ADVANCED ELECTRONICS AND RELATED INDUSTRIES

APRIL 2004

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INTRODUCTION

INTRODUCTION

The American Electronics Association (AEA, 2002) produces an annual Cyberstates report on "the high technology industry." That report summarizes establishment, job, and financial statistics on advanced electronics manufacturing and related service industries for the 50 states, the District of Columbia, and Puerto Rico. It also has charted trends on some of the same subjects. Even a brief perusal of the report demonstrates that this is a large, multi-billion dollar industry that is growing.

This report provides more detailed information about the industry in Ohio and compares the state with others and the nation. The report has four major sections after this introduction. The first concerns the industry in Ohio, noting the leading companies, foreign and domestic, as well as recent expansions and newcomers. The composition and distribution of the industry in Ohio are described. The second compares the industry characteristics in Ohio with other states and the nation. The third summarizes analysts' views of the current situation and their expectations for the future. Last, an appendix with detailed statistics, technical terms, and references is provided for readers wanting a more in-depth understanding of this important industry. The charts and tables appearing in the first three sections are based on the appendix tables.

The tables, graphs and discussions herein are based on, and refer to, statistics collected primarily by the U.S. Bureau of the Census. Statistics from the U.S. Bureau of Labor Statistics and private sector sources are also used.

EXECUTIVE SUMMARY

- Approximately 182,000 Ohio workers are employed in advanced electronics and related industries; about four-fifths of them work in the service clusters: computer services, telecommunications, and tech.

- 100 companies on Fortune magazine's U.S. 1,000 or Global 500 lists have establishments in Ohio that are part of this industry.

- SBC Communications is the largest industry employer in Ohio with 6,800 workers; NASA-Glenn follows with 6,100; 25 more companies have at least 1,000 employees in the state.

- 50 foreign companies from 13 nations have industry subsidiaries in Ohio; 16 of the companies are on Fortune's Global 500 list.

- Altogether, the foreign-based companies employ over 11,400 people; Honda is the largest industry employer with 2,500 people working at its Transportation Research Center.

- Even though industry employment is generally not concentrated in Ohio, there are a number of individual industries and groups with over 10,000 workers: semiconductors and electronic components; electronic instruments; wired telecommunications carriers; engineering services; custom computer programming; and computer system design.

- Manufacturing establishments were located in 57 counties in 2001, but the majority could be found in seven: Cuyahoga, Franklin, Hamilton, Lake, Lucas, Montgomery, and Summit. Similarly, the counties with the greatest number of manufacturing jobs summing to the majority include Cuyahoga, Franklin, Lake, Montgomery, and Richland.

- Establishments on the service side of the industry were far more numerous and, collectively, located in every county. However, the counties with the most in 2001 were Cuyahoga, Franklin, Hamilton, Montgomery and Summit. Far and away, the largest number of service side jobs clustered in just three counties: Cuyahoga, Franklin and Hamilton.

- As judged by value added, an average of 4.1 percent of the nation's communications equipment has been made in made in Ohio during recent years, ranking the state 6th. The manufacture of computers and other electronic products is a multi-billion dollar industry in Ohio, but it is not concentrated here.

- Microchips are at the heart of the advanced electronics industry; they are integral parts of computers and myriad other electronic products. Their increasing power, sophistication, and diversity of use are credited with boosting labor productivity and American economic expansion, most notably in the last half of the 1990s.

- The percentage of American households with personal computers (PCs) rose from 22 to 59 between 1993 and 2002.

- The Internet has evolved from a military data and communications network to a decentralized communications network of host computers at various sites. No one owns the Internet, and no central authority oversees it or can track its traffic. Consequently, entry barriers to it are low, and participants - both organizations and individuals - have increased over 1,600 fold from 1995 to 2002.

- The ability to digitize audio and video signals and the development of high-speed/higher-capacity network equipment have broken down barriers between network equipment, telecommunications, and cable TV companies. The Telecommunications Act of 1996 and other legal changes allow these industries to enter one another's business.

- The demand for software (and the programming skills to use it) grows as computer use grows. The greater processing power of computers requires more sophisticated software to run them and make use of their capacities.

- There may be an upper limit to the speed, power and cost effectiveness of microchips even with the extension of current technology. Circumventing this limit would require taking experimental technologies from the lab to the factory.

- Independent of business cycles, PC sales are expected to grow at a faster-than-average rate, although slower than they did in the 1990s. The Asia-Pacific market outside of Japan may have the best long-term growth prospects.

- Computer services and participation on the Internet are expected to grow with PC sales. The dollar value of business done on the Internet is expected to quadruple by 2006 from its level in 2002.

HOW ADVANCED ELECTRONICS AND RELATED INDUSTRIES ARE GROUPED:

The Manufacturing Cluster:

2002 NAICS Code	Group Title - Number of Individual Industries
3341	Computers & Peripheral Equipment - 4
3342	Communications Equipment - 3
3343	Audio and Video Equipment - 1
3344	Semiconductors and Electronic Components - 9
3345(p)	Navigational, Measuring, Medical, Control Instruments (part) - 9

The Computer Services Cluster:

2002 NAICS Code	Title - Number of Individual Industries
5112	Software Publishers - 1
518 (5142 & 5419p in 1997)	Internet Service Providers, Search Portals, and Data Processing - 3
5415	Computer Systems Design and Related Services - 4
61142	Computer Training - 1

Telecommunications:

2002 NAICS Code	Title - Number of Individual Industries
517 (51322 & 5133 in 1997)	Telecommunications - 7

The Tech Cluster:

2002 NAICS Code	Title - Number of Individual Industries
54133	Engineering Services - 1
54138	Testing Laboratories - 1
54171	Physical, Engineering, and Biological Research - 1

INDUSTRY DEFINITION

Many of the nation's economic statistics are now gathered and published according to the North American Industry Classification System (NAICS). Establishments producing goods or providing services sufficiently alike are classified in the same *industry* and assigned a six-digit NAICS code. Closely related industries form an *industry group*. The first four digits of the six-digit code indicate the group to which the industries belong. (Industries with the first five digits in common may be thought of as a *subgroup*.) Industry groups with more abstract elements in common comprise a *major industry*. The first three digits of the NAICS code indicate the major industry.[1]

Advanced electronics and related industries are divided into four *clusters*: one manufacturing and three service - computer services, telecommunications, and tech. The manufacturing cluster includes five of the six industry groups in the major industry Computers and Electronic Products (NAICS 334) - these are listed on the opposing page. The group Manufacturing and Reproducing Magnetic and Optical Media (NAICS 3346) is excluded, as is Watches, Clocks, and Parts (NAICS 334518). Altogether, this cluster includes 26 individual industries.

The service clusters include 19 individual industries selected from five major industries; see the list on the opposing page. All of these industries have in common a heavy reliance on the products from the manufacturing cluster. Without those products, the service clusters industries either would not exist, or the provision of services would be substantially different from their current methods.

The industry definition follows the one used by the American Electronics Association (AEA) for its annual Cyberstates report with a few exceptions. The AEA excludes Watches, Clocks and Parts (NAICS 334518). This report includes it in discussions when it cannot be separated from the group of which it is a part. The AEA includes the manufacture of Optical Instruments, Lenses, Photographic and Photocopying Equipment (NAICS 333314 and 333315), Semiconductor Machinery (the machines used to make semiconductors - NAICS 333295), and Fiber Optic Cables (NAICS 335921). Those industries are excluded from this report because they are not part of Computers and Electronic Products. See the NAICS codes definitions and examples in the Appendix for a more detailed description of what products and services are included and excluded.

DESCRIPTION OF THE INDUSTRY IN OHIO

OHIO'S Advanced Electronics and Related Industries

Establishments employing at least 500 in Ohio's advanced electronics and related industries

Legend

- Establishment Location
- Ohio County

Source:
2004 Harris Ohio Industrial Directory
Harris InfoSource, Twinsburg, Ohio

Prepared by:
Ohio Department of Development,
Office of Strategic Research (March 2004)

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LEADING AND NOTABLE EMPLOYERS

One hundred companies on Fortune magazine's U.S. 1,000 or Global 500 lists have establishments in Ohio's advanced electronics and related industries. The state is world headquarters for a number of these companies: AK Steel, American Electric Power, Cincinnati Bell, Dana, Diebold, Eaton, Ferro, FirstEnergy, Goodyear Tire & Rubber, NCR, Owens Corning, Parker Hannifin, Procter and Gamble, Sherwin-Williams, and Timken. (Many of these names appear because they have engineering, testing, and research and development facilities in Ohio.) Others headquartered in Ohio, but not making the Fortune U.S. 1,000, include the Battelle Memorial Institute (Battelle), Keithley Instruments, Kendle International, Noveon, OCLC (the Online Computer Library Center), and SARCOM. The list of companies in appendix tables A1a-A1e provides information about these and other companies, including the primary 1997 NAICS codes of their establishments, the number of employees, and their locations.

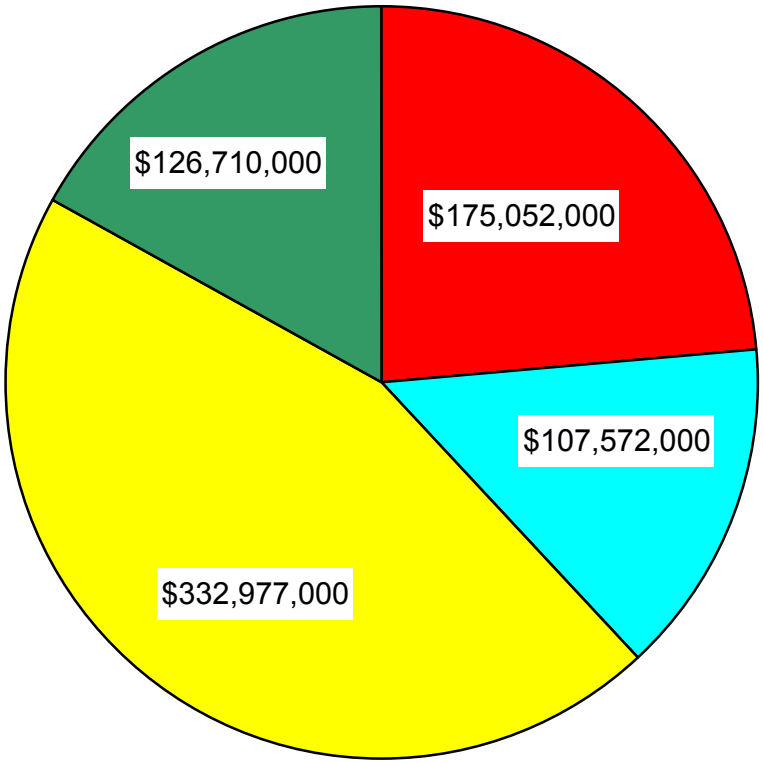
Companies employing at least 1,000 people in Ohio are found in every industry cluster. The manufacturers include ABB, Emerson Electric, Lucent, the Matsushita-Toshiba joint venture (MT Picture Display), NCR, and Philips Medical Systems (a Royal Philips Electronics subsidiary). Computer services providers include OCLC and SBC. Telecommunications companies include Alltel, Cincinnati Bell, Qwest, SBC, Sprint, Time Warner, and Verizon. Tech cluster companies include Ashland, Battelle, Honda, Procter & Gamble, and Rockwell Automation. Neither the National Aeronautics and Space Administration's John H. Glenn Research Center (NASA-Glenn) nor the U.S. Environmental Protection Agency is a private sector company, but both are included in the tech cluster.

SBC is the largest industry employer in Ohio with 6,800 workers, followed by NASA-Glenn with 6,100. Other companies employing at least 1,000 industry workers regardless of cluster (and not mentioned in the preceding paragraph) include Diebold, General Electric (U.S.), MCI, and Northrop Grumman. The map on the opposing page shows the locations of the 47 establishments with at least 500 employees.

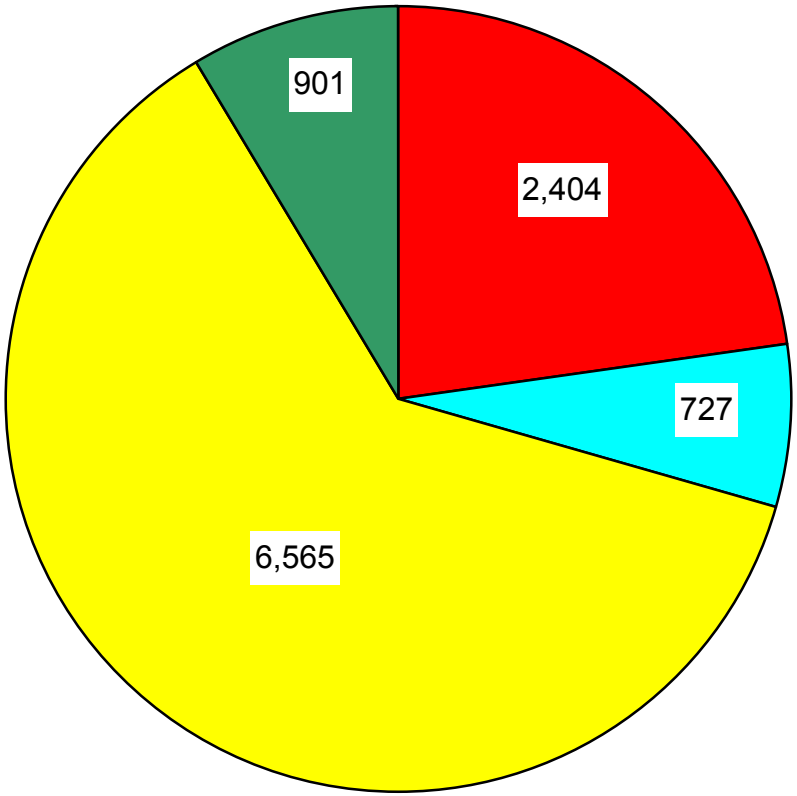
See Tables A1a-A1e

Announced Investments in Advanced Electronics and Related Industries, 2000-2002

Dollars To Be Invested: $742,311,000



Anticipated Jobs: 10,597



Manufacturing Telecommunications Computer Services Tech

Source: Office of Strategic Research

RECENT EXPANSIONS AND ATTRACTIONS

The Ohio Dept. of Development recorded 184 major investments announced by 165 advanced electronics and related companies from 2000 through 2002. The $742.3 million (M) to be invested was expected to create almost 10,600 new jobs. The largest parts of these amounts - $333M and 6,500-plus jobs - were expected in the computer services cluster. This was followed by $175M and 2,400 jobs in the manufacturing cluster, $107.6M and 700-plus jobs in telecommunications, and $126.7M and 900 jobs in the tech cluster.

