

HIGH-TECHNOLOGY ACTIVITIES IN ARIZONA

September 2003



ARIZONA DEPARTMENT OF COMMERCE

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Prepared by

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September 2003

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HIGH-TECHNOLOGY ACTIVITIES IN ARIZONA

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INTRODUCTION

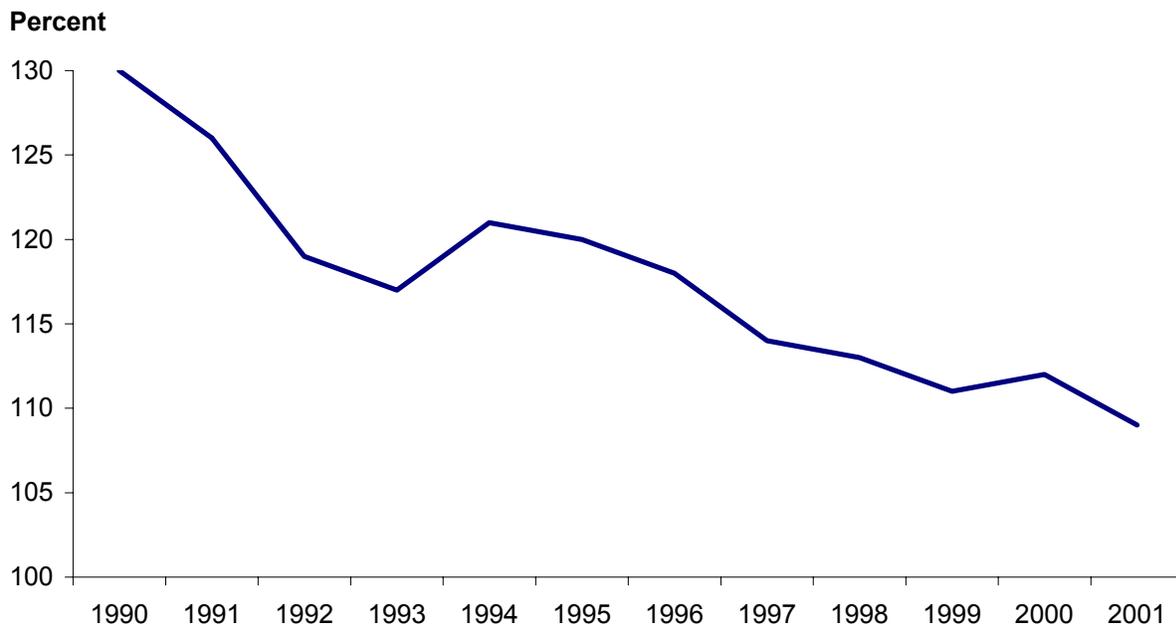
This report was commissioned by the Arizona Department of Commerce on behalf of the Governor's Council for Innovation and Technology. The information will be used to assist in the preparation of the state's plan for improving Arizona's business climate in support of technology industries. The report has four primary components:

- Define Arizona's high-technology activities using the North American Industry Classification System (NAICS).
- Describe high-technology activities in Arizona using the latest data (2001) on employment and payroll.
- Analyze the change in high-technology activities between 1990 and 2001.
- Estimate the economic impact of high-technology activities.

SUMMARY

The concentration of high-technology activities in Arizona declined between 1990 and 2001. Arizona no longer has a high-technology presence much different than the national average. However, since high-technology activities primarily are export-oriented (selling most of their output to customers from outside the state), high-tech's economic impact is considerable.

PER PERSON EMPLOYMENT IN HIGH-TECHNOLOGY ACTIVITIES IN ARIZONA AS A RATIO TO THE NATIONAL AVERAGE

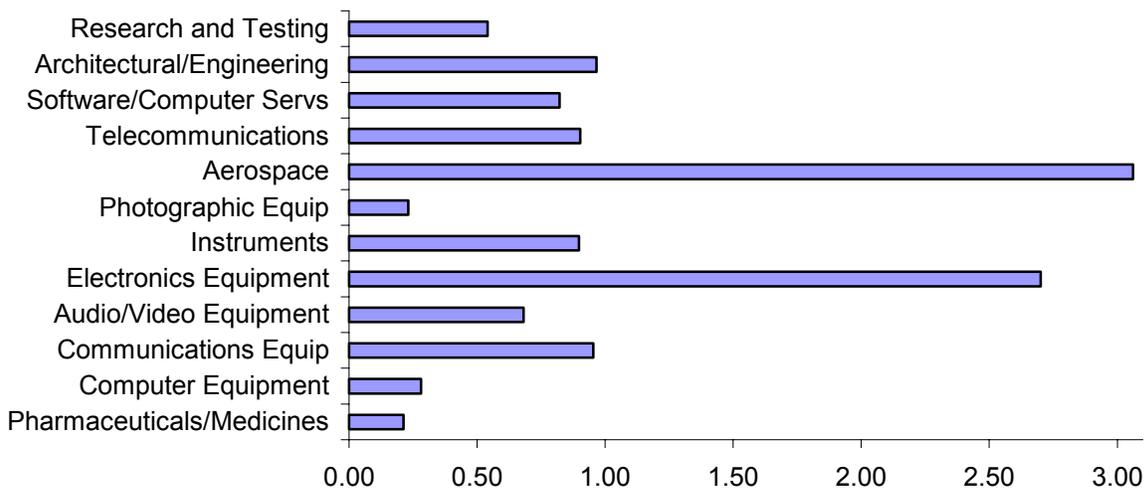


Employment in high-technology activities rose a little more in Arizona than the national average between 1990 and 2001, but the state’s population growth and employment growth in other sectors was even greater, causing Arizona’s high-tech concentration to fall. Per capita employment in high-technology activities in Arizona decreased from 30 percent higher than the national average in 1990 to 9 percent more in 2001.

Based on payroll, Arizona’s high-technology activities expanded less rapidly than the national average over the 11 years. Thus, the downward trend in Arizona’s high-technology concentration was more precipitous based on payroll, with per capita payroll dropping from 26 percent higher than the national average in 1990 to 4 percent lower in 2001.

Arizona has a narrow base of high-technology activities. Only two of 12 high-tech categories — manufacturing of aerospace products and of semiconductors and other electronic components — had a greater relative presence in Arizona (a figure greater than 1 in the following chart) than the national average in 2001. In the past, two other categories (communications equipment and instruments) also had an above average concentration in Arizona.

