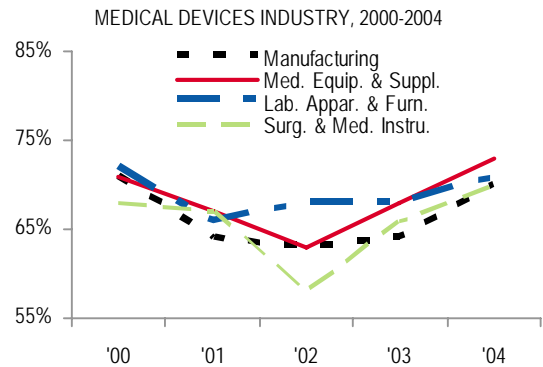
- **Home-Healthcare Products:** Directly associated with the aging population, home-healthcare products will emerge from the need of an efficient and feasible alternative to hospital care. Home healthcare workers with little prior skills or knowledge will need to continue to get training for new emerging medical devices associated with cardiac and pulmonary disease, among others.
- **Convergence of Biotechnology and Medical Manufacturing:** Many new treatments are expected to be unavailable through conventional delivery devices (i.e. pill, injection, etc.). Therefore, new products will be developed from biotechnological research, hence the need for a cluster of industries that will require cooperation from the medical devices manufacturing industry to create practical application of new treatments.
- **Picture Archiving and Communication Systems (PACS):** PACS is a system that facilitates replacing traditional film with digital technology that may be stored with a patient's medical history. Doctors would have remote access to information, reducing reviewing time and allowing for increased caseloads. PACS also eliminates the need for film, developing chemicals, and processing labor, which translates into considerable savings. The combination of this new technology with existing medical devices manufacturing (i.e. radiology) constitutes a major development in the cooperation of the industry and other sectors of high technology.
- **E-Commerce:** The availability and variety of products in the medical devices industry has increased dramatically with the capability of purchasing on the Internet. E-commerce is expected to increase demand and availability of new devices directly associated with home-healthcare products.



## Capacity

Production capacity utilization rates in the medical devices industry have remained on par with the overall national manufacturing industry. With the exception of the laboratory, apparatus, and furniture industry sector, the medical devices market has followed the trend of peaking in 2000, bottoming in 2002, and then recovering fully into 2004. On the other hand, the laboratory, apparatus, and furniture sector experienced a significant increase in production in 2002 after falling from its 2000 peak and bottoming in 2001. All three sectors show increasing production capacity utilization rates, which provide an indication that the industry is growing.

### PRODUCTION CAPACITY UTILIZATION RATE



Source: U.S. Census Bureau

## Breakdown of Production Inputs

Total cost of inputs for the medical devices industry rose 22% from 1997 to 2002. Surgical and orthopedic supply inputs alone increased 69% during the same time period. The production cost increases for the industry are significant, as it provides indicators that more products are being produced. As new technologies emerge and become more complex, manufacturing input costs will continue to climb. The only effective method for keeping production costs low, relative to output, is to introduce more highly automated production processes that reduce manufacturing times and increase product yield and quality.

### MEDICAL INSTRUMENT MANUFACTURING INPUTS

Input	Delivered Costs (\$1,000)	
	1997	2002
Total materials	\$4,358,602	\$5,304,602
All other materials/components/parts/containers/supplies	23.6%	24.0%
Materials, ingredients, containers, and supplies, nsk	27.6%	23.5%
Surgical and orthopedic supplies	14.5%	20.2%
Fabricated plastics products	9.3%	10.5%
Plastics products consumed in the form of sheets, rods, etc.	4.8%	5.3%
Plastics resins consumed in the form of granules, pellets, etc.	4.3%	3.1%
Paperboard containers, boxes, and corrugated paperboard	3.0%	1.9%
Resistors/capacitors/transformers/other electronic components	6.1%	1.9%
Other fab. metal products (exc. bolts/nuts/washers/etc.)	ND	1.9%
Fab. rubber products (exc. tires/tubes/hose/belting/gaskets)	1.4%	1.1%

Source: Census; Top Ten Costs of Inputs; NAICS 339112

## Geographic Concentration

### National Medical Devices Manufacturing Industry Cluster Distribution 2004

The medical devices industry traditionally is clustered in metropolitan areas such as San Diego, San Francisco, Chicago, Orlando, Boston, and New York. A quick glance at this cluster map illustrates the industry's presence in high cost, highly educated areas such as the Northeast and West Coast.