The plurality of dollars to be invested and the majority of jobs anticipated were announced in 2000: $365.3M and 6,600. The numbers were smaller in 2001 ($163.3M and 2,600) and 2002 ($216.7M and 1,400).

ZoomTown.com, Inc. plans to invest $80.5M in 2000 for Internet services lead all other companies in any year. ServerTown followed with $60M in 2002 for computer services. Other companies that planned to invest at least $10M include Genome Research ($35M), Sawyer Research/NDK ($31.5M), CMS Communications ($20.3M), Argent/ABR Infocom and TDS Tele-com ($20M each), Thomson Learning (almost $19.3M), Panasonic ($17M), Liebert Corp. ($16.8M), Compuserve (almost $16.5M), iMedd ($16.3M), Colo.com and iwidgets ($15M each), PECO II ($12.75M), Hana Microdisplay Group ($12M), International Paper and SmartPipes ($11.7M each), and Adelphia Business Solutions, Community ISP, CoreComm, Microsoft and its Great Plains subsidiary, and TelePlace (at least $10M each).

These figures are part of the Private Investment Survey annually compiled by the Office of Strategic Research (2003). A major investment must meet at least one of the following criteria: 20,000 square feet of new space; $1M to be spent for land, building(s), or equipment; or 50 new jobs. Many of the major investments are phased in over a two-to-three year cycle, with production and employee counts phased in after project completion. However, companies may change their plans after announcements as circumstances warrant.

See Table A2

FOREIGN INVESTMENT IN OHIO

Fifty foreign-based companies have subsidiaries in Ohio's advanced electronics and related industries; 16 of them are on Fortune's Global 500 list. The following list identifies them, the countries where their home offices are located, their subsidiaries in Ohio, whether they work in the manufacturing or service sides of the industry (a few do both), and the total number of employees in the state.

Foreign Parents	Country	Ohio Subsidiaries	Cluster	Total Jobs
ABB, Inc.*	Switzerland	ABB, Inc.	Mfg.	1,200
AEG Elektrofotografie	Germany	AEG Photoconductor Corp.	Mfg.	68
BOC Group PLC	United Kingdom	BOC Gases	Mfg.	30
Fabreeka International	United Kingdom	Tech Products Corp.	Mfg.	35
Halma PLC	United Kingdom	Marathon Sensors, Inc.	Mfg.	20
Institut DR Foerster	Germany	Foerster Systems, Inc.	Mfg.	17
IRM s.e.	Belgium	Industrial Research & Measure	Mfg.	20
Marconi PLC	United Kingdom	Marconi Communications	Mfg.	250
Matsushita*-Toshiba*	Japan	MT Picture Display Corp. of America	Mfg.	1,300
Morgan Crucible Co. PLC	United Kingdom	Morgan Electro Ceramics	Mfg.	100
Murdoch & Co.	United Kingdom	Sovereign Circuits, Inc.	Mfg.	120
Nippon Electric Glass	Japan	Techneglas, Inc.	Mfg.	430
Norwe GmbH	Germany	Norwe Corp.	Mfg.	25
Pepperl & Fuchs GmbH	Germany	Pepperl & Fuchs, Inc.	Mfg.	150
Pioneer Industrial Corp.	Japan	Pioneer Industrial Components	Mfg.	300
Royal Philips Electronics NV*	Netherlands	Philips Medical Systems	Mfg.	1,200
SAES Getters SpA	Italy	Getters Corp. of America	Mfg.	100
Sansei Showa Co., Ltd.	Japan	Sansei Showa Co., Ltd.	Mfg.	12
Scriptel, Inc.	S. Korea	Scriptel Corp.	Mfg.	20
Sumitomo Metal Industries-Mitsubishi Materials	Japan	SUMCO USA	Mfg.	340
THK Manufacturing Japan	Japan	THK Manufacturing of America	Mfg.	210
Valtronic SA	France	Valtronic USA, Inc.	Mfg.	40
Yaskawa Electric Corp.	Japan	Motoman, Inc.	Mfg	400
YXLON International X-Ray GmbH	Germany	Yxlon International	Mfg.	60
Akzo Nobel, Inc.*	Netherlands	Flexsys America LP	Service	70
Alstom SA*	France	Alstom Power, Inc.	Service	35
Atos Origin, Inc.	France	Atos Origin, Inc.	Service	20
Cognos, Inc.	Canada	Cognos, Inc.	Service	48
E.On*	Germany	Degussa Corp. and Degussa Flavors	Service	175
Hitachi*-Volvo AB*	Japan-Sweden	Euclid-Hitachi Heavy Equipment	Service	100
Honda Motor Co.*	Japan	Honda R & D America's, Inc. and Transportation Research Center	Service	2,500
Imperial Chemical Industries PLC	United Kingdom	ICI Paints	Service	250

Foreign Parents	Country	Ohio Subsidiaries	Cluster	Total Jobs
Invensys PLC	United Kingdom	Invensys Systems, Inc. and Ranco, Inc.	Service	140
Kumho Group	S. Korea	Kumho Technical Center	Service	26
Lafarge SA	France	Millerville Lime, Inc.	Service	85
Linde AG	Germany	AGA Gas	Service	25
Michelin*	France	Michelin N. America	Service	60
NEC*	Japan	NEC	Service	25
Nestle*	Switzerland	Nestle USA and the R & D Center	Service	325
Severn Trent PLC	United Kingdom	Severn Trent Laboratory	Service	100
SMS Demag AG	Germany	Pro-Eco Strip Processing Systems	Service	20
Tata Consultancy Services	India	Tata Consultancy Services	Service	N/A
Thinkpath, Inc.	Canada	Thinkpath, Inc.	Service	70
Tyco International, Inc.*	Bermuda	Real Time Systems, Inc.	Service	25
Japan Energy Corp.	Japan	Gould Electronics, Inc.	Both	260
Saint-Gobain Co.*	France	Crystals & Detectors, NorPro	Both	200
Siemens AG*	Germany	Siemens: Airfield Solutions, Dematic, Energy & Automation, and Machine Tool Business	Both	467

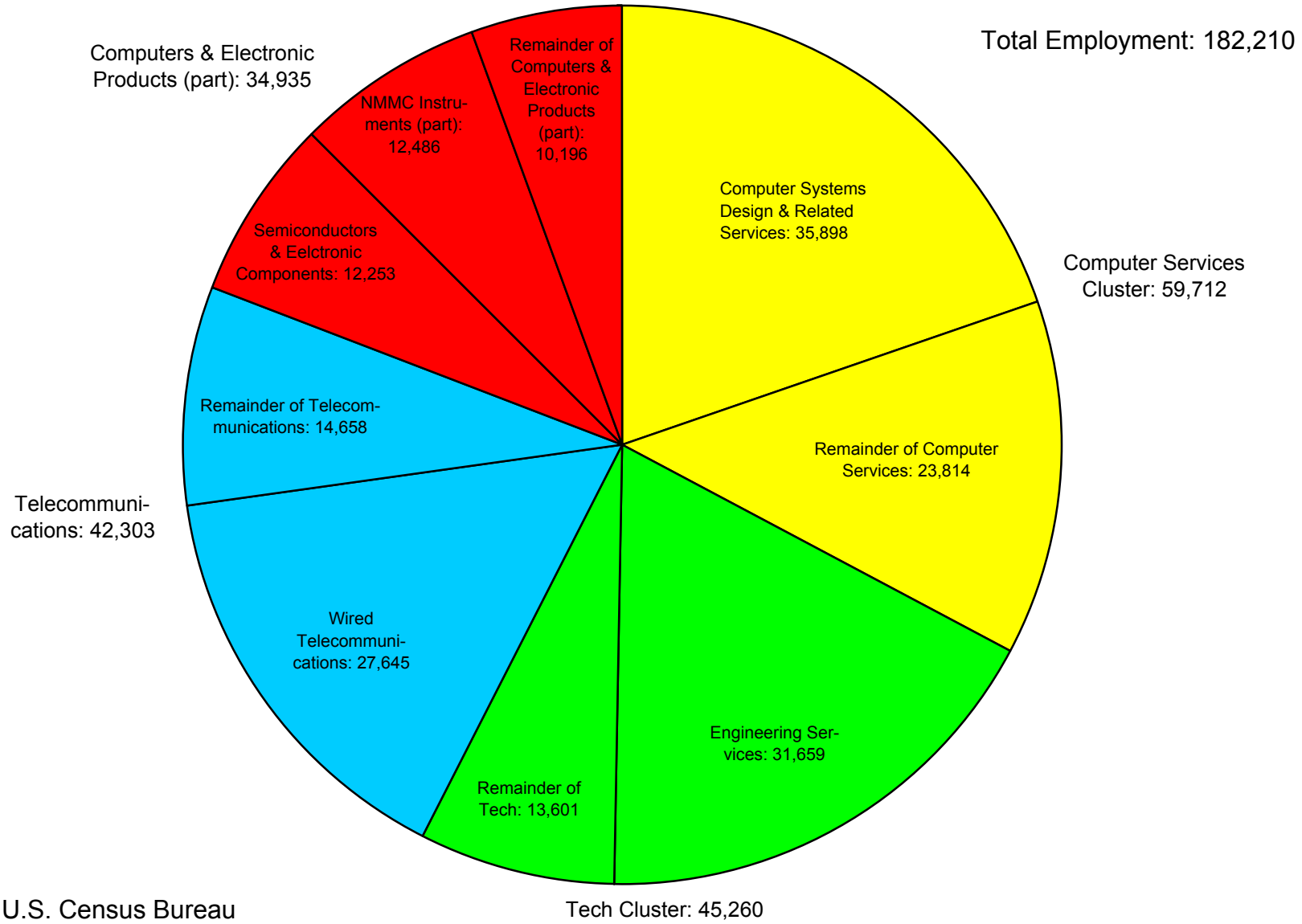
Note: * - The company is on Fortune's Global 500 list; N/A – Not Available.

Sources: Conroy (2003), Fortune (2003), Google (2003), Harris (2003a, 2003b), LexisNexis (2003), Niquette (2003), and Office of Strategic Research (2002, 2004).

Honda is the largest employer, on the services side and overall, with 2,500 workers, while the Matsushita-Toshiba joint venture is the largest manufacturer with 1,300 workers. Other companies employing at least 1,000 people include ABB and the Royal Philips Electronics. Altogether, the companies employ over 11,400 people in Ohio. Unlike the industry at large (see the following Description of the Industry in Ohio), the majority of these employees work in manufacturing.

The headquarters of the 50 companies are located in 13 nations. Thirteen of these are located in Japan, nine in Germany, eight in the United Kingdom, and six in France. Two each are in Belgium, Canada, South Korea, and Switzerland, and one each in Bermuda, India, Italy, the Netherlands, and Sweden.

Employment in Advanced Electronics and Related Industries in Ohio: 2001



Source: U.S. Census Bureau

THE COMPOSITION OF THE INDUSTRY IN OHIO

Almost 8,500 industry establishments employed over 182,200 people in Ohio during 2001.[2] The computer services cluster was the largest industry segment with 59,700 people in almost 3,800 establishments. In turn, the largest part of the cluster was employment in the computer systems design and related services group (NAICS 5415) - almost 35,900 at 2,876 establishments. The four largest individual industries within the tech cluster were computer systems design (NAICS 541512), custom computer programming (NAICS 541511), data processing and related services (NAICS 51821), and software publishers (NAICS 5112). The number of jobs in each of these four ranged from about 9,800 to over 15,900.

The tech cluster was the next-largest segment with 45,200-plus people at 2,424 establishments. It is dominated by engineering services (NAICS 54133), the largest individual industry of all in this report with 31,600-plus people at 1,854 establishments.

The telecommunications cluster, a major industry by itself (NAICS 517), employed 42,300 people at 1,781 establishments. Like the tech cluster, it is mostly comprised of a single large industry. Wired telecommunications carriers (NAICS 5171 in 2002, 51331 in 1997) employed 27,600-plus people at 1,102 establishments, making it the second-largest individual industry in this report.