**PER PERSON EMPLOYMENT IN ARIZONA
RELATIVE TO NATIONAL AVERAGE
High-Technology Activities, 2001**



Geographically, high-technology activities are highly concentrated in the state’s two large urban areas. In 2001, the Phoenix area had above average activity in several categories, though only the aerospace and electronics categories were much above the national average. The Tucson area’s activity was highly focused in the aerospace category.

The gross contribution of high-technology activities to the Arizona economy can be assessed by using conventional input-output models to calculate the economic impacts of total employment in this sector. This kind of calculation suggests that, when multiplier effects are included, high-tech activities can account for 19 percent of employment, 23 percent of value added (gross state product) and 25 percent of earnings in Arizona.

An economic impact analysis by county indicates that high-technology activities accounted for 22 percent of employment, 25 percent of value added and 28 percent of earnings in Maricopa County in 2001. In Pima County, high tech accounted for 19 percent of employment, 23 percent of value added and 27 percent of earnings. High-tech activities are much less significant in other counties. In no other county does high tech account for more than 6 percent of employment or more than 8 percent of earnings.

DEFINITION OF HIGH-TECHNOLOGY ACTIVITIES

Multiple efforts to define high-technology activities have been made by different groups using the Standard Industrial Classification (SIC). (The SIC has a hierarchical structure, with 10 divisions divided into a number of two-digit major groups, which are further subdivided into three-digit industry groups and four-digit industries.) Seven definitions made since 1998 were reviewed, each using three-digit SIC industry groups as the building blocks of a high-technology group:

- U.S. Bureau of Labor Statistics (BLS): “High-Technology Employment: A Broader View,” *Monthly Labor Review*, June 1999. Based on research and development (R&D) and technology-oriented employment, the BLS identified 12 high-technology intensive industry groups and another 19 high-technology groups. (Joe Esher at the University of Arizona used the list of 31 groups as the basis for the Industry Cluster Analysis.)
- U.S. Department of Commerce: *The Emerging Digital Economy*, June 1999. Based on judgment, 14 industry groups were selected.
- American Electronics Association (AEA): *Cyberstates 4.0*. Eleven industry groups were selected, based on judgment.
- RFA: Eleven industry groups were included based on judgment.
- Milken Institute: *America’s High-Tech Economy*, July 1999. Fourteen industry groups were considered to spend an above-average amount of revenue on R&D and employ an above industry-average number of technology-using occupations.
- National Science Foundation: *Science and Engineering Indicators*, 1998. A short list of six manufacturing industry groups with high R&D spending was created.
- One Source Information Services: A long list of 48 industry groups were classified as high-technology.

The more extensive lists of industry groups from the BLS and One Source include a number of activities not generally considered to be high technology. The shorter BLS list and the lists from the other five sources were compared. Any industry group appearing on more than one list was included in the definition of high technology used for this project. One exception was made: engineering and architectural services was included though it appeared only on the Milken list (it also was on the long lists of the BLS and One Source). The result was a list of 16 three-digit SIC industry groups (in two of these industry groups, a four-digit industry was omitted), which were aggregated into 12 high-technology categories.

The SIC is being replaced by the North American Industry Classification System (NAICS). Like the SIC, the NAICS is hierarchical, increasingly detailed from two-digit sectors to three-digit subsectors to four-digit industry groups to five- and six-digit industries. Using Appendix B of the NAICS manual, which matches SIC codes to NAICS codes, a list of high-technology activities based on NAICS was developed. In the drug manufacturing and photographic equipment categories, the NAICS definition exactly matched that based on the SIC. Otherwise, a three-digit SIC industry group usually could be closely correlated to a four-digit NAICS industry group or a six-digit NAICS industry. The exceptions were engineering and architectural services, and research, development and testing services (see Table 1 for the description of these categories) — caution should be exercised in comparing 1997 or earlier data to subsequent data.

**TABLE 1
COMPONENTS OF HIGH-TECHNOLOGY ACTIVITIES
BY STANDARD INDUSTRIAL CLASSIFICATION AND NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM**

SIC	SIC Description	NAICS	NAICS Description
283	Manufacturing of Drugs	3254	Pharmaceutical and Medicine Manufacturing
357 except 3579	Manufacturing of Computer and Office Equipment (except Office Machines not elsewhere classified)	3341 and 333313	Computer and Peripheral Equipment Manufacturing and Office Machinery Manufacturing
365	Manufacturing of Household Audio and Video Equipment	3343 and 51222	Audio and Video Equipment Manufacturing and Integrated Record Production and Distribution
366	Manufacturing of Communications Equipment	3342	Communications Equipment Manufacturing
367	Manufacturing of Electronic Components and Accessories	3344	Semiconductor and Other Electronic Component Manufacturing
372 and 376	Manufacturing of Aircraft and Parts and Manufacturing of Guided Missiles and Space Vehicles and Parts	3364	Aerospace Product and Parts Manufacturing
381, 382 and 384	Manufacturing of Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems, Instruments and Equipment; Manufacturing of Laboratory Apparatus and Analytical, Optical, Measuring, and Controlling Instruments; and Manufacturing of Surgical, Medical and Dental Instruments and Supplies	3345, 3391 and 333314	Navigational, Measuring, Electromedical and Control Instruments Manufacturing; Medical Equipment and Supplies Manufacturing; and Optical Instrument and Lens Manufacturing
386	Photographic Equipment and Supplies	325992 and 333315	Photographic Film, Paper, Plate and Chemical Manufacturing and Photographic and Photocopying Equipment Manufacturing
481 and 489	Telephone Communications and Communication Services not elsewhere classified	5133	Telecommunications
737 except 7377	Computer Programming, Data Processing, and Other Computer Related Services except Computer Rental and Leasing	3346, 5112, 514191, 5142, 5415 and 811212	Manufacturing and Reproducing Magnetic and Optical Media; Software Publishers; On-Line Information Services; Data Processing Services; Computer Systems Design and Related Services; and Computer and Office Machine Repair and Maintenance

(continued)

TABLE 1 (continued)
COMPONENTS OF HIGH-TECHNOLOGY ACTIVITIES
BY STANDARD INDUSTRIAL CLASSIFICATION AND NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM

871	Engineering, Architectural, and Surveying Services	5413 except 54138	Architectural, Engineering and Related Services except Testing Laboratories
873	Research, Development and Testing Services	54138 and 5417	Testing Laboratories and Scientific Research and Development Services
-	-	333295	Semiconductor Machinery Manufacturing
-	-	54162	Environmental Consulting Services
-	-	54169	Other Scientific and Technical Consulting Services

Source: The list of SIC activities was derived from the sources described in the text. The SIC was matched to NAICS using Appendix B of the *North American Industry Classification System* manual produced by the U.S. Office of Management and Budget, 1997.