### National Medical Devices Manufacturing Industry Growth Distribution 1995-2004

However, recent growth in the industry has occurred more in the Midwest and West Coast than on the highly medical device industry concentrated East Coast. This shows the beginning of the industry's transition out of high cost areas in search of a more favorable business climate. The challenge will entail finding low-cost metros that meet infrastructure and labor force requirements.



## 3.4: Optics Manufacturing

### Industry Overview

Three primary segments of manufacturing encompass the optics manufacturing industry.

The **Optical Instrument and Lens Manufacturing** industry engages in manufacturing of optical instruments, such as binoculars, microscopes, telescopes, prisms, and lenses.

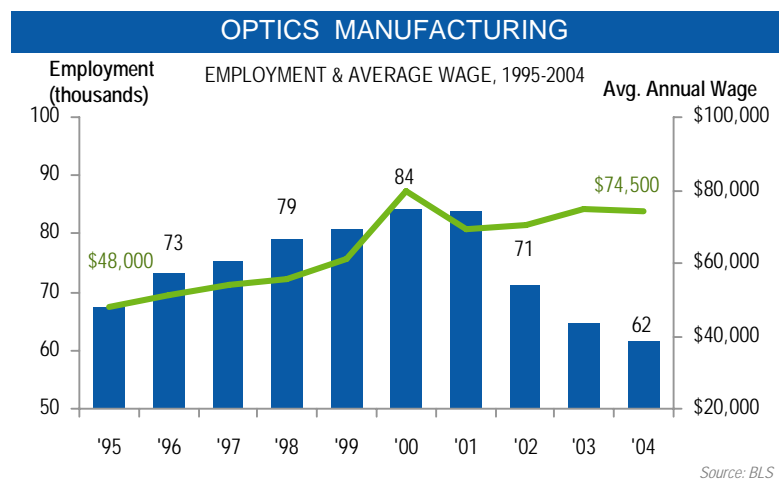
The **Fiber Optic Cable Manufacturing** industry includes the development of insulated fiber-optic cable from purchased fiber-optic strands. Fiber optics involves transmitting communication signals over hair thin strands of glass or plastic. The technology has been used commercially for 25 years. A single fiber can carry more communications than giant copper cables. Products and services generated from this industry include electronic wire and cable, building wire and cable, power wire and cable, optical fiber, telephone and telegraphic wire, control and signal wire, cable, internet, local area networks (LANs), CATV for video, Voice over Internet Protocol (VoIP), utilities (management of power grid), security (closed-circuit TV and intrusion sensors), and military-related products.

The **Computer Storage Device Manufacturing** industry is comprised of firms that are primarily engaged in the manufacturing of computer storage devices. These products allow for the storage and retrieval of data from magnetic or optical media. Examples of products made by companies in the industry include optical disk drives, CD-ROM drives, floppy disk drives, hard disk drives, and tape storage and backup units.

OPTICS MANUFACTURING	
<b>NAICS Description</b>	
333314	Optical Instrument and Lens Manufacturing
335921	Fiber Optic Cable Manufacturing
334112	Computer Storage Device Manufacturing
<b>U.S. Industry Employment</b>	
61,700	
<b>Average Wage</b>	
\$74,500	
<b>Location Criteria</b>	
Educated Workforce	
Research Institutions	
High Tech Cluster	
Access to Capital	

### Historical Growth Trends

The optics manufacturing industry has closely followed the performance of the overall high tech industry over the past decade. As the tech bubble came to a peak in 2000, the optics market also peaked and has lost employment each year through 2004. Likewise, following the aftermath of the tech bubble fall-out, the optics industry faced a heavy sell-off in the stock market, as well as a difficult operating environment during the recent recession.