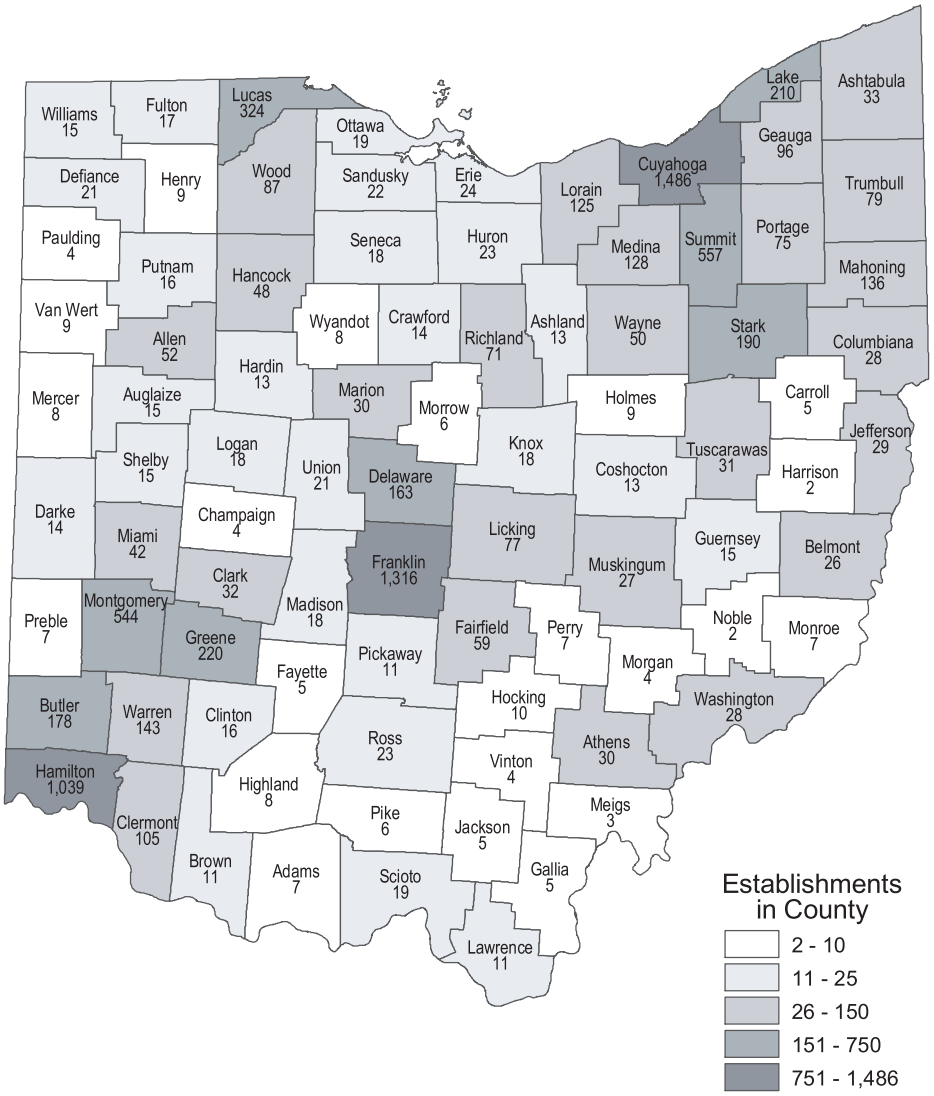
The manufacturing cluster is most of a major industry by itself (NAICS 334p). It had over 34,900 people at 493 establishments. This cluster is largely comprised of two industry groups: semiconductors and electronic components (NAICS 3344) and electronic instruments (NAICS 3345p). Employment in each group surpassed 12,200, but no individual industry stood out as the large employers mentioned above.

Despite these large numbers, advanced electronics and related industries are not concentrated in Ohio. County Business Patterns data showed that 4.3 percent of total covered employment in the nation was located in Ohio. However, only 2.8 percent of U.S. advanced electronics and related industry jobs were in the state. All of the clusters and industry groups in the state represented no more than 3.5 percent of the corresponding national totals. It is only when individual industries are considered that exceptions to the rule may be found. The most notable examples of the latter are the production of electron tubes (NAICS 334411) and automatic environmental controls (NAICS 334512) with 23 and 14 percent, respectively, of America's jobs located in Ohio.

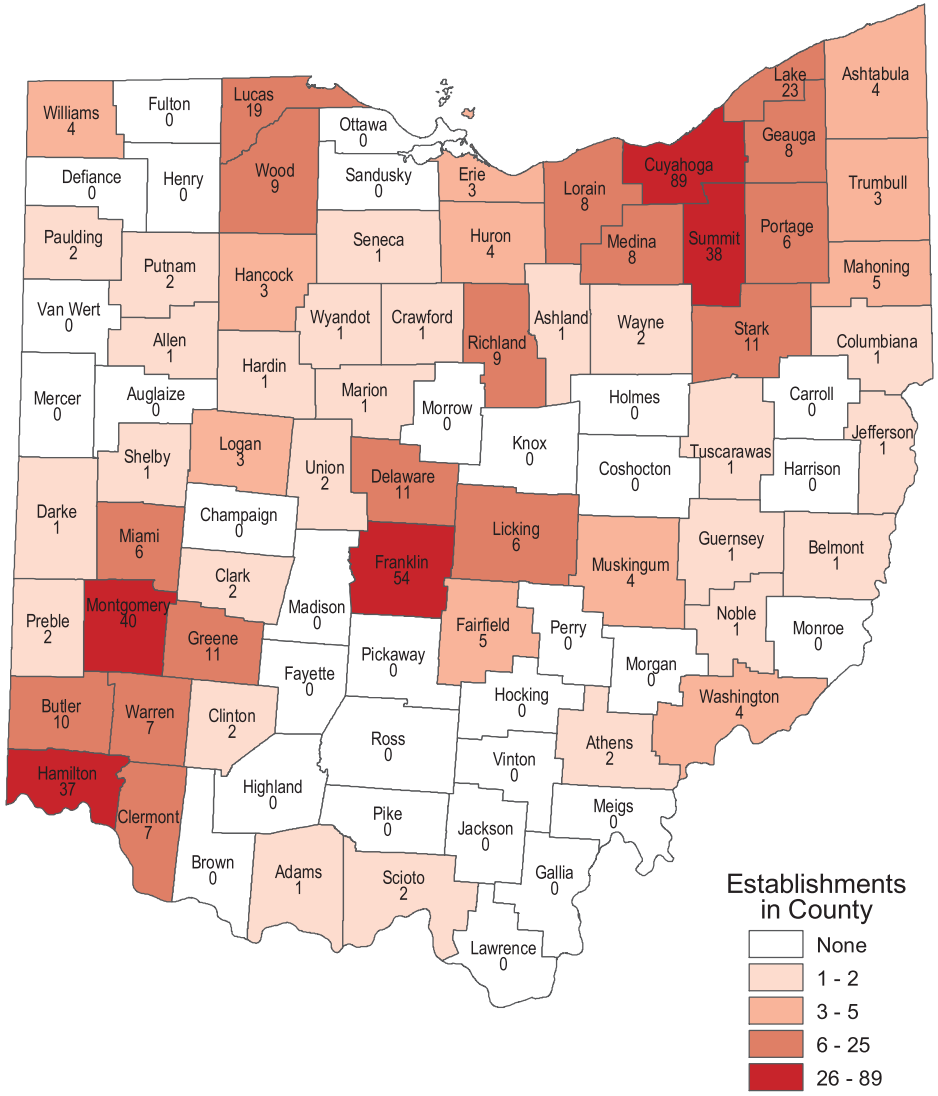
See Tables A3 & A4

Establishments in Ohio's Advanced Electronics and Related Industries

Industry Total
State Total: 8,496



Manufacturing Cluster
State Total: 493



Source: 2001 County Business Paterns,
U.S. Census Bureau, Washington, D.C.

Prepared by: Ohio Department of Development,
Office of Strategic Research (March 2004)

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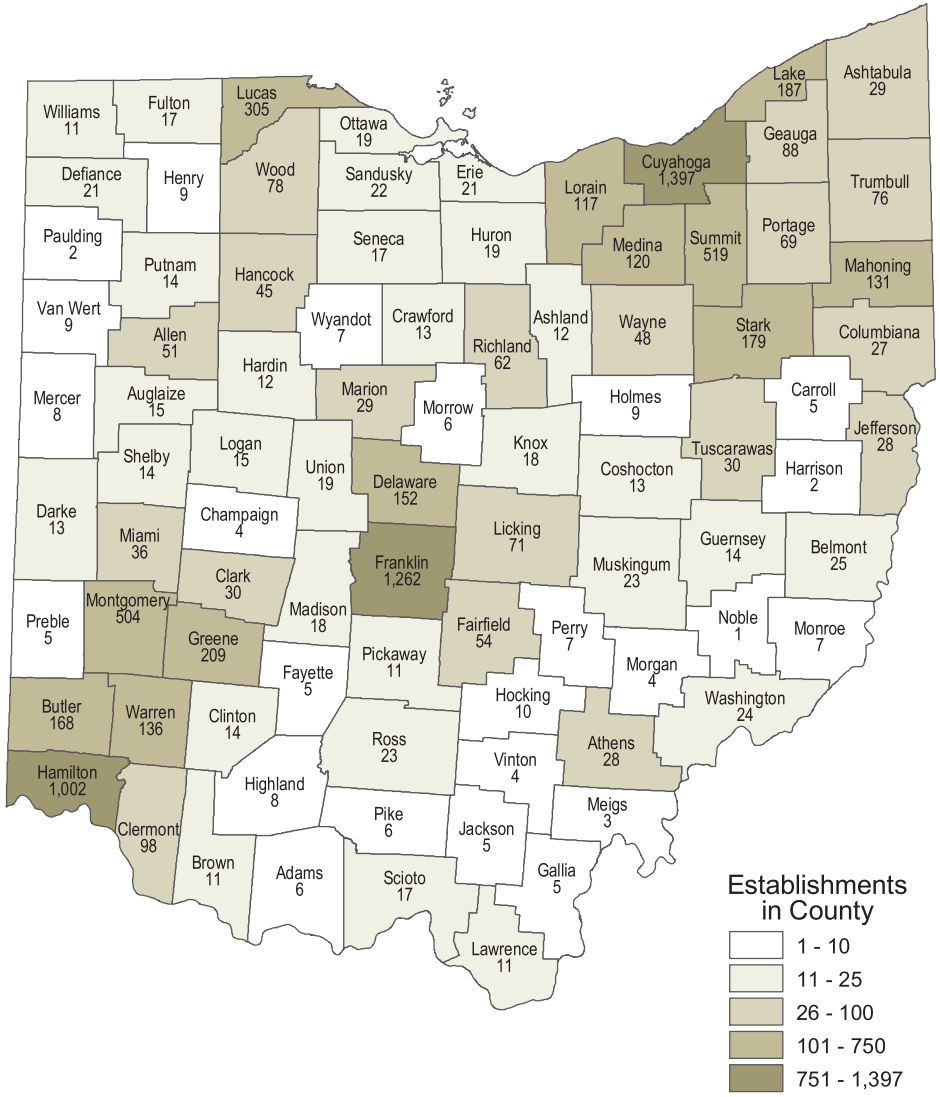
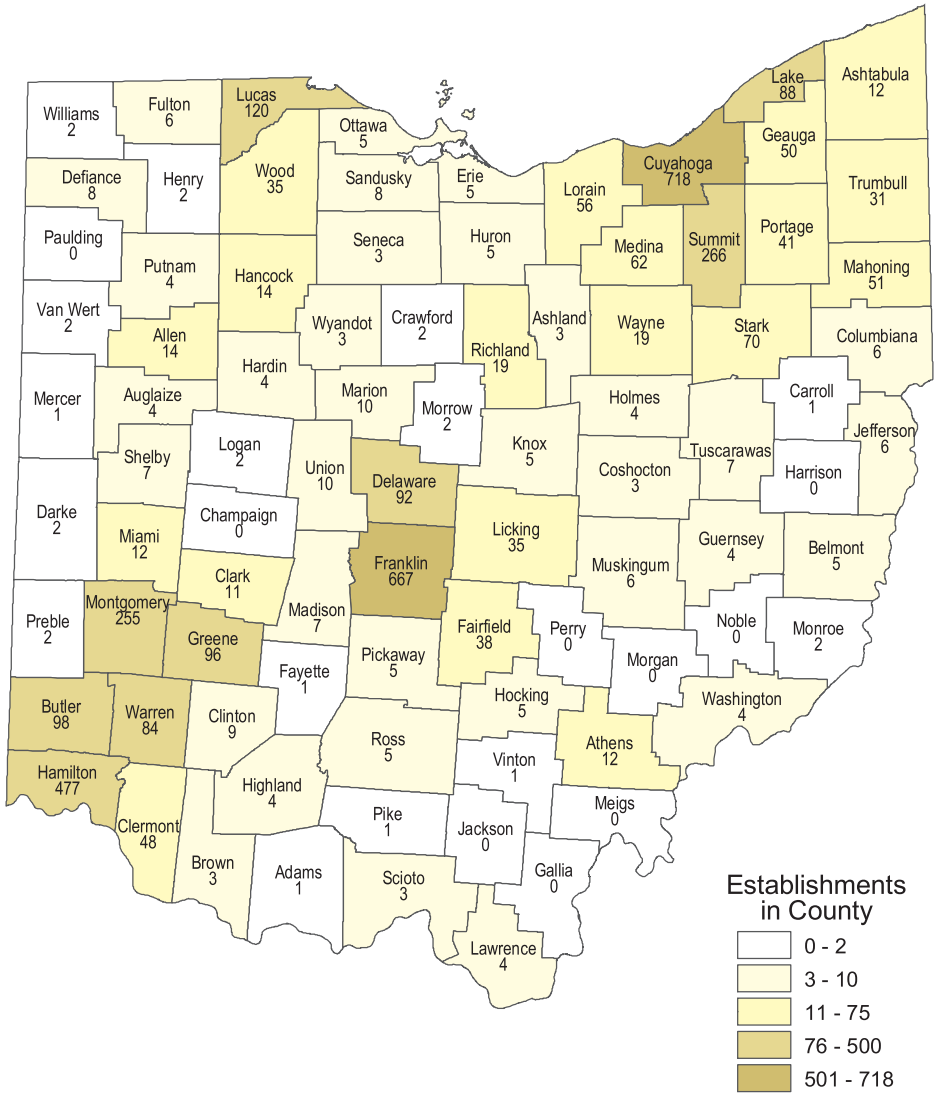
Establishments in Ohio's Advanced Electronics and Related Industries

Service Clusters
State Total: 8,003



Computer Services
State Total: 3,798



Source: 2001 County Business Paterns,
U.S. Census Bureau, Washington, D.C.