In addition to this matching process, three additional NAICS industries (all small in size) were considered to be high-technology activities. By SIC these activities cannot be isolated because of their inclusion with a multitude of activities in “not elsewhere classified” industries.

County Business Patterns, an annual product of the U.S. Bureau of the Census, is the only source of detailed sectoral data for states and counties. It excludes government and a few private-sector activities (such as crop and animal production and rail transportation). Data were reported by SIC through 1997 and by NAICS from 1998 through the latest data for 2001. The number of establishments, employment and payroll are reported for the full detail of the SIC or NAICS, but the employment and payroll data frequently are withheld to avoid violating federal disclosure limitations. These undisclosed data were estimated for this project.

To provide a historical background, data from 2001 were compared to 1990, a comparable year within the economic cycle. Annual data were collected for the state and nation, but the data collection at the county level was limited to 1990 and 2001.

DESCRIPTION OF HIGH-TECHNOLOGY ACTIVITIES IN ARIZONA

Arizona

Establishments, Employment and Payroll in 2001

Based on all three measures of size reported in *County Business Patterns* — number of establishments, employment, and payroll — the largest high-technology category in Arizona in 2001 was software and computer services (see Table 2A). Semiconductor and other electronic component manufacturing was second largest based on employment and payroll, followed by aerospace product and parts manufacturing. These two categories were dominated by establishments with a large number of employees; the number of establishments in each was relatively few. Telecommunications and architectural, engineering and related services were among the top five on all three measures.

As a share of private-sector employment counted in *County Business Patterns*, the high-technology activities as a whole accounted for 5.5 percent of the state’s establishments, 8.3 percent of its employment, and 14.7 percent of its payroll. Thus, the average high-technology establishment size (27 workers) is greater than the private-sector average (17 workers) and the average payroll per employee in high tech is considerably higher than the all-sector average.

At about \$54,400, the average high-technology payroll per employee in 2001 was 77 percent higher than the private-sector total of \$30,700. Five high-tech categories — all of moderate-to-large size — had a figure in excess of \$55,000: aerospace manufacturing, communications equipment manufacturing, electronic component manufacturing, instruments manufacturing, and software/computer services.

Arizona’s high-technology activities account for a greater share of total private-sector activity than the national average on each of the three measures of size. In 2001, the high-technology

share in Arizona as a ratio to the national high-technology share was 1.10 based on number of establishments, 1.20 calculated on employment, and 1.22 measured by payroll.

TABLE 2A
SUMMARY OF ARIZONA'S HIGH-TECHNOLOGY ACTIVITIES
BY CATEGORY, 2001

	Number of		First Quarter		Payroll per
	Establishments	Employment	In Thousands	Employment per	Payroll per
				Establishment	Employee
Software/Computer Services	2,101	34,314	\$474,778	16	\$55,345
Electronic Components Mfg	150	30,358	440,454	202	58,035
Aerospace Mfg	66	25,641	419,446	389	65,434
Architectural/Engineering Services	2,051	21,378	231,297	10	43,278
Telecommunications	815	21,224	245,840	26	46,332
Instruments Mfg	315	13,056	183,037	41	56,078
Research and Testing Services	326	4,893	58,547	15	47,862
Communications Equipment Mfg	39	4,788	75,995	123	63,488
Computer Equipment Mfg	51	1,147	12,038	22	41,981
Pharmaceuticals/Medicines Mfg	27	924	10,530	34	45,584
Audio/Video Equipment Mfg	12	476	3,806	40	31,983
Photographic Equipment Mfg	17	212	1,398	12	26,377
HIGH-TECHNOLOGY SUBTOTAL	5,970	158,411	2,157,166	27	54,470
Other High Technology	476	2,755	34,013	6	49,384
HIGH-TECHNOLOGY TOTAL	6,446	161,166	2,191,179	25	54,383
Other than High Technology	109,858	1,780,433	12,714,060	16	28,564
PRIVATE-SECTOR TOTAL	116,304	1,941,599	14,905,239	17	30,707

Notes:

Employment is expressed as of the week including March 12 and includes part-time employees.

Payroll per employee is calculated as first quarter payroll divided by employment, times four.

Employment and payroll figures were estimated for 2001 in the communications equipment, computer equipment, and audio/video equipment categories.

Source: Calculated from U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*, 1990 through 2001.

TABLE 2B
SUMMARY OF ARIZONA'S HIGH-TECHNOLOGY ACTIVITIES
BY CATEGORY, 1990 TO 2001 PERCENT CHANGE

	Number of Establishments	Employment	Payroll	Employment per Establishment	Payroll per Employee
Software/Computer Services	329%	447%	637%	28%	35%
Electronic Components Mfg	-4	12	76	16	58
Aerospace Mfg	6	-9	24	-15	36
Architectural/Engineering Services	89	102	132	7	15
Telecommunications	189	71	81	-41	6
Instruments Mfg	176	2	15	-63	13
Research and Testing Services	57	21	120	-23	82
Communications Equipment Mfg	77	-25	-14	-58	15
Computer Equipment Mfg	24	-66	-69	-73	-9
Pharmaceuticals/Medicines Mfg	125	6	57	-53	49
Audio/Video Equipment Mfg	-8	1	11	9	10
Photographic Equipment Mfg	113	175	142	30	-12
HIGH-TECHNOLOGY SUBTOTAL	139	40	78	-41	27
Other than High Technology	31	58	98	21	25
PRIVATE-SECTOR TOTAL	34	57	95	17	24

Notes:

Employment is expressed as of the week including March 12 and includes part-time employees.

Payroll is for the first quarter.

Payroll per employee is calculated as first quarter payroll divided by employment, times four.

The 1990 to 2001 percent change is inflation-adjusted for payroll and payroll per employee.

The percent change could not be calculated for the "other high technology" category (the three industries identifiable only in the NAICS classification).

Employment and payroll figures were estimated for 2001 in the communications equipment, computer equipment, and audio/video equipment categories and for 1990 in the categories of software/computer services, instruments, computer equipment, audio/video equipment, and photographic equipment.