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However, average wages for the optics industry have remained high since the industry's peak in 2000. From an average wage of \$79,500 at the height of the tech boom, the optics market still posts an average wage of \$74,500, a modest decline. However, this is a 55% increase above the industry's 1995 average wage of only \$48,000.

In spite of the strong performance in average wages, employment in the optics industry has not fared so well. From a 2000 high of 84,000, the optics manufacturing industry currently employs around 61,700 people, a 26% loss. However, preliminary 2005 figures indicate that optics employment will stabilize.

## Industry Forecast

**Optical instrument and lens manufacturing:** The increasing demand in the defense and security industry will drive growth in the optical instrument industry. Face recognition devices that require highly sophisticated optical equipment and software programs are one of the primary focuses in the security industry. The Department of Defense also invests large amounts in improving satellite surveillance systems, allowing them to monitor detailed activity on a global scale. Optical devices are also used in advanced manufacturing processes. Optical monitoring devices are becoming more sophisticated and cost-effective for quality control inspections along the assembly line.

**Fiber Optic Cable Manufacturing:** There are two main demand drivers for fiber optic cable manufacturing: The optical networking market and the fiber optic test, measurement, and automation equipment market.

In the *optical networking market*, the past decade has witnessed explosive growth in the volume of data traffic. This is largely due to the soaring popularity of the Internet and related bandwidth-intensive applications. According to IT industry analysts, the number of Internet users around the world is expected to increase from 400 million in 2001 to over one billion, or 15% of the total population, by 2007. Additionally, users are increasingly seeking applications that require a great deal of bandwidth such as video conferencing, video-on-demand, HDTV, e-commerce, and rich media streaming. The dramatic increase in Internet users and bandwidth-intensive applications has created a tremendous need for high-capacity communication networks. To meet this increasing demand for bandwidth, many telecommunication carriers are designing and installing new networks based on optical fiber, deploying additional fiber within their existing networks, and using advances in optical technology such as Dense Wavelength Division Multiplexing (DWDM). DWDM involves combining beams of light of slightly different wavelengths through a single fiber with each wavelength carrying its own stream of information. DWDM has wide market acceptance because it incorporates technologies that greatly reduce the cost of optical transmission over long distances and because it provides network flexibility in access and metropolitan areas. According to Kessler Marketing Intelligence (KMI), the global DWDM transport equipment market increased from \$7.1 billion in 2001 to \$23.2 billion in 2005.

*Fiber optic test, measurement, and automation equipment* is essential for research and development, manufacturing, network installation and maintenance, as well as for network monitoring. Fiber-optic test and measurement equipment is critical for measuring network conditions and supporting carriers and manufacturers of optical components, value-added optical modules, and optical networking systems. This sub-industry plays a vital role in ensuring network performance, efficiency, and reliability.

The fiber-optic test, measurement, and automation market has not been immune to the challenging conditions in the optical networking sector. However, vendors with extensive product portfolios that include advanced optical test instruments were still able to market their products to carriers who need to upgrade their networks to higher transmission rates or add DWDM channels. Likewise, vendors whose products increase efficiency and reduce

costs on the production floor still attract the attention of optical component and system manufacturers, who keep investing in their R&D programs to stay ahead of the competition.

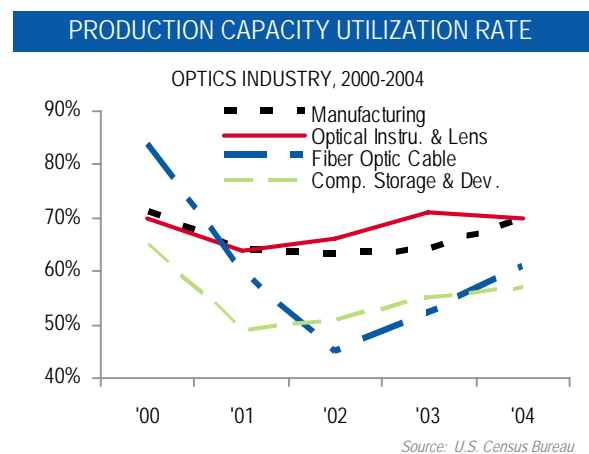
**Computer Storage Device Manufacturing:** The computer and electronic product manufacturing industry employed 1.3 million workers in 2004. Also in 2004, the industry included about 20,000 companies, many of which were small, employing only one or a few workers. Large companies with over 250 workers employed approximately 61% of the industry's workforce. Employment in the industry is expected to decline by 7% between 2004 and 2014, compared with a projected increase of 14% in all industries. Although the output of this industry is projected to increase more rapidly than that of any other industry, employment will still decline as a result of continued rapid productivity growth, and increased efficiency.