Prepared by: Ohio Department of Development,
Office of Strategic Research (March 2004)

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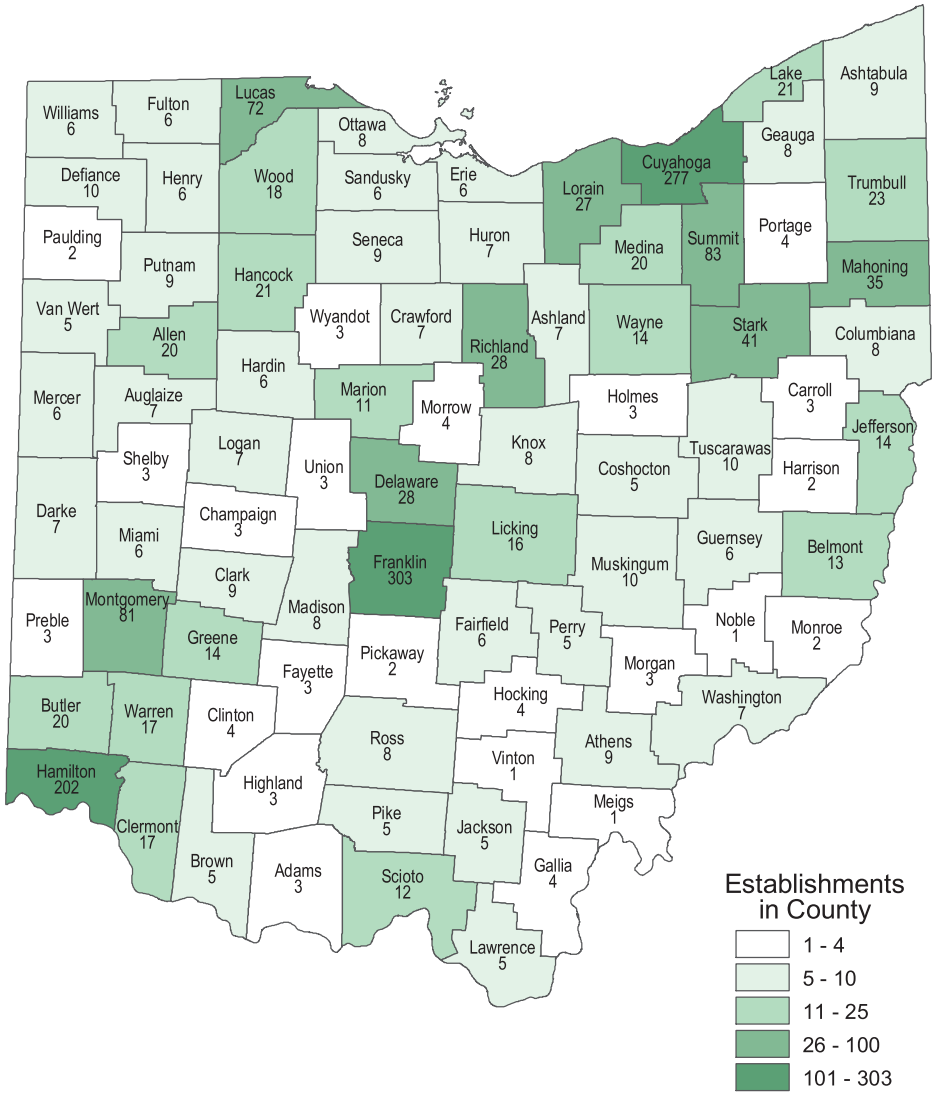
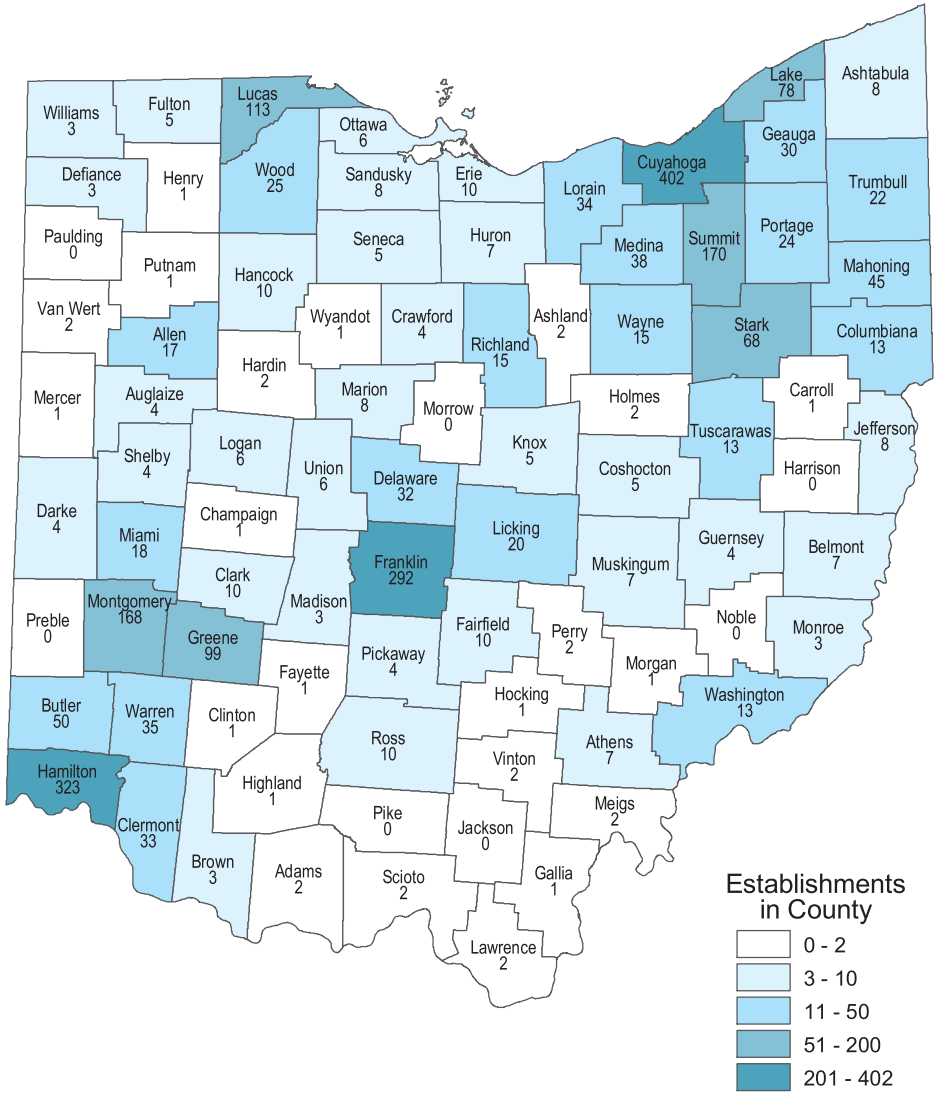
Establishments in Ohio's Advanced Electronics and Related Industries

Telecommunications
State Total: 1,781



Tech
State Total: 2,424



Source: 2001 County Business Paterns,
U.S. Census Bureau, Washington, D.C.

Prepared by: Ohio Department of Development,
Office of Strategic Research (March 2004)

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THE GEOGRAPHIC DISTRIBUTION OF ESTABLISHMENTS

The 493 establishments manufacturing computers and electronic products (NAICS 334p) were found in 57 of Ohio's counties in 2001. However, 300 (61 percent) of these were located in seven counties. Cuyahoga had the most with 89, followed by Franklin (54), Montgomery (40), Summit (38), Hamilton (37), Lake (23), and Lucas (19). Other counties with 10 or 11 establishments included Butler, Delaware, Greene, and Stark. Twelve counties had from five to nine establishments, and 34 counties had from one to four.

The 3,798 computer services establishments were found in 79 counties. Six counties had at least 100 each: Cuyahoga (718), Franklin (667), Hamilton (477), Lucas (120), Montgomery (255), and Summit (266). These six counties accounted for 66 percent of all such establishments in Ohio. Ten counties had 50 to 98 establishments, 16 counties had 10 to 48 establishments, and 47 counties had from one to nine establishments.

Every county in Ohio had at least one telecommunications establishment in 2001, but three counties accounted for 44 percent of the total (1,781): Cuyahoga (277), Franklin (303), and Hamilton (202). Three more counties had from 72 to 83 (Lucas, Montgomery, and Summit). Twenty-four counties had 10 to 41, and 58 counties had less than 10 each.

The majority of the 2,424 tech cluster establishments in Ohio were found in six counties: Cuyahoga (402), Hamilton (323), Franklin (292), Summit (170), Montgomery (168), and Lucas (113). Four more counties had from 50 to 99 establishments (Butler, Greene, Lake, and Stark). Twenty-three counties had from 10 to 45 establishments, and 48 counties had from one to nine.

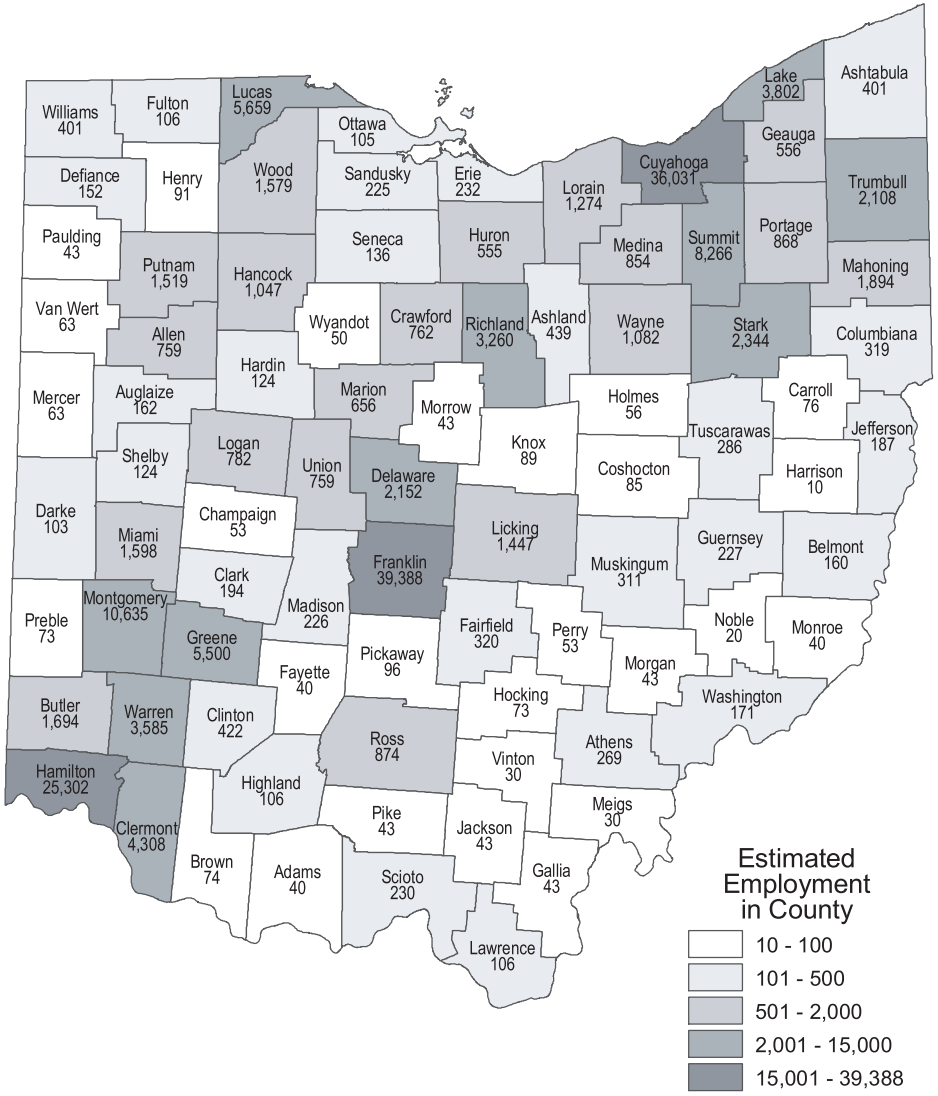
Overall, Cuyahoga had the most industry establishments (1,486), followed by Franklin (1,316) and Hamilton (1,039), together comprising 45 percent of the state. Adding the establishments in either Summit (557) or Montgomery (544) would account for the majority of the state. Other counties with hundreds of industry establishments include Greene (220), Lake (210), and Lucas (324).

Every one of the counties mentioned above is either the central-city county of a metropolitan area or one of the larger adjacent counties in the metropolitan area.

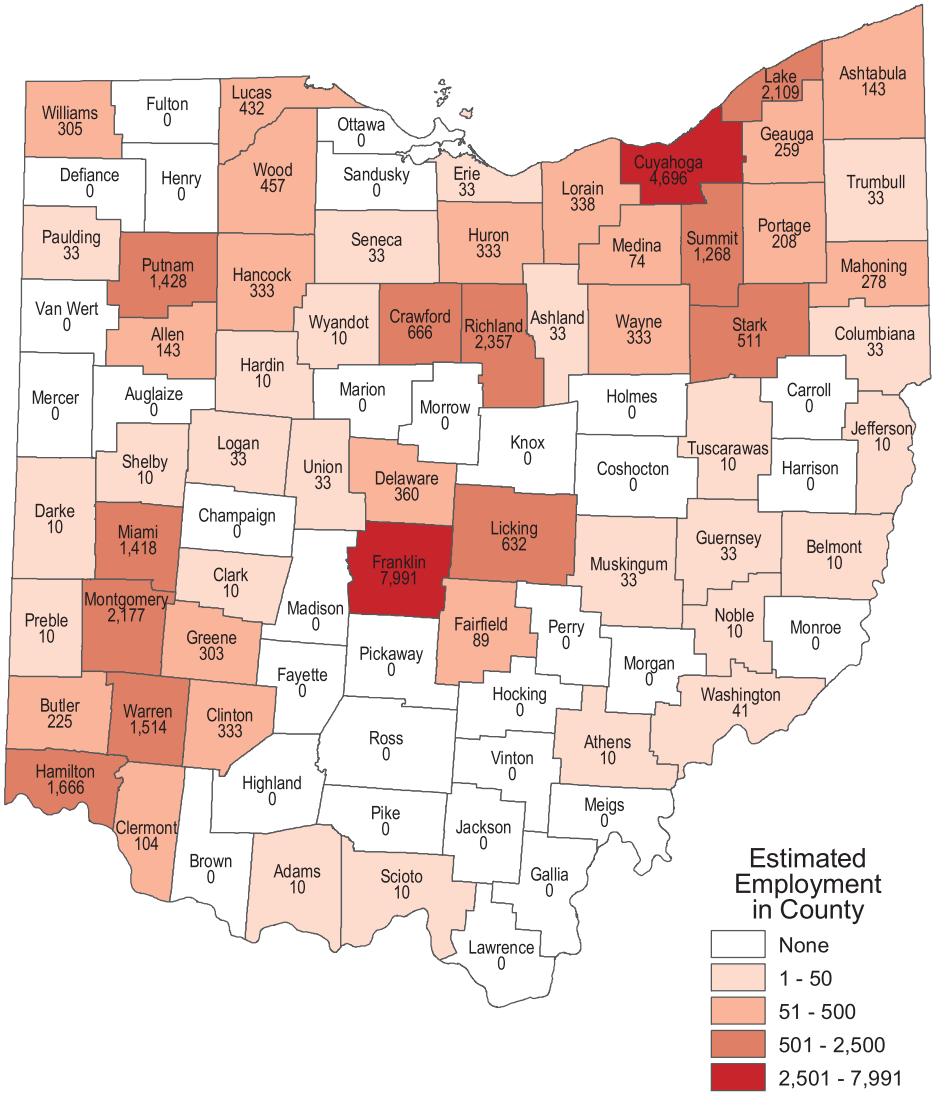
See Table A5

Estimated Employment in Ohio's Advanced Electronics and Related Industries

Industry Total
State Total: 182,167



Manufacturing Cluster
State Total: 34,892



Source: 2001 County Business Paterns,
U.S. Census Bureau, Washington, D.C.