Source: Calculated from U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*, 1990 through 2001.

This ratio of the concentration of an activity in a local area (such as a state) to the national concentration also is known as the “location quotient.” Calculating location quotients based on sectoral share overstates the concentration of any activity in Arizona since the state’s private sector is small relative to the state’s population. Location quotients also can be calculated based on per capita measures; Arizona’s figures (presented in a later section) are not as high on this basis.

Using employment, Arizona’s sectoral share in 2001 was larger than the national average in four of the 12 high-technology categories. The sectoral shares in the electronic components and aerospace categories were at least three times greater than the national average but were only slightly higher in the architecture/engineering services and communications equipment categories.

The average establishment size in Arizona in 2001 was well above the national average in the electronics and aerospace categories (at more than 200 employees per physical location) and about the same as the national average in communications equipment (an average of 123 workers) and software/data processing (an average of only 16 employees). The overall high-technology figure was 12 percent higher than the national average despite a smaller than average figure in eight of 12 categories.

Nationally, each of the 12 high-technology categories had a payroll per employee figure in excess of \$50,000 in 2001. At nearly \$75,000, the software/data processing category was the only one with a figure greater than \$63,100. Payroll per employee in Arizona in 2001 was between 7 and 11 percent greater than the national average in the aerospace, instruments, and electronics categories. The figure was about average in communications equipment, but below average in the other eight categories (by more than 20 percent in six categories). The Arizona figure was far below the national average, and only about equal to Arizona’s all-sector average, in the audio/video equipment and photographic equipment categories. Overall high-tech payroll per employee in Arizona was 11 percent less than the national average. In the private sector as a whole, Arizona’s average wage was 13 percent less than the national average.

Change in Establishments, Employment and Payroll between 1990 and 2001

The number employed in Arizona’s high-technology activities rose 41 percent between 1990 and 2001, a little more than the national high-tech average of 33 percent, but less than Arizona’s all-sector figure of 57 percent. High-technology employment in Arizona rose faster than the national high-tech average in the 1994-95 period, but growth in the other years since 1990 ranged from a little more to a little less than the national average. Relative to overall employment growth in Arizona, high-tech lagged behind in each year through 1997, but generally increased more than the slowing overall rate from 1998 through 2001.

The inflation-adjusted percent change in Arizona’s high-technology payroll was 78 percent between 1990 and 2001, a little less than the national high-tech average of 84 percent. Overall payroll growth in Arizona was 95 percent. The percentage increase in the number of high-tech establishments was greater in Arizona than nationally, and also was greater than the overall Arizona figure. The average number of employees per high-technology establishment dropped

significantly between 1990 and 2001 nationally and in Arizona. Average high-tech payroll per employee rose 27 percent in Arizona but 39 percent nationally; the private-sector increase in Arizona was 24 percent. As late as 1994, high-tech payroll per employee in Arizona was only 3 percent less than the national average, but was 11 percent less by 2001.

As a share of the private-sector total, high-technology employment in Arizona slipped from 9.1 percent in 1990 to 8.3 percent in 2001; nationally, the share rose during this period. The high-tech share of payroll also dropped in Arizona, from 15.9 to 14.7 percent, while the national share increased. The location quotient based on sectoral share decreased from 1.45 to 1.20 for employment and from 1.56 to 1.22 for payroll.

On each of the three measures, the software/computer services category posted the fastest growth by far between 1990 and 2001 both nationally and in Arizona. The architecture and engineering services and telecommunications categories expanded significantly both nationally and in Arizona. Research and testing services expanded rapidly as well, though employment growth in Arizona was modest. The very small photographic equipment category also expanded rapidly in Arizona, but shrunk considerably nationally. Employment decreased nationally in instruments, computer equipment, audio/video, aerospace, and photographic equipment. In Arizona, the decline was much less than the national average in aerospace but much more in computer equipment. Communications equipment employment also fell in Arizona (see Table 2B).

Payroll per employee in Arizona jumped in the research and testing services category and also rose substantially in electronic components and pharmaceuticals/medicines. Nationally, the average wage gain was considerable in software/computer services and electronic components.

Counties

More than three-fourths of the state's high-technology employees worked in Maricopa County in 2001 — compared to the county's 60 percent share of residents. Of the 12 high-technology categories, the Phoenix area's share exceeded 90 percent in four, including electronic components manufacturing, and topped 75 percent in four others. The notable exceptions were instruments manufacturing and aerospace manufacturing.

Pima County's share of the state's high-technology employment slightly exceeded its 16 percent population share. Close to half of the state's aerospace workers were in the Tucson area. The county also had relatively large shares in two small categories — research and testing and photographic equipment.

Little high-technology employment was located in the other 13 counties (see Table 3A). While these counties account for nearly one-fourth of the state's residents, they have only 5 percent of the high-technology employment (Table 3B). The share is under 20 percent in each category and exceeds 10 percent only in instruments manufacturing and research and testing services.

In 11 counties, high-technology activities accounted for less than 4 percent of private-sector employment in 2001. The share was greater than the state average of 8.3 percent in Pima, Maricopa and Cochise counties.

TABLE 3A
HIGH-TECHNOLOGY EMPLOYMENT BY CATEGORY AND COUNTY, 2001

	ARIZONA	Maricopa	Pima	Balance	Apache	Cochise	Coconino	Gila
Pharmaceuticals/Medicines Mfg	924	899	19	6	0	0	0	0
Computer Equipment Mfg	1,147	930	179	38	0	0	34	0
Communications Equipment Mfg	4,788	4,350	269	169	0	0	2	0
Audio/Video Equipment Mfg	476	432	42	2	0	0	0	0
Electronic Components Mfg	30,358	27,812	2,110	436	59	2	127	12
Instruments Mfg	13,056	8,433	2,813	1,810	0	31	1,186	20
Photographic Equipment Mfg	212	130	73	9	0	0	7	0
Aerospace Mfg	25,641	13,450	12,072	119	0	0	0	0
Telecommunications	21,224	18,154	1,699	1,371	143	146	109	51
Software/Computer Services	34,314	26,761	5,801	1,752	3	1,389	56	23
Architectural/Engineering Services	21,378	17,051	2,928	1,399	11	361	172	69
Research and Testing Services	4,893	2,421	1,591	881	1	372	166	2
HIGH-TECHNOLOGY SUBTOTAL	158,411	120,823	29,596	7,992	217	2,301	1,859	177
Other	2,755	2,291	300	164	0	5	67	3
HIGH-TECHNOLOGY TOTAL	161,166	123,114	29,896	8,156	217	2,306	1,926	180