Employment in the sub-industry will also be adversely affected by continued increases in imports of electronics and computer-related products. Outsourcing of some professional functions, such as computer programming and engineering, to lower wage countries will also adversely affect employment. While much of the design of computer and electronics products are done domestically, most of the mass manufacturing of these products occurs abroad. Despite the overall projected decrease in employment, the technological revolutions taking place in computers, semiconductors, and telecommunications, and the need to replace the many workers who leave the industry due to retirement or other reasons, should continue to provide many employment opportunities in the industry, especially in research and development.

Furthermore, since defense expenditures are expected to increase, sales of military electronics will undoubtedly increase. As a result, firms will continue to develop new products and create new markets within the industry. Smaller, more powerful computer chips are constantly being developed and incorporated into an even wider array of products, and the semiconductor content of all electronic products will continue to increase. Therefore, the growth of digital technology, artificial intelligence, and nanotechnology, the expansion of the Internet, and the increasing demand for global information networking, will continue to create new opportunities optics industry.

## Capacity

The optics manufacturing industry has experienced significant declines in production in recent years, following the tech bust. The sub-industry sector that experienced the greatest decline was the fiber optic cable manufacturing market. The market went from a production volume of 84% of full capacity in 2000 to a low of only 45% in 2002. The market has recently recovered to back over 60% of capacity, but the industry remains well below pre-tech bubble production levels. However, the optical instrument and lens manufacturing market avoided a sharp decline in production unlike all other sectors in the industry. In fact, this market experienced a considerable increase in production from 2001 to 2003. On a positive note, capacity utilization rates have all increased over the past two years, signifying a recovery.



## Breakdown of Industry Inputs

Total costs of inputs for the optics manufacturing industry declined by 5% between 1997 and 2002. The decrease in input costs is largely due to the downturn in the business cycle. The lower costs of inputs in 2002 coincide with decreased employment, production capacity utilization, and output. Printed circuit assemblies, loaded boards, and modules declined by a substantial 51% over the 5-year period, mainly due to efficiencies in the production process.

OPTICAL INSTRUMENT / LENS MANUFACTURING INPUTS		
Input	Delivered Costs (\$1,000)	
	1997	2002
Total materials	\$1,042,917	\$990,509
Materials, ingredients, containers, and supplies, nsk	20.6%	44.9%
All other materials/components/parts/containers/supplies	19.9%	17.9%
Optical instruments/lenses (exc. sighting/tracking/fire control)	ND	11.1%
Glass and glass products (excluding windows and mirrors)	18.8%	7.2%
Printed circuit assemblies, loaded boards, and modules	7.2%	3.7%
All other misc. comps./access. for elect. circuitry (exc. tubes)	1.1%	2.9%
Other fab. metal prods. (exc. forgings/metal stampings/etc.)	9.6%	2.4%
Plastics resins consumed in the form of granules, pellets, etc.	2.3%	1.5%
Fabricated plastics products (exc. gaskets, hoses, & belting)	3.7%	1.2%
Semiconductors (incl. transistors/etc.), for electronic circuitry	2.2%	1.1%

Source: Census; Top Ten Costs of Inputs

## 3.5: Pharmaceutical Manufacturing

### Industry Overview

The pharmaceutical and medicine manufacturing industry consists of approximately 2,500 establishments located throughout the country. These industry firms are primarily engaged in the manufacturing of biological, medicinal, and pharmaceutical products in various formats including tablets, capsules, vials, ointments, powders, and solutions. These are then sold to pharmacies or distributed through hospitals.