Prepared by: Ohio Department of Development,
Office of Strategic Research (March 2004)

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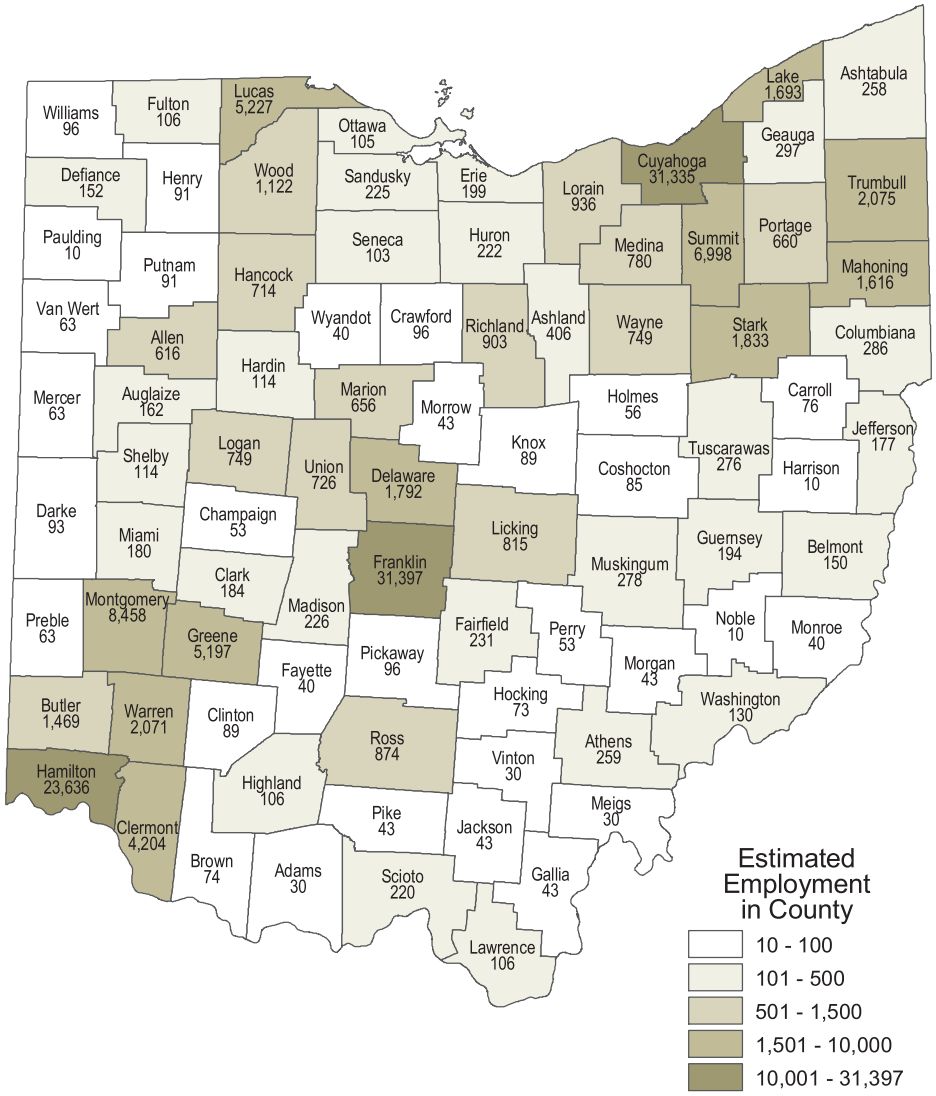
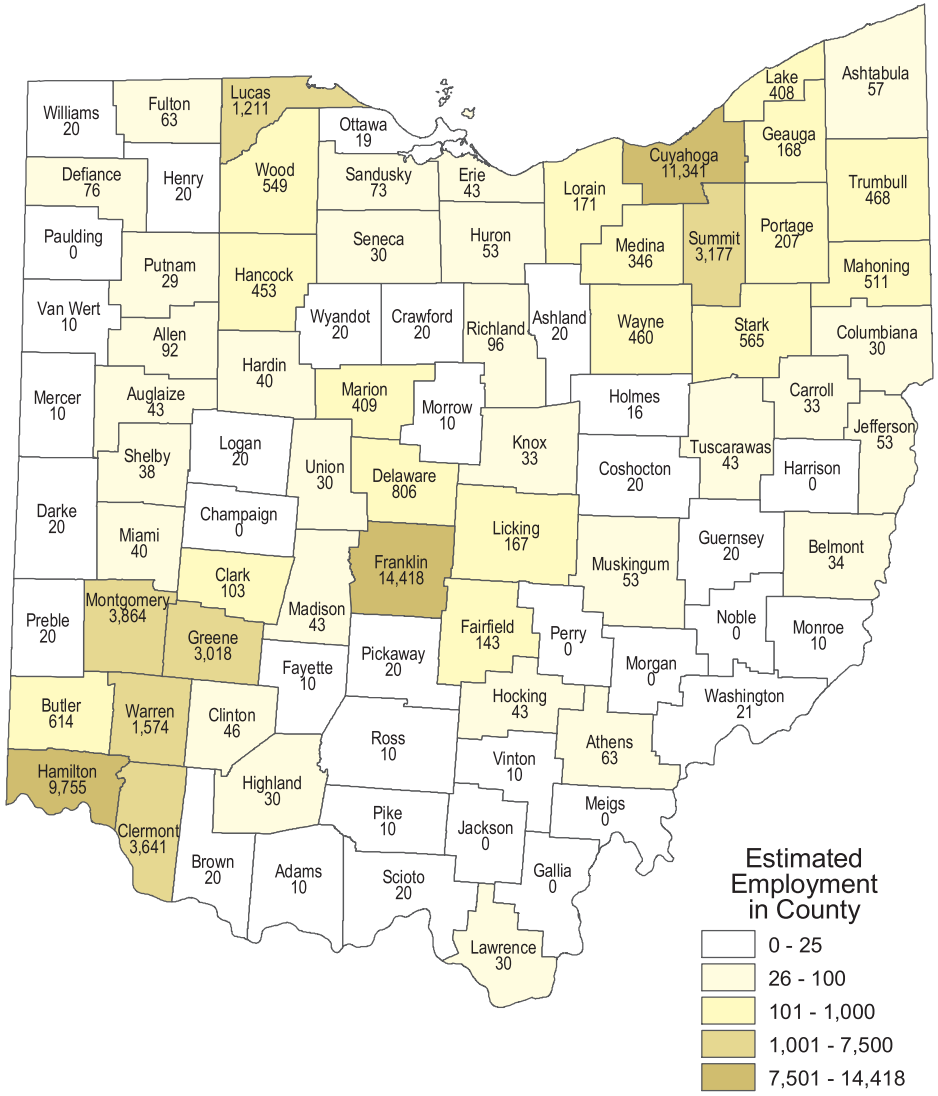
Estimated Employment in Ohio's Advanced Electronics and Related Industries

Service Clusters
State Total: 147,275



Computer Services
State Total: 59,712



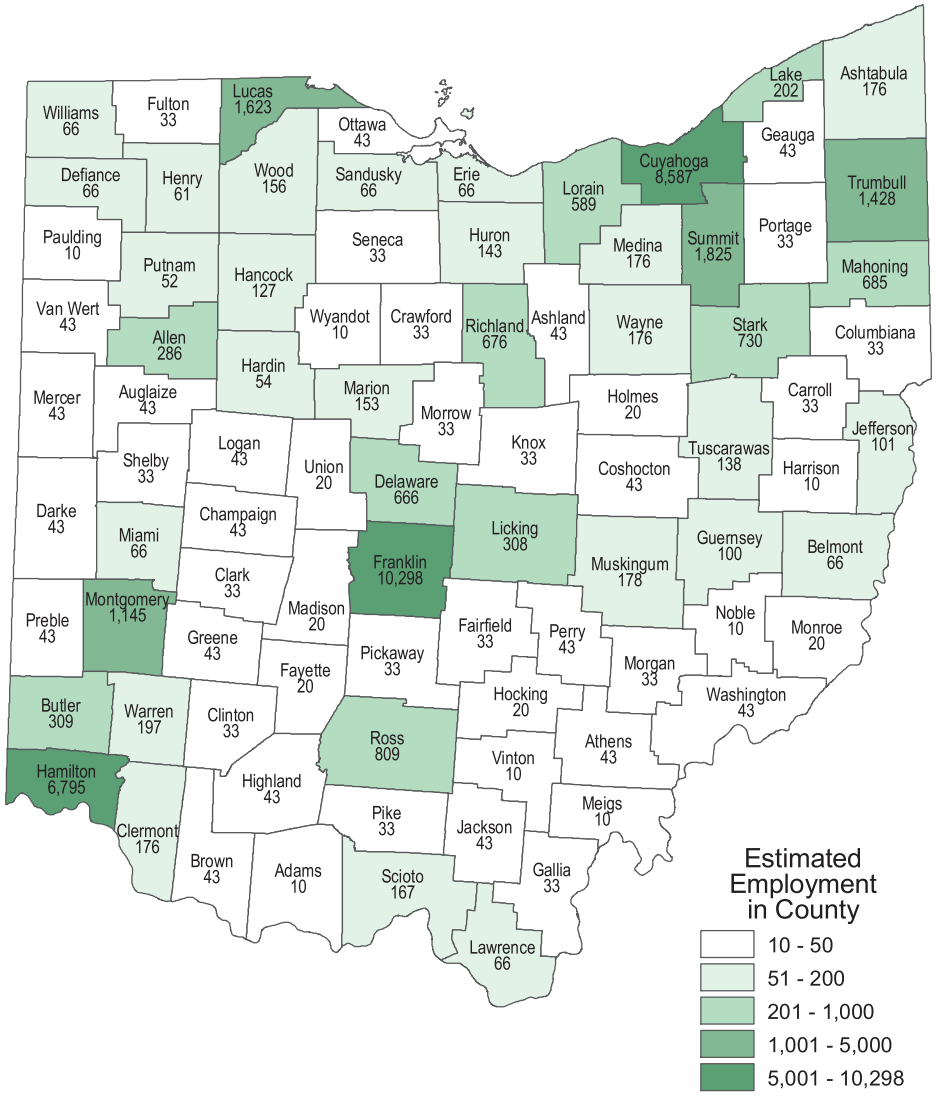
Source: 2001 County Business Paterns,
U.S. Census Bureau, Washington, D.C.

Prepared by: Ohio Department of Development,
Office of Strategic Research (March 2004)

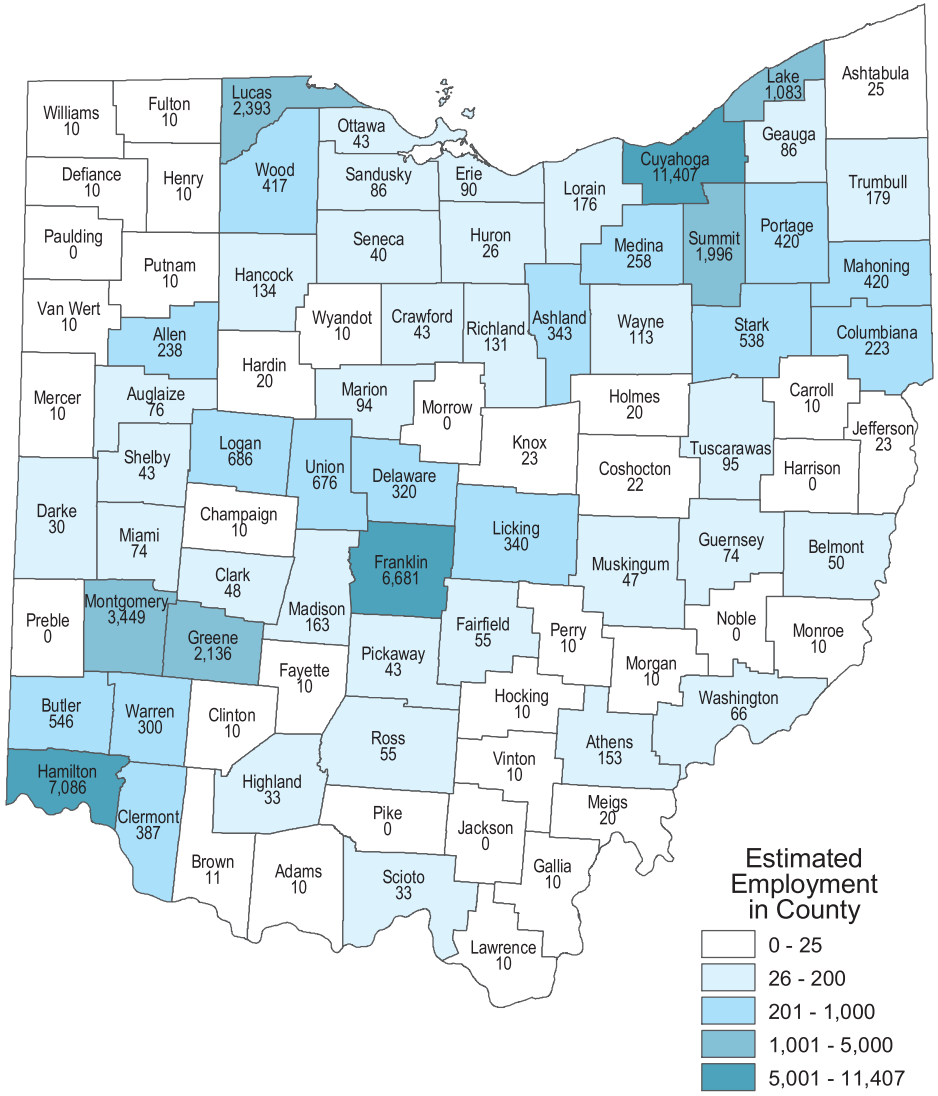
R102303A

Estimated Employment in Ohio's Advanced Electronics and Related Industries

Telecommunications
State Total: 42,303



Tech
State Total: 45,260



Source: 2001 County Business Paterns,
U.S. Census Bureau, Washington, D.C.