(continued)

TABLE 3A (continued)
HIGH-TECHNOLOGY EMPLOYMENT BY CATEGORY AND COUNTY, 2001

	Graham	Greenlee	La Paz	Mohave	Navajo	Pinal	S. Cruz	Yavapai	Yuma
Pharmaceuticals/Medicines Mfg	0	0	0	2	2	0	0	2	0
Computer Equipment Mfg	0	0	0	2	0	0	0	2	0
Communications Equipment Mfg	0	0	0	0	0	0	0	167	0
Audio/Video Equipment Mfg	0	0	0	2	0	0	0	0	0
Electronic Components Mfg	0	0	0	60	0	26	123	16	11
Instruments Mfg	0	0	0	208	15	2	108	167	73
Photographic Equipment Mfg	0	0	0	2	0	0	0	0	0
Aerospace Mfg	7	0	0	27	0	0	14	71	0
Telecommunications	20	7	29	335	113	97	20	209	92
Software/Computer Services	6	0	0	32	19	6	10	88	114
Architectural/Engineering Services	28	0	2	140	27	59	11	328	162
Research and Testing Services	0	0	0	31	24	221	19	37	8
HIGH-TECHNOLOGY SUBTOTAL	61	7	31	841	200	411	305	1,087	460
Other	0	0	0	5	28	10	3	24	19
HIGH-TECHNOLOGY TOTAL	61	7	31	846	228	421	308	1,111	479

Note: Employment is expressed as of the week of March 12, 2001 and includes part-time employees. Many of the employment figures were estimated.

Source: Calculated from U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*, 2001.

TABLE 3B
HIGH-TECHNOLOGY EMPLOYMENT BY CATEGORY AND COUNTY
AS A PERCENTAGE OF THE STATE TOTAL, 2001

	Maricopa	Pima	Balance	Apache	Cochise	Coconino	Gila
Pharmaceuticals/Medicines Mfg	97.29%	2.06%	0.65%	0.00%	0.00%	0.00%	0.00%
Computer Equipment Mfg	81.08	15.61	3.31	0.00	0.00	2.96	0.00
Communications Equipment Mfg	90.85	5.62	3.53	0.00	0.00	0.04	0.00
Audio/Video Equipment Mfg	90.76	8.82	0.42	0.00	0.00	0.00	0.00
Electronic Components Mfg	91.61	6.95	1.44	0.19	0.01	0.42	0.04
Instruments Mfg	64.59	21.55	13.86	0.00	0.24	9.08	0.15
Photographic Equipment Mfg	61.32	34.43	4.25	0.00	0.00	3.30	0.00
Aerospace Mfg	52.46	47.08	0.46	0.00	0.00	0.00	0.00
Telecommunications	85.54	8.01	6.46	0.67	0.69	0.51	0.24
Software/Computer Services	77.99	16.91	5.11	0.01	4.05	0.16	0.07
Architectural/Engineering Services	79.76	13.70	6.54	0.05	1.69	0.80	0.32
Research and Testing Services	49.48	32.52	18.01	0.02	7.60	3.39	0.04
HIGH-TECHNOLOGY SUBTOTAL	76.27	18.68	5.05	0.14	1.45	1.17	0.11
Other	83.16	10.89	5.95	0.00	0.18	2.43	0.11
HIGH-TECHNOLOGY TOTAL	76.39	18.55	5.06	0.13	1.43	1.20	0.11
Population	60.20	16.26	23.54	1.29	2.25	2.22	0.97

(continued)

TABLE 3B (continued)
HIGH-TECHNOLOGY EMPLOYMENT BY CATEGORY AND COUNTY
AS A PERCENTAGE OF THE STATE TOTAL, 2001

	Graham	Greenlee	La Paz	Mohave	Navajo	Pinal	S. Cruz	Yavapai	Yuma
Pharmaceuticals/Medicines Mfg	0.00%	0.00%	0.00%	0.22%	0.22%	0.00%	0.00%	0.22%	0.00%
Computer Equipment Mfg	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.17	0.00
Communications Equipment Mfg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.49	0.00
Audio/Video Equipment Mfg	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.00
Electronic Components Mfg	0.00	0.00	0.00	0.20	0.00	0.09	0.41	0.05	0.04
Instruments Mfg	0.00	0.00	0.00	1.59	0.11	0.02	0.83	1.28	0.56
Photographic Equipment Mfg	0.00	0.00	0.00	0.94	0.00	0.00	0.00	0.00	0.00
Aerospace Mfg	0.03	0.00	0.00	0.11	0.00	0.00	0.05	0.28	0.00
Telecommunications	0.09	0.03	0.14	1.58	0.53	0.46	0.09	0.98	0.43
Software/Computer Services	0.02	0.00	0.00	0.09	0.06	0.02	0.03	0.26	0.33
Architectural/Engineering Services	0.13	0.00	0.01	0.65	0.13	0.28	0.05	1.53	0.76
Research and Testing Services	0.00	0.00	0.00	0.63	0.49	4.52	0.39	0.76	0.16
HIGH-TECHNOLOGY SUBTOTAL	0.04	0.00	0.02	0.53	0.13	0.26	0.19	0.69	0.29
Other	0.00	0.00	0.00	0.18	1.02	0.36	0.11	0.87	0.69
HIGH-TECHNOLOGY TOTAL	0.04	0.00	0.02	0.52	0.14	0.26	0.19	0.69	0.30
Population	0.63	0.16	0.37	3.05	1.89	3.56	0.75	3.31	3.11

Note: Employment is expressed as of the week of March 12, 2001 and includes part-time employees. Many of the employment figures were estimated.

Source: Calculated from U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*, 2001.

Between 1990 and 2001, high-technology employment increased 35 percent in Maricopa County, considerably less than the 62 percent rise in all private-sector employment. The Phoenix area experienced strong increases in the software/computer services (428 percent), architectural/engineering services (135), and telecommunications categories (90), but employment fell significantly in the computer equipment (-71), communications equipment (-32), aerospace categories (-31), and instruments (-22).