Some of the primary activities of firms established in the industry include the manufacturing of biological and medicinal products, processing (i.e., grading, grinding, and milling) botanical drugs and herbs, isolating active medicinal principals from botanical drugs and herbs, and manufacturing pharmaceutical products intended for internal and external consumption.

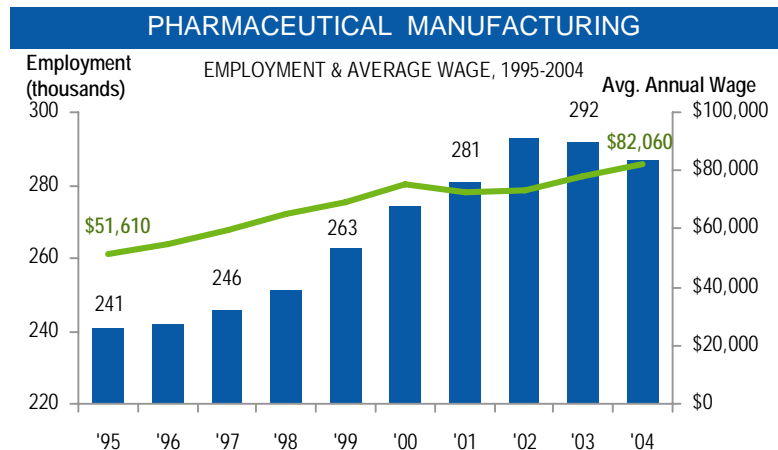
A few of the major products and services that are outputted annually by the industry include pharmaceutical preparations, medicinal and botanical products, in-vitro diagnostic products, and various biological products.

PHARMACEUTICAL MANUFACTURING	
<b>NAICS Description</b>	
3254	Pharmaceutical and Medicine Manufacturing
325411	Medicinal and Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
<b>U.S. Industry Employment</b>	
287,000	
<b>Average Wage</b>	
\$82,000	
<b>Location Criteria</b>	
Educated Workforce	
Research Institutions	
Affordable Lab Space	
Access to Venture Capital	

### Historical Growth Trends

According to the BLS, this industry ranks among the fastest growing manufacturing industries in the nation. Although employment growth has been declining since 2001, the pharmaceutical manufacturing industry has experienced tremendous overall growth since 1998. In 2001, growth reached its highest point in the past ten years. As a result, employment in 2002 reached a recent high of 293,179 people.

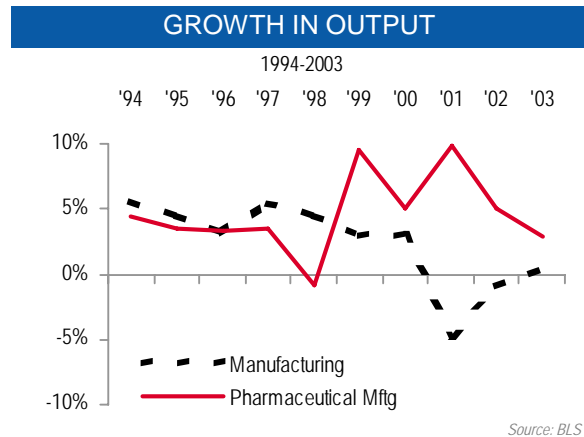
Even though employment growth declined in 2003 and 2004, average annual wages for the industry continued to increase, reaching a high of \$82,060 in 2004. Since 1995, employment has increased 19.3%, and average wages have increased a substantial 59% in the industry.



Source: BLS

Pharmaceutical Research and Manufacturers of America (PhRMA), which represents the country's leading pharmaceutical research and biotechnology companies, alone invested an estimated \$39.4 billion in 2005 in discovering and developing new medicines. Industry wide research and investment reached a record \$51.3 billion in 2005.

Through the early nineties, pharmaceutical output kept pace with overall manufacturing. However, since 1999, pharmaceutical output has outpaced the overall industry by a wide margin. Output growth cooled in 2003, bringing it more in line with the manufacturing industry as a whole, but is forecasted to outpace the industry in the long term.