Prepared by: Ohio Department of Development,
Office of Strategic Research (March 2004)

R102303A

THE GEOGRAPHIC DISTRIBUTION OF EMPLOYMENT

More people in Franklin County were employed in manufacturing computers and electronic products (NAICS 334p - close to 8,000) than in any other county in the state in 2001.[3] It was followed by Cuyahoga (almost 4,700), Richland (about 2,350), Lake and Montgomery (between 2,100 and 2,200 each). These five counties combined for 57 percent of the industry manufacturing jobs in Ohio in 2001. Five more counties had between 1,200 and 1,700 manufacturing jobs each: Hamilton, Miami, Putnam[4], Summit, and Warren. Twenty counties are thought to have had between 100 and 700 jobs, and 26 counties appeared to have had less than 100 jobs each.

Franklin (14,400), Cuyahoga (almost 11,350), and Hamilton (9,750) Counties combined for 59 percent of the 59,700 jobs in the computer services cluster. Clermont, Greene, Montgomery, and Summit followed with 3,000 to 3,850 jobs each, while Lucas and Warren had between 1,200 and 1,600. Seventeen counties had 100 to 800 jobs, and 53 counties had less than 100 jobs each.

Three-fifths of the telecommunications jobs also were found in the combination of Franklin, Cuyahoga, and Hamilton Counties (almost 10,300, 8,600, and 6,800, respectively). Four counties had between 1,100 and 1,900 such jobs: Lucas, Montgomery, Summit and Trumbull. Two dozen counties had from 100 to 800 jobs; the remaining counties had fewer than 100 jobs each.

The majority of tech cluster employment also was located in Cuyahoga, Franklin and Hamilton Counties (about, 11,400, 6,700, and 7,100, respectively). Greene, Lake, Lucas, Montgomery and Summit each had between 1,000 and 3,500 jobs. Twenty-two counties had between 100 and 700 jobs, and 51 counties had less than 100 such jobs.

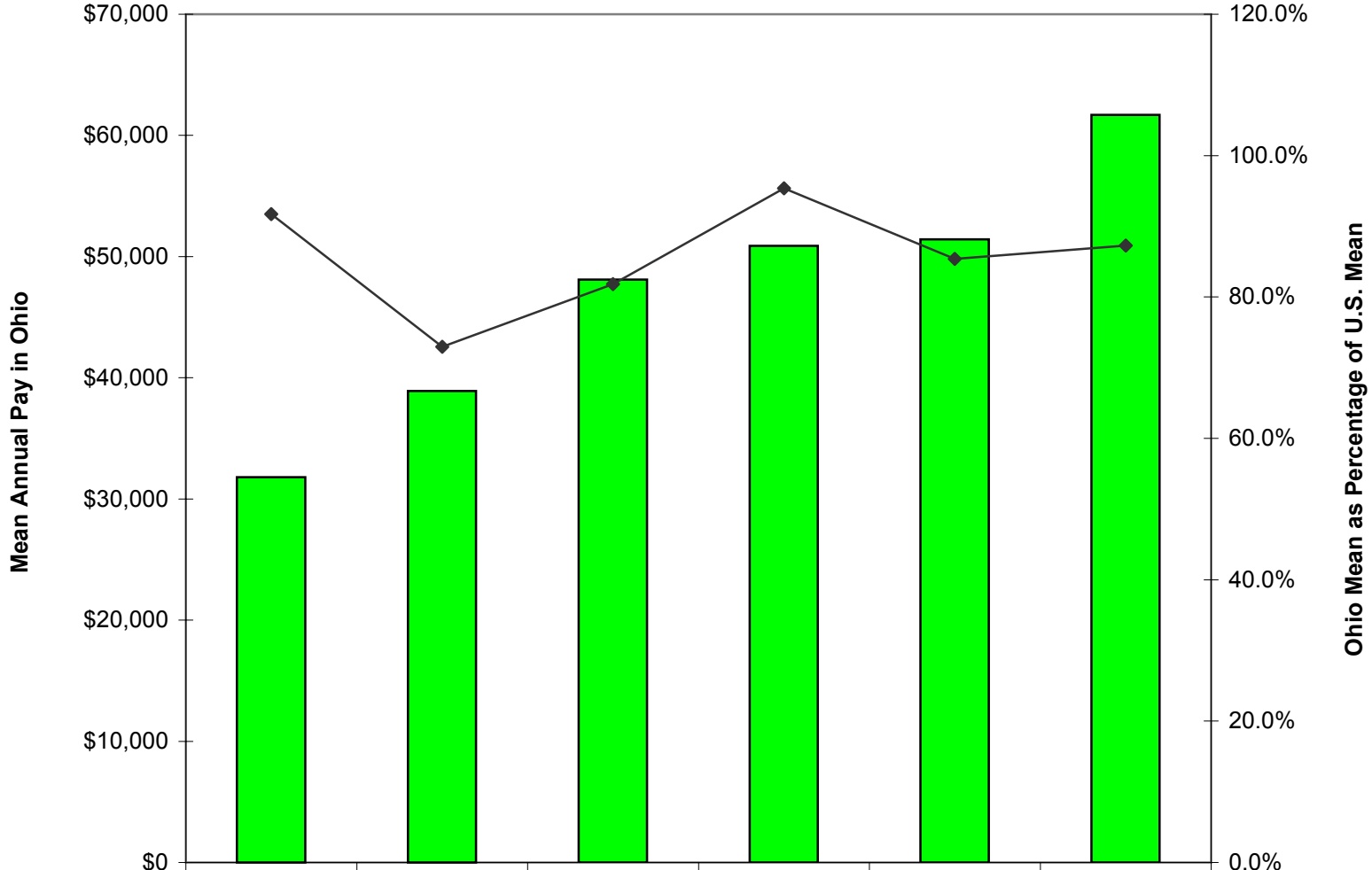
Overall, Franklin County had the largest number of industry employees (almost 39,400), followed by Cuyahoga (about 36,000) and Hamilton (25,300), together comprising 55 percent of the state. Montgomery County is the only other one with at least 10,000 industry jobs. Nineteen other counties had between 1,000 and 8,300 jobs, while the remaining counties had less than 1,000 apiece. The Census Bureau lacked sufficient information to locate about 50 jobs by county.

Every one of the counties mentioned above (except Putnam) is either the central-city county of a metropolitan area or one of the larger adjacent counties in the metropolitan area.

See Table A5

OHIO: STATE AND U.S. COMPARISONS

Comparing Pay in Ohio with the U.S., 2001



	Total Covered Employment	Computers & Electronic Products (part)	Tech Cluster	Telecommunications	Advncd. Elctrncs. & Rltd. Indstrs.	Computer Services Cluster
Mean Annual Pay in Ohio, 2001	$31,800	$38,918	$48,093	$50,891	$51,434	$61,696
Ohio Pay as % of U.S.	91.7%	73.0%	81.8%	95.4%	85.4%	87.3%

Source: U.S. Census Bureau.

INDUSTRY WAGES: OHIO AND THE U.S. COMPARED

The preceding chart shows that for all of the jobs covered by County Business Patterns in 2001, annual wages in Ohio averaged $31,800. People employed in the state's advanced electronics and related industries averaged over $51,400 per year. The average annual pay in every cluster and every industry group was greater than the overall average for the state. Generally, this is a well-paying industry in which to work.

While the industry average in Ohio exceeded the overall state average by $19,600, the industry average in Ohio ($51,400) was more than 14 percent below the corresponding national industry average ($60,200-plus). Within the industry, none of the clusters and just two of the 15 groups exceed the corresponding national averages. The two groups were: audio and video equipment (NAICS 3343 - 113 percent) and Internet service providers and search portals (NAICS 5181 - 140 percent). Two more groups in the state are within one percent of the national averages: wired telecommunications carriers (NAICS 5171) and data processing and related services (NAICS 51821).

See Table A6

VALUE ADDED BY GROUP IN MANUFACTURING

PRODUCTION IN OHIO BY GROUP: 1997-2001 AVERAGES

NAICS: Industry Title	Value-added (in millions)	Percent of U.S.	Apparent Rank*	Top Five States*
334: Computers & electronic products+	$4,988.3	1.9%	15th	CA, TX, MA, AZ, OR
3341: Computers & peripheral eqpt.	$435.3	1.0 %	12th	CA, TX, MA, NH, CO
3342: Communications eqpt.	$2,175.3	4.1%	6th	CA, TX, MA, IL, FL
3343: Audio & video eqpt.	n.a.	n.a.	below 10th	CA, MA, TN, IN, IL
3344: Semiconductors & other components	$800.0	0.9%	18th	CA, AZ, TX, OR, PA
3345: NMMC instruments	$1,523.7	2.6%	16th	CA, MA, TX, WA, MN

Notes: * - where information is available; + - includes NAICS 3346; eqpt. - equipment; n.a. - not available. Source: U.S. Census Bureau (2003).

By focusing on the dollar values of goods produced, value-added data provide a different perspective on manufacturing computers and electronic products (NAICS 334) than do counts of establishments and employment. The 2001 Annual Survey of Manufactures (ASM) (U.S. Bureau of the Census, 2003) found a sufficient number of sub-sector establishments in 45 states, allowing it to publish information for them. Manufacturing computers and electronic products is a multi-billion (B) dollar industry in Ohio, averaging almost $5B per year from 1997 through 2001. The largest parts of it are the production of communications equipment (NAIC 3342) and navigational, measuring, medical, and controlling instruments (NAIC 3345), averaging over $2.1B and $1.5B per year, respectively.

Perhaps the most-notable finding from the ASM is that manufacturing communications equipment is slightly concentrated in Ohio, with 4.1 percent of such value-added in the nation originating here. By comparison, 3.7 percent of the nation's gross domestic product originated in Ohio (Office of Strategic Research, 2003). The percentages of America's value-added in Ohio in other industry groups - computers and peripheral equipment (NAICS 3341), semiconductors and other components (NAICS 3344), and navigational, measuring, medical and control instruments - are less than three percent of the nation's output. They are not concentrated here.

See Table A7

CAPITAL EXPENDITURES BY GROUP IN MANUFACTURING

CAPITAL EXPENDITURES IN OHIO BY GROUP: 1997-2001 AVERAGES

NAICS: Industry Title	Amount (in millions)	Percent of U.S.	Apparent Rank*	Top Five States*
334: Computers & electronic products+	$266.0	1.1%	19th	CA, TX, OR, AZ, MA
3341: Computers & peripheral eqpt.	$32.5	1.2%	12th	CA, MN, OR, TX, MA
3342: Communications eqpt.	$61.6	1.7%	11th	CA, IL, TX, MA, VA
3343: Audio & video eqpt.	n.a.	n.a.	below 10th	TN, MA, CA, IN, WA
3344: Semiconductors & other components	$87.0	0.6%	20th	CA, TX, OR, AZ, NM
3345: NMMC instruments	$76.7	2.4%	14th	CA, MA, CO, TX, WA

Notes: * - where information is available; + - includes NAICS 3346; eqpt. - equipment; n.a. – not available. Source: U.S. Census Bureau (2003).

Capital expenditures are funds spent for buildings and equipment used in manufacturing. Such expenditures in Ohio for use in manufacturing advanced electronic products averaged $266 million (M) per year from 1997 through 2001—about one percent of the national total. No one sub-sector of the industry dominated, although expenditures in semiconductors and other components (NAICS 3344) and navigational, medical, measuring and control instruments (NAICS 3345) were greater than other sub-sectors. With the exception of communications equipment (NAICS 3342), the percentages of industry capital expenditures going into Ohio are roughly proportional to the value-added produced here.

See Table A8

INDUSTRY ANALYSIS AND OUTLOOK

FROM MICROCHIPS TO THE INTERNET AND BEYOND

Microchips lie at the heart of the advanced electronics industry. Microchips contain integrated circuits - assemblies of transistors[5] and other passive and active components - on silicon[6] wafers. Depending on how the components are configured, microchips perform different functions. The most familiar are digital chips, which work with information as a series of zeros and ones. There are three types of digital chips: memory, microprocessors, and logic devices. Memory chips are temporary storage for specific programming instructions and data; they are analogous to an electronic blackboard where changes may be made to the data according to the instructions. Data are copied from here to a permanent storage device. Memory chips also are where the microprocessor works with the keystrokes and mouse clicks made by the user. The microprocessors contain the basic arithmetic, logic and control circuitry for data processing; i.e., the calculations and manipulations.[7] Logic devices are the most variable chips, and also are used for the manipulation and interchange of data. Other types of chips include analog chips, which process continuous signals from real world phenomena such as electromagnetic waves, pressure, and sound into digital signals and *vice versa*, and opto-electronic chips, which transmit and receive optical signals (Bensinger, 2003: 17; Graham-Hackett, 2003a: 17, 28-29; Smith, 2003: 18-19).