In Pima County, high-technology employment rose 63 percent, well above the pace in Maricopa County and also greater than the Tucson area's private-sector advance of 40 percent. Large gains were realized in software/computer services (708 percent), instruments (202), research and testing (76), aerospace (43), and architectural/engineering services (28). Only electronic components had a sizable drop in employment (-33).

In the rest of the state, high-technology employment rose 50 percent, about equal to the 52 percent climb in private-sector employment. High-tech categories with significant gains included software/computer services (266 percent), instruments (64), research and testing (46), and architectural/engineering services (35).

CONCENTRATION OF HIGH-TECHNOLOGY ACTIVITIES IN ARIZONA RELATIVE TO NATIONAL AVERAGE

This section summarizes location quotients in Arizona over the 12-year period from 1990 through 2001. The location quotients discussed in this section were calculated from per capita figures rather than from sectoral shares. Arizona's employment location quotient of the 12 high-tech categories combined fell from 1.30 in 1990 to 1.09 in 2001, the lowest value over the 12 years. A greater decrease was experienced in the high-tech location quotient based on per capita payroll — from 1.26 in 1990 to 0.96 in 2001. The location quotient based on per capita establishments also dropped, from 1.05 in 1990 to 0.97 in 2001. Based on these figures, Arizona no longer has a high-technology presence much different than the national average.

Including the three small industries identifiable in the NAICS but not in the SIC (manufacturing of semiconductor equipment, environmental consulting services, and other scientific and technical consulting services), Arizona's overall high-technology location quotient based on per capita employment was 1.08 in 2001, down slightly from 1.13 in 1998, the first year of NAICS data. The remainder of this section is based on the employment location quotient.

Arizona

Only two of Arizona's 12 high-technology categories had a location quotient (LQ) in excess of 1 in 2001: Aerospace manufacturing's LQ was a very high 3.06 and the LQ for semiconductor and other electronic component manufacturing was nearly as high at 2.70. Six of the 12 categories experienced a declining LQ over the 12 years, while four had a rising value.

Categories with Rising Location Quotients

Aerospace Product and Parts Manufacturing: From a low of 2.28 in 1992 and 1993, the LQ climbed considerably, reaching a high of 3.06 in 2001.

Architectural, Engineering and Related Services: The LQ has climbed moderately from a low of 0.76 in 1992 to 0.97 in 2001.

Software and Computer Services: The LQ climbed between 1991 and 1999, from 0.55 to 0.84. The 2001 value was 0.82.

Photographic Equipment Manufacturing: Though rising, the LQ remained very low in 2001 at 0.23. It had been as low as 0.06 in 1990.

Categories with No Trend in Location Quotients

Audio and Video Equipment Manufacturing: The LQ has fluctuated between 0.53 and 0.84, with the 2001 value of 0.68 about equal to that in the early 1990s.

Telecommunications: The LQ has held between 0.8 and 1.0 except for a lower value in 2000. The 2001 value was 0.90.

Categories with Declining Location Quotients

Semiconductor and Other Electronic Component Manufacturing: The LQ exceeded 3 through 1993 but then dropped to a low of 2.55 in 1997. The 2001 value of 2.70 was typical of the period since 1995.

Communications Equipment Manufacturing: The LQ has fluctuated widely over the period, from 0.67 in 1995 to 1.75 in 1990 and 1991. After four consecutive years above 1, the LQ in 2001 was 0.95.

Instruments Manufacturing: The LQ was above 1 through 1998 and as high as 1.4 in 1995 and 1996. The 2001 value of 0.90 was the lowest over the period.

Computer and Peripheral Equipment Manufacturing: The LQ fell substantially during the 1990s from 0.84 in 1990 to 0.29 in 1997, with most of the drop occurring between 1991 and 1992. The 2001 LQ of 0.28 was the lowest over the 12-year period.

Pharmaceutical and Medicine Manufacturing: The very low LQ of 0.21 in 2001 was the lowest over the 12-year period. The highest LQ was 0.47 in 1994.

Testing Laboratories and Scientific Research and Development Services: The 2001 LQ was down to 0.54, the lowest over the 12 years; the 1990 LQ was 0.83.

Counties

Two Arizona counties — Maricopa and Pima — had high-technology location quotients (based on per capita employment) in excess of 1 in 2001. No other county had a figure approaching 1 and only a few categories had a LQ in excess of 1 in any of these 13 counties (see Table 4).

Maricopa County's overall high-technology location quotient was close to 1.4 in 2001, with seven of the 12 categories having a LQ greater than 1. The LQ in two of these categories barely exceeded 1. Only in Arizona's two major categories — aerospace and electronics — was the LQ in the Phoenix area above 1.5.

In Pima County, the overall high-technology location quotient was a little above 1.2, but only four categories had a LQ more than 1, and three of these were less than 1.2. The Tucson area had a strong concentration only in the aerospace category — with a very high LQ of close to 9.

Cochise and Coconino were the only other counties with overall high-technology location quotients greater than 0.3. In Cochise County, the software/computer services and research and testing categories had moderately high location quotients. Cochise was the only county with a location quotient greater than 1.1 in these categories. In Coconino County, the LQ was a high 3.7 in instruments manufacturing, but much of this was due to the activities of one company. The only other LQ greater than 1.1 was for electronic components manufacturing in Santa Cruz County.

The decline in the state's high-technology location quotient between 1990 and 2001 resulted from a drop in Maricopa County from 1.77 to 1.38. Large decreases in LQ occurred in several of the Phoenix area's high-tech categories: computer equipment, communications equipment, electronic components, instruments, and research and testing services. Modest increases were registered in the software/computer services and architectural/engineering services categories.

In contrast to Maricopa County, the overall location quotient rose a little in Pima County, from 1.15 to 1.25, despite a large fall in the LQ for electronic components. Aerospace, instruments, and software/computer services had sizable increases.

Changes in location quotients between 1990 and 2001 were minimal in the 13 less populous counties. The largest changes in the overall high-technology LQ occurred in Apache County, with a decrease from 0.37 in 1990 to 0.12 in 2001, and in Coconino and Santa Cruz counties, which had increases of just more than 0.1.