## Industry Forecast

The number of jobs in the pharmaceutical and medicine manufacturing industry is expected to increase by about 26% through 2014. This compares favorably with an expected 14% gain for all industries during the same time period. Demand for the industry's products is expected to remain strong into the foreseeable future. Even during soft economic environments, there will always be a market for over-the-counter and prescription drugs. Demand is also anticipated to remain high for diagnostic equipment and services used in hospitals, laboratories, and homes. Similarly, vaccines, analgesics, antibiotics, and "lifestyle" drugs are also expected to remain in high demand.

Despite the increasing demand for drugs, drug producers and consumers are expected to place more emphasis on cost-effectiveness due to concerns about the rising cost of healthcare and prescription drugs. Growing competition from the producers of generic drugs may also exert cost pressures on many firms in this industry, particularly as brand-name drug patents expire. Additionally, the average time for the FDA to review "non-priority" drug applications is becoming longer, further delaying the time a drug comes to market. As a result, these factors, combined with continuing improvements in manufacturing processes, are expected to result in slower employment growth over the next 10-year period compared with the previous decade.

In other areas of the industry, advances in biotechnology and information technology are transforming drug discovery and development. Within biotechnology, scientists have learned a great deal about human genes, but the real work—translating that knowledge into viable new drugs—has only recently begun. So far, millions of people have benefited from medicines and vaccines developed through biotechnology, and several hundred new biotechnologically derived medicines are currently in the pipeline. These new medicines, all of which are in human clinical trials or awaiting FDA approval, include drugs for cancer, infectious diseases, autoimmune diseases, neurological disorders, and HIV/AIDS and related conditions. Other new technologies, such as regenerative therapy using stem cell research, also will allow the natural healing process to work faster or will enable the re-growth of missing or damaged tissue.

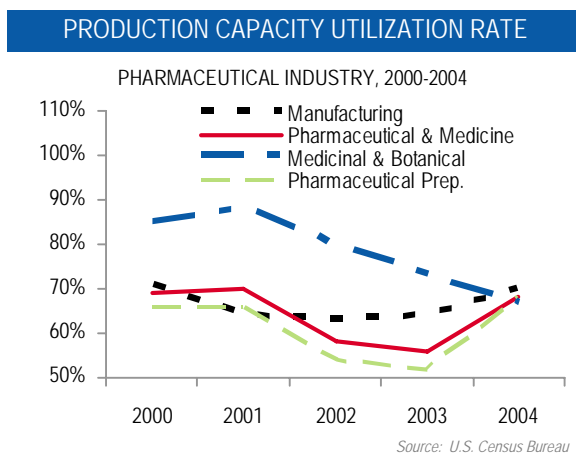
Although the use of drugs, particularly antibiotics and vaccines, has helped to eradicate or limit a number of deadly diseases, many others, such as cancer, Alzheimer's, and heart disease, continue to elude cures. Ongoing research and development and the manufacture of new products to combat these diseases will continue to contribute to employment growth.

Because so many of the pharmaceutical and medicine manufacturing industry's products are related to preventive or routine healthcare rather than just illness, demand is expected to increase as the population expands. The growing number of older people who will require more healthcare services will further stimulate demand. Furthermore, the anticipated continued growth of both the public and the private health insurance programs will allow for augmented coverage of the cost of drugs and medicines. Therefore, demand for drugs and medicines will further increase as insurance programs continue to enhance coverage of patients' needs.

One final noteworthy factor propelling demand in the industry is the increasing popularity of "lifestyle" drugs. These medicines are designed to treat the symptoms of chronic non-life-threatening conditions resulting from aging or genetic predisposition. Other factors expected to increase the demand for drugs include greater personal income and the rising health consciousness and expectations of the general public.

## Capacity

The pharmaceutical industry has been operating at approximately the same percentage of total production capacity as the overall national manufacturing industry. The only sub-sector that has performed differently has been the medicinal and botanical manufacturing sector. This sector experienced an increase of production from 2000 to 2001 before peaking and beginning a steady drop-off in production through 2004. The other sub-sectors also experienced a drop in capacity utilization after 2001 but were able to recover to near 2000 levels by 2004. The pharmaceutical industry is showing signs of increasing capacity utilization in recent years, an indication of strong future growth.