Most chips are sold either directly or indirectly to equipment manufacturers. Chipmakers may work with a client during the design and development process for a new electronic product. Once a company's chip is designed into the customer's end product, it may be difficult for another company to replace it (Smith, 2003: 17).

The 10 largest microchip manufacturers, in descending order of 2002 revenue, are Intel, Samsung, Texas Instruments, STMicroelectronics, Toshiba, NEC, Infineon, Hitachi, Motorola, and Taiwan Semiconductor. This list will change because "[s]hifting consumption patterns for electronic goods have encouraged specialized chipmakers like Intel, STMicroelectronics, and Infineon to diversify their semiconductor product offerings to protect themselves from a slowdown in any one electronics end market… Meanwhile, many large conglomerates are spinning off their chipmaking units in an effort to stabilize the parents' profitability" (Smith, 2003: 10). Examples of the latter include NEC, Hitachi, Siemens, Lucent, and Rockwell International (Smith, 2003: 8-10).

"Factors affecting the decision on where to locate [a chip manufacturing plant] include proximity to markets, availability of an appropriately skilled labor force, and cost considerations involving labor, construction, transportation, and taxation" (Smith, 2003: 17). The most advanced chips made in the nation have come from plants in the San Francisco Bay area (a.k.a. Silicon Valley), Southern California, Boston's Rt. 128 corridor, Dallas, and Austin. More recently, new plant builders have sought locations with lower construction and living costs. (However, establishments doing chip design and research can be scattered across the country "in part to attract scarce engineering talent by offering work in smaller towns that offer a desirable lifestyle" (Smith, 2003: 17).)

Smaller, faster, more sophisticated chips - the most powerful today contain about 5,000,000 transistors - produced at lower costs are a significant part of advancements in computing, communications, and myriad electronic applications. These improvements, in turn, boosted labor productivity and American economic expansion particularly in the last half of the 1990s. Productivity continued to advance even in the slowdown of 2001, and has since increased (Bensinger, 2003: 17; Smith, 2003: 7, 11). Improvements to memory and operating systems have also helped (Graham-Hackett, 2003a).

At every phase of development in the computer equipment industry, the price for computing power has dropped, usability has increased, and the scope of applications has broadened. Computers initially were used by governments and their militaries during World War II. Some businesses began using computers in the 1950s, and many were automating back office operations by the 1970s. Continuing technological advances increased computing power while making computers smaller. They became small enough to put on a desk by the 1980s, at which point they became personal productivity tools and moved out of the domain of hobbyists. The demand for such personal computers (PCs) - for individual and organizational use - increased with further advances in processor design and manufacturing technologies. The downward trend in PC prices primarily reflects the downward trend in component prices, although some of the former may be credited to pass-through savings from cost-cutting efforts by PC makers (Graham-Hackett, 2003a: 6-7; Smith, 2003: 11).

Mostly the same set of names keeps showing up as being leading producers in various segments of the computer equipment market. From the most powerful mainframes through minis, workstations, servers, and entry-level PCs, the rank order of market share for each segment is largely reshuffled for another segment. The leading computer manufacturers in 2001 (i.e., those with at least a five percent market share in any one segment) are listed in alphabetic order: Dell, Fujitsu, Fujitsu-Siemens, the Hewlett-Packard/Compaq combination (HP), International Business Machines (IBM), and Sun Microsystems. IBM still dominates the market for more powerful machines, while HP leads in servers, and roughly shares the lead with Dell in the PC market. The PC market is becoming increasingly concentrated. The top 10 producers accounted for about one-half of sales in 1992; beginning in 1999, the top five vendors had almost one-half of sales (Graham-Hackett, 2003a: 6-10).

With the development of faster, more sophisticated processors and larger memory capacities, tasks formerly the province of more powerful machines can now be done on smaller machines. This effectively brings more companies into competition with one another. It also forces companies to broaden the range of products and services offered. Consequently, industry observers have seen a wave of consolidation. Compaq acquired Digital in the mid-1990s, getting high-end Unix systems and a worldwide service organization. It also bought Tandem in 1997, and got the latter's expertise in networking computers. HP acquired Compaq in 2002. Other notable acquisitions include Gateway's purchase of Advanced Logic and IBM's purchase of Sequent and PriceWaterhouseCooper's consulting unit. In a similar move, Sun Microsystems forged alliances with Electronic Data Systems and Computer Sciences Corp. to strengthen its service sector (Graham-Hackett, 2003a: 12).

One of the more significant technical developments in recent years has been the ability of computers to communicate with one another. For a number of years as computers developed, this was not possible. Virtually the only way for data users at different locations to share data was to physically transport computer tapes.[8]

This began to change in the late 1960s with a U.S. Dept. of Defense data communications network conceived by its Advanced Research Project Agency (ARPA). It used telephone lines in such a way that one or more of its facilities could fail, but the network would still function; i.e., data could still be moved.[9] The network equipment could even detect local congestion and reroute the data accordingly. ARPA ceded control to the National Science Foundation (NSF) in 1985. The NSF converted ARPAnet into a civilian network linking universities and commercial users, and expanded from six to 16 the number of super computers used in the backbone. This was the emergence of the Internet (Kessler, 2003: 17).

Beginning in 1995, the NSF first allowed private companies access to its backbone, and later to build and maintain networks that now comprise part of the Internet. Access was provided at network access points (NAPs) operated by telecommunications companies. Internet service providers (ISPs) purchased access from the companies running the NAPs. ISPs then provided access to their customers: individuals and organizations, including smaller ISPs. However, the presence of NAPs no longer compels ISPs to use them; ISPs have arranged among themselves direct connections to the Internet (Kessler, 2003: 18). In essence, the Internet has become a decentralized communications network of host computers at various sites (Rudy, 2003: 11).

The implications of this are far-reaching. "This decentralization of traffic means that no centralized authority oversees the Internet or can track Internet traffic" (Kessler, 2003: 18). It also means that no one owns the Internet, and since no one owns it, barriers to entry are low. Relatively small capital expenditures permit organizations to inform consumers and clients worldwide about their missions, products and services. PC and peripheral prices under $1,000 are not unheard of, and Internet access fees are in the range from $20 to $40 per month (Kessler, 2003: 22-23). Consequently, the Internet has grown explosively from 23,500 web servers in mid-1995 to 38,100,000 by early 2002 (Kessler, 2003: 13).

The Internet idea has its counterpart in many organizations. Organizations have abandoned or curtailed earlier systems - where users at terminals were connected to a single mainframe - in favor of a client/server system comprising a local area network (LAN). In the latter, the clients' PCs communicate with servers via a network. The network facilitates quick and easy transfer of files and e-mail between users, and permits them to share access to other resources such as printers. This reduces material costs and streamlines operations (Graham-Hackett, 2003b: 11). Limited or full access to the organization's network may also be granted to outsiders such as customers, distributors and/or suppliers (Rudy, 2003: 11). In this sense, the Internet also may be described as interconnected computer networks.

A number of businesses have benefited from the Web. They use it as a sales channel, service delivery mechanism, and an advertising medium. It also may be used for video conferencing. In essence, the Internet enables companies to establish a wider geographic presence without having to invest in physical infrastructure. Worldwide business spending conducted via the Internet doubled from 2000 to 2002. Most of the business conducted on the Internet is between two firms, although retailers do sell products to individual consumers. On-line shopping has a number of benefits for consumers: convenience, variety, and access to information. This makes comparison-shopping easier. This is particularly true for apparel, books, CDs, and consumer electronics. One person may also sell to another person via the Internet. E-Bay is perhaps the best-known auction platform for such exchanges (Kessler, 2003).

Some analysts say that the ability to network PCs and the emergence of the Internet attracted both corporate and individual users with their advantages, thus boosting PC sales (Graham-Hackett, 2003a: 6-7; Smith, 2003: 11). On the other hand, Kessler (2003: 13) thinks that the rapid growth in PC sales facilitated the growth of the Internet. Perhaps these are just two parts of a positive feedback loop. Either way, the rapid adoption of PCs and the desire to link them created a strong demand for network hardware products such as wires and cables, switches and routers, and hubs.

This same network technology also was finding applications in other areas. The telephone, broadcasting, and cable TV industries used equipment for handling analog signals for a number of years after they started. However, the development of the analog chips meant that computer network equipment could now be used to transmit sound and video as well as data because such chips converted signals from analog to digital and back.[10] For example, it became possible to use the Internet for telephone conversations (Bensinger, 2003). Using a single network to carry different types of traffic can substantially reduce an organization's communications costs (Graham-Hackett, 2003b).

Digital signals have advantages over analog signals. They are more accurately transmitted because they are less likely to be affected by static and background noise. They need to be boosted less frequently because they are less likely to fade. Consequently, digital equipment needs less electrical power than analog equipment (Bensinger, 2003: 17-18).

However, the digitalization of audio and video produces data streams that are very large in comparison with those that computer network equipment was originally designed to handle, and the performance of a network can degrade when usage increases beyond a certain point. Companies have addressed this problem with two general solutions: use the network more efficiently, and increase the speed at which the network equipment can operate. Fortunately, packet-switched networks, originally designed for handling digital data, are more efficient than the earlier circuit-switched networks because the former use paths with the least amount of traffic.[11] In addition, digital equipment allows multiple users simultaneous access to a channel. This is a real boost to system capacity.[12] By contrast audio or video will occupy a path in a circuit-switched network as long as the connection is maintained - even if no traffic is on it (for example, a long

pause in a conversation). With digitalization, audio and video are increasingly using packet-switched networks. For all these reasons, digital equipment is replacing analog (Bensinger, 2003: 17-18).

It is the anticipation of these changes that lead voice and data network equipment manufacturers to merge with one another and/or buy small start-up firms specializing in emerging technologies. The most notable events have been Bay Networks merger with Northern Telecom to form Nortel Networks, Lucent's combination with Ascend Communications, and Cisco's purchase of literally dozens of small companies - all in pursuit of expanded product lines and services (Graham-Hackett, 2003b: 13-14).[13]

The idea of using one network to carry different kinds of traffic also may be applied to households, and this is where cable TV becomes part of the mix. About 70 percent of households with a TV subscribe to cable. The Telecommunications Act of 1996, rule changes by the Federal Communications Commissions (FCC), and other legal changes permit cable operators and telephone companies to enter one another's businesses. Cable Internet started to develop in 1996 and 1997. It initially was "a patchwork of fledgling networks with incompatible standards" (Amobi, 2003: 16), but a single standard for cable modem technology emerged in late 2001.

Just as network hardware and communications equipment companies merged or formed alliances, so have cable TV companies partnered with ISPs. By the end of 2002, cable modems accounted for almost two-thirds of all high-speed Internet access. The high-speed Internet access of cable modems far exceeds the transmission rate (56 kbps) of dial-up services first offered by telephone companies. The latter now offer the much faster digital subscriber lines (DSLs), but cable is still favored because it is slightly easier to install, and has prices 10 to 20 percent lower than those of regional Bells. Customers also like the cost savings and convenience of using one provider. High-speed data transmission via satellites is also available, but remains a distant third behind cable modem and DSL due to its high cost (Amobi, 2003).

The use of fiber optic cable by cable TV operators enables them to offer a variety of new services in addition to more channels (there were at least 300 as of early 2003) and even higher speed Internet access. Included are telephone service, high-definition TV (HDTV)[14], and interactive TV. Interactive TV allows users to do things that ordinary TV does not: connect to other viewers, select a video from a central library, play games, shop, and conduct banking transactions. The large investment required of both the service provider and consumer may explain why it has not been widely adopted (Amobi, 2003: 17).

Most communications equipment lasts for 10 to 15 years. Although rapid technological progress continues to be made, owners are reluctant to replace the extant equipment because it costs millions of dollars to build and expand networks. The boom in equipment spending in 2000 was the result of new competitors starting business after deregulation. They

bought the latest equipment, but financial difficulties during 2001 forced many of the new competitors into bankruptcy. Nevertheless, the new equipment will remain in place under different owners, and there will be a reduced need for fiber-optic equipment for years. Similarly, the initial work in building nationwide wireless networks is largely complete. Spending for wireless equipment may be greater than for wireline as the service providers in the former seek upgrades (Bensinger, 2003: 23).

The digitalization of communications and the incorporation of sophisticated chips have enabled connections to the Internet without the use of a computer and associated wires or cables. The use of wireless phones or personal data assistants for such purposes further blurs the distinction between computing and communications equipment. More recently, such devices incorporate cameras and picture transmission capabilities (Smith, 2003: 12). This is a stark contrast with the way things were. Commercially available mobile telephone service began in 1946, but the transmission devices were heavy, the costs high, calling distances limited, and capacity limited to 35 concurrent calls in the local area. Things began to change in 1983 with the introduction of cellular technology (so-called because the regional transmitters relayed a call from one transmission cell to another). The market for wireless communication has grown since then (Bensinger, 2003: 17).

The infrastructure for wireless communications includes switches, base stations, antennas and even satellites. Users need only buy handsets and/or pagers. Wireless services use various portions of the electromagnetic spectrum for different types of transmissions. Reduced prices and improved transmission quality have drawn increasing numbers of users into the market, particularly for cell phones and satellite television. (The only difference between cellular and PCS is that the former usually is based on analog technology and uses a lower frequency in the electromagnetic spectrum than the latter). One consequence of this has been pressure on the FCC to change the rules about who can use which portion(s) of the spectrum (Bensinger, 2003: 21-22).[15]

Computers and the networks of which they are a part do not work without software. Software is a generic term referring to sets of instructions in symbolic languages that control computer hardware. Software also is how users communicate with computers to create, retrieve, modify, output or save data.[16] There are two overarching types of software: systems software, and applications software. Systems software - specifically the operating system - monitors and controls a computer's resources and organizes data. Different types of computers need different operating systems.[17] Applications software enables computers to perform sets of specific functions as the user directs. There are applications packages for word processing, graphic design, various mathematical and statistical analyses, and accounting and payroll processing.

Software has become increasingly important as computers and related electronic devices proliferate. The expansion of the Internet also is spurring the spread of software applications. Examples include online banking and payments, financial services, travel services, retail and delivery systems (Rudy, 2003).