TABLE 4
PER CAPITA EMPLOYMENT LOCATION QUOTIENTS IN 2001 BY CATEGORY AND COUNTY

	Counties															
	AZ	Mar	Pima	Ap	Coch	Coco	Gila	Grah	Gre	LPaz	Moh	Nava	Pinal	SC	Yava	Yum
Pharmaceuticals/Medicines Mfg	0.21	0.34	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.00
Computer Equipment Mfg	0.28	0.38	0.27	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.00
Communications Equipment Mfg	0.95	1.44	0.33	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	0.00
Audio/Video Equipment Mfg	0.68	1.03	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00
Electronic Components Mfg	2.70	4.11	1.15	0.41	0.01	0.51	0.11	0.00	0.00	0.00	0.18	0.00	0.07	1.47	0.04	0.03
Instruments Mfg	0.90	0.96	1.19	0.00	0.09	3.67	0.14	0.00	0.00	0.00	0.47	0.05	0.00	0.99	0.35	0.16
Photographic Equipment Mfg	0.23	0.24	0.49	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Aerospace Mfg	3.06	2.67	8.87	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.11	0.00	0.00	0.22	0.26	0.00
Telecommunications	0.90	1.28	0.44	0.47	0.28	0.21	0.22	0.14	0.19	0.33	0.47	0.25	0.12	0.11	0.27	0.13
Software/Computer Services	0.82	1.06	0.85	0.01	1.48	0.06	0.06	0.02	0.00	0.00	0.03	0.02	0.00	0.03	0.06	0.09
Architectural/Engineering Services	0.97	1.28	0.81	0.04	0.73	0.35	0.32	0.20	0.00	0.02	0.21	0.06	0.07	0.07	0.45	0.24
Research and Testing Services	0.54	0.44	1.08	0.01	1.83	0.83	0.02	0.00	0.00	0.00	0.11	0.14	0.69	0.28	0.12	0.03
SUBTOTAL	1.09	1.38	1.25	0.12	0.70	0.57	0.13	0.07	0.03	0.06	0.19	0.07	0.08	0.28	0.23	0.10
Other	0.84	1.16	0.56	0.00	0.07	0.92	0.09	0.00	0.00	0.00	0.05	0.45	0.09	0.12	0.22	0.19
TOTAL	1.08	1.37	1.23	0.11	0.69	0.58	0.12	0.07	0.03	0.06	0.19	0.08	0.08	0.28	0.23	0.10

Note : Location quotients of 1.10 or higher are in bold.

Source: Calculated from U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*, 2001.

ECONOMIC IMPACT OF HIGH-TECHNOLOGY ACTIVITIES IN ARIZONA

Methodology

Economic impact analysis traces the full impact, direct and indirect, of an industry on jobs and incomes in a local economy. An industry directly affects an economy by employing workers and paying income to workers and owners. Even more significant are the indirect effects that arise when an industry purchases goods and services from other local businesses, when these suppliers place upstream demands on other producers, when workers either directly or indirectly associated with industry operations spend a portion of their incomes in the local economy and when governments spend new tax revenues. In the end, the cumulative changes in jobs and incomes are a multiple of the initial direct effects.

Economic impacts were estimated using the Arizona module of IMPLAN, an input-output model developed and maintained by the Minnesota IMPLAN Group, Inc. The specific model used was based on IMPLAN's 2000 national economic database. In building the model, trade flows were calculated using IMPLAN's "regional purchase coefficients," which are econometrically derived estimates of the percentage of demand for a specific commodity that is satisfied by local producers. Type SAM (Social Accounting Matrix) multipliers were used with a maximum amount of spending assumed to be recycled. Leakages from the Arizona economy arise from import purchases and saving.

IMPLAN provides estimates of the impact of an activity on local employment, employee compensation (earnings) and value added. Employment consists of both full- and part-time jobs. Employee compensation includes wages, salaries and benefits. Value added is the sum of employee compensation, proprietor income, property income and indirect business taxes. An activity's contribution to gross state product can be measured by its value added. Impacts on state and local tax revenues were calculated outside of IMPLAN. Each activity was assumed to generate tax revenues in a fixed proportion to its value added. The factor used to estimate revenues was the ratio of total Arizona state and local tax revenues in fiscal year 2000 to gross state product.

The economic impacts estimated for each high-technology industry were based on and driven by that industry's total employment. The impacts represent the gross contribution an industry makes to the local economy, not the amount of economic activity that is supported by purchases from out-of-state funds.

Arizona

When both direct and indirect effects are considered, high-technology activities accounted for approximately 19 percent of total employment in Arizona in 2001 (see Table 5). In terms of their full economic impact, the three high-tech categories most important to Arizona's employment were electronic components (accounting for 5.0 percent of employment), aerospace (3.4 percent) and telecommunications (3.1 percent).

The overall employment multiplier for Arizona's high-technology activities was 3.5 in 2001, meaning that each high-technology job supports an additional 2.5 jobs. Employment multipliers are highest in categories with high earnings per worker and high interindustry purchases per

**TABLE 5
ECONOMIC IMPACT OF HIGH-TECHNOLOGY ACTIVITIES ON THE ARIZONA ECONOMY IN 2001**

	Direct Effects			Total Effects			
	Employment	Value Added	Employee Compensation	Employment	Value Added	Employee Compensation	Tax Revenues
Pharmaceuticals/Medicines Mfg	924	\$115.0	\$51.5	3,252	\$241.0	\$128.4	\$19.9
Computer Equipment Mfg	1,147	101.0	89.3	5,378	335.2	236.6	27.6
Communications Equipment Mfg	4,788	523.6	291.5	24,452	1,669.1	1,012.9	137.5
Audio/Video Equipment Mfg	476	25.1	21.7	1,396	75.0	52.9	6.2
Electronic Components Mfg	30,358	4,287.2	2,692.7	141,863	10,410.1	6,459.3	857.8
Instruments Mfg	13,056	952.5	871.7	45,122	2,710.4	1,965.9	223.3
Photographic Equipment Mfg	212	11.1	8.6	920	50.5	33.1	4.2
Aerospace Mfg	25,641	2,221.7	1,800.5	95,897	6,071.8	4,222.8	500.3
Telecommunications	21,224	2,726.1	1,127.2	87,209	6,297.7	3,317.3	518.9
Software/Computer Services	34,314	2,279.5	1,827.2	75,525	4,483.8	3,168.8	369.5
Architectural/Engineering Services	21,378	1,032.4	856.8	59,217	2,924.3	2,034.6	241.0
Research and Testing Services	4,893	157.8	142.5	9,590	416.3	296.1	34.3
HIGH-TECHNOLOGY SUBTOTAL	158,411	14,433.1	9,781.2	549,823	35,685.0	22,928.5	2,940.4

Note: Dollar values are in millions.