## Breakdown of Production Inputs

Total production inputs for the pharmaceutical industry declined 21.4% from 1997 to 2002. The sizeable decline can be largely attributed to the large decrease in the cost of raw materials such as flower, grains, seeds, and other agricultural products. One of the largest increases in costs for the industry was seen in the cost of vitamins, which increased 233% from 1997 to 2002. The increasing output in pharmaceutical manufacturing coupled with the decreasing cost of inputs provides an indication that the industry is increasing productivity and efficiency.

MEDICINAL AND BOTANICAL MANUFACTURING INPUTS		
Input	Delivered Costs (\$1,000)	
	1997	2002
Total materials	\$4,997,852	\$3,929,302
All other bulk medicinal and botanical uncompounded drugs	7.7%	13.2%
Vitamins, natural & synthetic, human & veterinary use (bulk)	4.5%	11.2%
All other materials/components/parts/containers/supplies	ND	6.6%
Other synthetic organic chemicals	3.1%	6.0%
Vitamins, natural and synthetic, for animal feeds (bulk)	0.7%	3.1%
Materials, ingredients, containers, and supplies, nsk	9.8%	2.1%
Agricultural products, crude (flowers, grains, seeds, etc.)	4.2%	0.8%
Plastics containers	0.4%	0.7%
Paperboard containers, boxes, and corrugated paperboard	0.6%	0.5%
Gelatin (pharmaceutical grade) and gelatin capsules	0.3%	0.3%

Source: Census; Top Ten Costs of Inputs; NAICS 325411

## Geographic Concentration

### National Pharmaceutical Manufacturing Industry Cluster Distribution 2004

The pharmaceutical manufacturing industry is heavily concentrated in the New England region of the East Coast. Other cities that have a strong cluster presence are Denver, San Diego, and Grand Rapids, MI, with minimal employment dispersed throughout the Southwest.



### National Pharmaceutical Manufacturing Industry Growth Distribution 1995-2004

Growth in the industry, however, is seen primarily in Los Angeles and San Diego on the West Coast, San Antonio and Houston in the Midwest, and large parts of New York, New Jersey, Massachusetts, and Connecticut on the East Coast. Like other advanced manufacturing sectors, the larger share of growth is occurring outside of the traditional high cost Northeast locations.



## Conclusion

This report presents a compelling case for viewing advanced manufacturing as a growth industry, one that provides high wages, a large economic impact, and significant opportunities for local economies. While the manufacturing industry has suffered in recent years, the potential for future growth and domestic relocation is high. Given the Centralina region's depth of manufacturing industries and workforce, advanced manufacturing is a natural target for the area, one that will bring collaboration between educational institutions, economic developers, workforce development agencies, the broader public sector, and private sector firms large and small.

A strategy to capture these opportunities will require well-planned collaboration among the area's many economic development stakeholders:

- Department of Commerce
- Community College System
- Universities
- North Carolina Military Business Center
- Small Business Centers
- Regional Partnership
- City and County Economic Developers
- Chambers of Commerce
- Small Business Technology Development Centers
- Utilities
- Industry Associations
- Workforce Developers

Subsequent reports from this study will offer new intelligence and ideas to guide these initiatives.

Our next report will examine regional factors that will influence the relocation and expansion of manufacturing companies. AngelouEconomics and RTI will assess regional resources and provide information on the niche sectors that exist locally, strengths and weaknesses these firms are facing, and recommend focus for the future. The targets will contain those industries that are expected to experience high future demand and can be supported by the current industry base, economic strengths, and research assets.

Once advanced manufacturing niche sectors have been identified, we will provide a strategy for sustaining and encouraging industry growth through the development of an Advanced Manufacturing Center in the Region. The project team will identify opportunities to nurture and support industry development in order to ensure that the entire nine-county region benefits from this growth.

These steps will be followed by a specific implementation and evaluation plan. We will provide recommendations for the structure of this center, guidelines for involvement and collaboration, and a system for evaluating and monitoring the effectiveness of the Center and the strategy formulated through this plan.

We look forward to your continued participation.

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