Source: Center for Business Research, L. William Seidman Research Institute, W. P. Carey School of Business, Arizona State University.

worker. For Arizona's high-tech categories, the largest employment multipliers (greater than 4.5) were in communications equipment, computer equipment, and electronic components. Employment multipliers were less than 2.5 in research and testing and software/computer services.

The direct and indirect effects of high-technology activities accounted for about 23 percent of Arizona's value-added (gross state product) in 2001. The three categories accounting for the largest shares were electronic components (6.7 percent), telecommunications (4.0 percent) and aerospace (3.9 percent).

The value-added multiplier for high-technology activities as a whole was 2.5 in 2001. Value-added multipliers tend to be highest in categories that place heavy demands on local suppliers in other industries and where earnings account for a large share of value added. Labor intensity is important because in regional input-output models labor income is assumed to be recycled within the local economy while capital income is not. Industries with relatively high value-added multipliers (greater than 3.1) in 2001 were photographic equipment, computer equipment, and communications equipment. Industries with low value-added multipliers (less than 2.1) were pharmaceutical manufacturing and software/computer services.

Including multiplier effects, high-tech activities accounted for roughly 25 percent of total earnings in Arizona in 2001. The three most important categories were electronic equipment (7.2 percent), aerospace (4.7 percent) and telecommunications (3.7 percent).

High-technology activities in Arizona had an overall earnings multiplier of 2.3 in 2001. Earnings multipliers are highest in industries with large interindustry purchases per dollar of earnings. Categories with high earnings multipliers (greater than 2.6) included photographic equipment, communications equipment, and telecommunications. Those with low earnings multipliers (less than 2.1) were software/computer services and research and testing.

Because of the way revenues were estimated, high-technology activities accounted for the same share of state and local tax revenues as of value added, 23 percent.

Counties

Economic impacts were estimated at the county level for industries with "significant" employment. County employment in an industry was considered significant if it exceeded 500 or was at least 100 with a location quotient of at least 0.75.

Maricopa County had a significant amount of employment in 11 of the 12 high-technology categories. When multiplier effects are included, these activities accounted for 22 percent of employment, 25 percent of value added and 28 percent of total earnings in the county.

Pima County had a significant amount of employment in seven high-technology categories. Together, these categories had an economic impact equal to 19 percent of county employment, 23 percent of value added and 27 percent of county earnings.

No other county in Arizona had significant employment in more than two high-technology industries (see Table 6). Counties with two significant industries included Cochise, Coconino and Santa Cruz. Yavapai County had one high-tech industry with significant employment. As a percent of total county employment, the economic impacts of significant high-tech industries in these counties ranged from 1 percent in Yavapai County to 6 percent in Cochise County. When measured by earnings, the contributions of significant high-tech activities ranged from 1 percent in Yavapai County to 8 percent in Cochise County.

TABLE 6
ECONOMIC IMPACT OF SELECTED HIGH-TECHNOLOGY ACTIVITIES
BY COUNTY IN 2001

	Direct Effects			Total Effects		
	Employment	Value Added	Employee Compensation	Employment	Value Added	Employee Compensation
Cochise County						
Software/Computer Services	1,389	\$77.7	\$62.4	2,593	\$138.2	\$98.2
Research and Testing Services	372	10.0	8.4	627	22.4	15.9
Total	1,761	87.8	70.8	3,220	160.6	114.1
Coconino County						
Instruments Mfg	1,186	69.8	58.9	3,448	167.5	120.5
Research and Testing Services	166	4.9	4.0	281	9.9	7.1
Total	1,352	74.7	62.9	3,729	177.4	127.6
Maricopa County						
Pharmaceuticals/Medicines Mfg	899	110.9	49.6	3,023	234.0	124.4
Computer Equipment Mfg	930	75.7	65.3	4,141	263.5	183.4
Communications Equipment Mfg	4,350	535.0	303.0	22,563	1,633.2	993.7
Audio/Video Equipment Mfg	432	23.5	20.3	1,241	69.6	49.1
Electronic Components Mfg	27,812	4,033.5	2,531.5	125,293	9,673.9	5,997.8
Instruments Mfg	8,433	661.9	612.2	28,706	1,838.7	1,344.5
Aerospace Mfg	13,450	1,134.0	929.8	48,608	3,171.5	2,214.6
Telecommunications	18,154	2,332.2	965.3	71,291	5,371.9	2,829.2
Software/Computer Services	26,761	1,838.3	1,484.3	57,643	3,575.8	2,537.9
Architectural/Engineering Services	17,051	868.8	724.9	46,498	2,427.8	1,699.9
Research and Testing Services	2,421	79.0	67.9	4,542	197.9	141.4
Total	120,693	11,692.7	7,753.9	413,550	28,457.9	18,115.9

(continued)

TABLE 6 (continued)
ECONOMIC IMPACT OF SELECTED HIGH-TECHNOLOGY ACTIVITIES
BY COUNTY IN 2001

	Direct Effects			Total Effects		
	Employment	Value Added	Employee Compensation	Employment	Value Added	Employee Compensation
Pima County						
Electronic Components Mfg	2,110	\$258.0	\$162.3	8,489	\$572.3	\$354.3
Instruments Mfg	2,813	175.0	157.0	7,840	420.3	306.4
Aerospace Mfg	12,072	1,115.3	885.9	39,343	2,446.3	1,705.0
Telecommunications	1,699	231.2	95.3	6,471	459.7	236.7
Software/Computer Services	5,801	359.2	280.8	11,793	648.3	455.4
Architectural/Engineering Services	2,928	126.8	103.8	7,425	325.4	225.4
Research and Testing Services	1,591	60.5	51.0	3,091	131.6	94.3
Total	29,014	2,326.0	1,736.1	84,453	5,003.9	3,377.5
Santa Cruz County						
Electronic Components Mfg	123	8.1	6.2	385	20.5	13.8
Instruments Mfg	108	4.5	3.9	248	10.6	7.6
Total	231	12.6	10.2	633	31.1	21.4
Yavapai County						
Communications Equipment Mfg	167	13.5	7.5	579	30.6	17.9
Total	167	13.5	7.5	579	30.6	17.9

Note: Dollar values are in millions.

Activities shown are those with employment of at least 100 and, if less than 500, a location quotient of at least 0.75.

Source: Center for Business Research, L. William Seidman Research Institute, W. P. Carey School of Business, Arizona State University.