Two software innovations simplified and enhanced access to the Internet: the World Wide Web (the www in Internet addresses, and a.k.a. the Web) and the browser. The Web, the largest segment of the Internet, uses hypertext mark-up language (HTML) to reference and view documents. Users can "gather information in various… formats, including text, photos, audio samples, and video clips" (Rudy, 2003: 11). Users also can download data sets for further processing with other applications software. Browsers are the graphic user interfaces for these purposes. The most popular browsers are those written by Microsoft and Netscape Communications (Kessler, 2003: 18-19). (America Online acquired the latter in 1999 before its merger with Time Warner.)

The demand for software (and the programming skills to use it) grows as computer use grows and spreads. The greater processing power of computers - whether PCs, servers, workstations, or mainframes - requires more sophisticated software to run them and make use of their capacities. Cycles in software sales follow improvements in hardware - there is a rush to upgrade software after new hardware arrives on the market, as well as cycles following the expansion and contraction of the economy (Rudy, 2003).

Microsoft and Oracle are the largest independent software vendors. In fact, Microsoft's Windows program package runs 90 percent of the PCs in the world. The company also has 90 percent of the Internet browser market (Graham-Hackett, 2003a; Rudy, 2003).[18] It should be noted that some of the largest software vendors are companies manufacturing computers, notably Sun Microsystems' Unix, and IBM (particularly after the latter's purchase of Lotus). Hardware companies may also encourage independent software companies to write software for their machines (Rudy, 2003: 8-9).

Beyond hardware and software are those individuals and organizations using them to provide services to clients. The computer services organizations engage in a variety of activities that can be classified into two general categories: professional services and processing services. The professional services category includes systems integration, programming, outsourcing, consulting, and training - usually customized to meet the clients' needs. Systems integration refers to connecting all of an organization's hardware and software into a smoothly functioning network processing a variety of data. Systems integration organizations stay in business because they have expertise surpassing that of their clients. Organizations also may hire a computer services firm to perform at least part of the data processing and management for them. The financial advantage to the client is a reduction of costs (employment and capital expenditures are shifted to the vendor) and taxes (outsourcing fees are deductible as a business expense; owning the hardware is merely depreciable). Customized programming is not growing as fast as other parts of this service industry because of the proliferation of packaged software (Stice, 2003: 15-17).

Processing service refers to the routine aspects of running an organization: collecting, organizing and storing information for record keeping. Whether it is financial information, insurance claims, payroll and other aspects, these firms achieve

economies of scale (and reduced expenses for their clients) by spreading their costs over a broad client base. Some companies specialize in information retrieval (Stice, 2003: 18).

The role of the computer services industry has always been to help clients use technology more efficiently, and the industry has changed as the technology has developed. The most notable recent technological developments affecting the industry have been the rapid expansion of the Internet and the linkage of organizations' computer equipment into networks. Computer service companies have helped their clients create easier-to-use and more informative web sites to facilitate transactions, and have the expertise to link various types of computers from different manufacturers into a functioning whole. Organizations in any industry may use computer services companies, but the largest spenders are manufacturers. Other multi-billion-dollar-spending industries include banks, governments, financial markets, and communication/media companies. IBM is the leading service provider in this area, but it has only 7.5 percent of the market (Stice, 2003: 10-11).

THE OUTLOOK

At least some of the trends mentioned in the preceding section are expected to continue for the foreseeable future, while others may not. Microchip manufacturing exemplifies both parts of the preceding statement. Over their 40-year history, microchip sales averaged 17 percent annual growth due to increasing power and applications, and falling prices. The number of transistors on a chip - and therefore its computing power - has doubled about every 18 months since 1975 because scientists and engineers continue to shrink circuitry line-widths and make interconnections of the chip with other components more reliable. Some people following the industry think companies can continue this trend for five or 10 more years because scientists and engineers have been adept at overcoming past technological obstacles.

However, average annual growth rates may fall to nine percent as the industry matures, and a minimum line-width may be reached beyond which circuits may no longer be made smaller due to the laws of physics. This in turn will limit the speed, power, and cost effectiveness chips (Smith, 2003: 10, 15). Circumventing this limit would require taking experimental technologies, such as quantum computing, from science labs to factories (Scientific American, n.d.).

Market forces may also combine with new technologies to reduce the demand for older technology products. For example, TV tube production (NAICS 334411) may decline in the U.S. for two reasons: much lower labor costs may be found overseas, and new display screen technologies may gain favor, especially as HDTV spreads (Niquette, 2003).

The percentage of American households with PCs increased from 22 to 59 between 1993 and 2002. While higher-than-average growth rates for PCs sales are expected over the long term (Kessler, 2003: 13), the near-term outlook remains lackluster, with only a small percentage increase in sales forecast for 2003. Adding to the modest current forecast is the fact that server market demand has stabilized at levels lower than the boom of the late 1990s. Nevertheless, Graham-Hackett (2003a: 1-5) thinks that there is an upgrade cycle in progress - one that is gradual and modest compared with past upgrade cycles. By contrast, international markets offer good prospects for long-term growth, with average annual rates greater than those forecast for the U.S. The Asia-Pacific market (excluding Japan) is expected to lead all others (Graham-Hackett, 2003a: 15). The PC manufacturing industry is expected to move further toward oligopoly with the top five PC makers expected to have 70 percent of sales in the near future (Graham-Hackett, 2003a: 7).

The growth of PC sales around the world would be part of the expected growth of the Internet. Worldwide business spending conducted via the Internet is expected to roughly quadruple from 2002 levels to between $5 and $6 trillion in 2006. In particular, European usage of the Internet, held back by the high cost of access, is expected to increase as telecommunications deregulation advances (Kessler, 2003: 12-13).

The nexus of the Internet with communications equipment and cable TV operators is one of considerable ferment. "Convergence of voice, data, video, and related applications will likely remain important themes for the foreseeable future. … a wave of continued innovation and technological development in broadcasting, telephony, and Internet services [will] have a profound long-term effect on the industry's fortunes and competitive landscape" (Amobi, 2003: 11). For example, the cable TV industry currently uses physical circuit-switch telephone technology. Coming soon is the implementation of packet-switching technology via soft switches with the Internet protocol commonly used in cable modems. It is cheaper than the technology currently in place. However, observers are unsure about how the FCC might classify this new technology, raising the possibility of retail rate regulations (Amobi, 2003: 16-17). Regardless of how such issues are resolved, further revenue growth is expected from home shopping, residential and business telephony, video games, video on demand and other interactive applications through high-speed Internet access (Amobi, 2003: 23).

The long term forecast for the software industry, independent of economic cycles, is for faster than average growth in sales and employment. Growth is expected to be greater at the PC end of the continuum than at the mainframe end. However, future growth, regardless of the product or service, is expected to be slower than in the past as the industry matures (Rudy, 2003).

Although some analysts' expectations for the future may be realized, readers should remember Graham-Hackett's caution: "In the world of technology, however, nothing is ever static. … The industry's participants are thus facing new challenges and challengers, and the competitive landscape could drastically change again over the next several years" (2003b: 19).

APPENDICES

DETAILED TABLES

TABLE A1a: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES – MANUFACTURING

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* ABB, Inc.	Lake	334513		1,200
* AT&T Corp./AT&T Government Solutions	Greene	334519		55
* Berkshire Hathaway/Scott Fetzer Co./Meriam Process Technologies	Cuyahoga	334513		100
* Cisco Systems, Inc.	Summit	33429		150
* Computer Associates International, Inc.	Cuyahoga	334119		103
* Danaher Corp./Namco Controls Corp.	Cuyahoga	334419		12
* Diebold, Inc.			862	
Diebold, Inc.	Stark	334119		600
Diebold, Inc.	Licking	33429		262
* Eastman Kodak/Scitex Digital Printing, Inc.	Montgomery	334119		595
* Eaton Corp.	Franklin	334119		250
* EMC Corp.	Cuyahoga	334112		50
* Emerson Electric Co.			1,400	
Fusite	Hamilton	334419		300
Therm-O-Disc, Inc.	Richland	334512		1,100
* Energizer Holdings, Inc./Schriber Co.	Montgomery	334512		100
* General Electric Co., Inc.			808	
General Electric Co., Inc.	Licking	334419		150
GE Energy Services	Tuscarawas	334416		24
GE Medical Systems	Cuyahoga	334517		54
GE Quartz, Inc.	Lake	334419		160
GE Reuter-Stokes, Inc.	Summit	334519		170
USA Instruments	Portage	334416		250
* Goodrich Corp.	Portage	334511		70
* Honeywell International, Inc./Honeywell Sensotec, Inc.	Franklin	334513		200
Keithley Instruments, Inc.	Cuyahoga	334515		500
* Lockheed Martin Corp./Naval Electronics	Summit	334511		600
* Lucent Technologies, Inc.			2,119	
Lucent Technologies, Inc.	Franklin	33421		15
Lucent Technologies, Inc.	Franklin	33429		2,104
* Matsushita-Toshiba/MT Picture Display Corp. of America[2]	Miami	334411		1,300
* Motorola, Inc.	Cuyahoga	33429		25
* NCR Corp.	Montgomery	334119		2,960
* Northrop Grumman Corp.			350	
Northrop Grumman Information	Greene	334413		100
Xetron Corp.	Hamilton	334511		250
* Parker Hannifin Corp.			140	
CTC Parker Automation	Clermont	334113		40
Parker Hannifin Corp.	Cuyahoga	334513		100
* PerkinElmer, Inc./PerkinElmer Optoelectronics	Montgomery	334419		34

TABLE A1a: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES – MANUFACTURING

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* Rockwell Automation, Inc.			616	
Reliance Electric Industrial	Cuyahoga	334513		600
Rockwell Automation, Inc.	Delaware	334513		16
* Royal Philips Electronics N.V./Philips Medical Systems	Cuyahoga	334517		1,200
* Saint-Gobain Co./Crystals & Detectors	Geauga	334519		200
* Siemens Corp.			405	
Siemens Airfield Solutions, Inc.	Franklin	334511		130
Siemens Energy & Automation	Clermont	334513		5
Siemens Energy & Automation/Siemens Machine Tool Business	Warren	334512		270
* SPX Corp./General Signal Corp.	Geauga	334515		10
Sumitomo Metal Industries-Mitsubishi Materials/SUMCO USA[4]	Warren	334413		340
Systemax, Inc./Systemax Manufacturing, Inc.	Miami	334111		550
* Thermo Electron Corp./Gould Instrument Systems, Inc.	Cuyahoga	334513		60
* Verizon Communications, Inc./Verizon Select Services, Inc.	Franklin	33421		7

See the footnotes and sources at the end of the last table.

TABLE A1b: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES - COMPUTER SERVICES

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* Alltel Corp.			661	
Alltel Information Services	Butler	51421		31
Alltel Communications, Inc.	Portage	541512		130
Alltel Data Center	Summit	541511		500
* Ball Corp./Ball Aerospace & Technologies Corp.	Greene	541519		200
* Banc One Corp./Banc One Services Corp.	Cuyahoga	51421		50
Battelle Memorial Institute	Montgomery	541511		28
* Cendant Corp.	Franklin	51121		135
* CenturyTel, Inc.	Lorain	514191		150
* Ceridian Corp./Ceridian Empowerment, Inc.	Cuyahoga	541511		25
CheckFree Corp./CheckFree Services Corp.	Franklin	541511		600
* Computer Associates International, Inc.			121	
Computer Associates International, Inc.	Greene	51121		15
Computer Associates International, Inc.	Warren	541511		106
* Computer Sciences Corp.	Greene	514191		45
* Dana Corp.	Lucas	541519		150
* Dominion Resources, Inc./Dominion Resources Services	Cuyahoga	541519		80
* Electronic Data Systems Corp.			45	
Electronic Data Systems Corp.	Montgomery	51421		20
Electronic Data Systems Corp.	Cuyahoga	541512		25
* Emerson Electric Co./Liebert Corp./Liebert Global Services, Inc.	Delaware	541519		200
* FedEx Corp./FedEx Services	Summit	541512		175
* Fiserv, Inc./Fiserv Cleveland, Inc.	Cuyahoga	541519		62
* Gannett Co., Inc./Gannett Media Technologies	Hamilton	541511		62
* General Electric Co., Inc.			210	
General Electric Co., Inc.	Hamilton	541513		150
Global Exchange Services	Cuyahoga	51421		60
* Harley-Davidson Motor Co./Harley-Davidson Dealer Systems	Cuyahoga	541511		100
* Honeywell International, Inc.	Hamilton	51121		100
* Intuit, Inc./M R I	Cuyahoga	541511		200
MCI and subsidiaries[3]			825	
MCI Subsidiary	Cuyahoga	514191		25
MCI Subsidiary	Franklin	514191		800
* NCR Corp./Gasper Corp.	Montgomery	541511		75
* NEC	Stark	541511		25
* NiSource, Inc./Columbia Energy Group Service	Franklin	541512		400
* Northrop Grumman Corp.			520	
ITTASC-TASC	Greene	541512		150
Northrop Grumman Information	Greene	541511		70
Northrop Grumman Information	Montgomery	541511		30

TABLE A1b: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES - COMPUTER SERVICES

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
Northrop Grumman Corp. (continued)				
Northrop Grumman Mission Systems	Montgomery	51121		200
Northrop Grumman Space/Mission	Franklin	541512		70
* Novell, Inc.	Franklin	541511		50
OCLC, Inc.			1,042	
OCLC, Inc.	Franklin	514191		1,000
OCLC, Inc.	Fayette	51421		42
* Quest Diagnostics, Inc./Medplus, Inc.	Hamilton	51121		100
* SBC Communications, Inc./Sterling Commerce, Inc.	Franklin	51121		1,000
* Science Applications International Corp.	Franklin	541512		30
* Sungard Data Systems, Inc./Sungard Recovery LP	Franklin	51421		20
* Time Warner, Inc.[6]/America Online, Inc.	Franklin	514191		500
* Tyco International, Inc./Real Time Systems, Inc.	Hamilton	541512		25
UGS PLM solutions	Clermont	541511		600
* Unisys Corp.	Franklin	541511		60
* Xerox Corp./Bradley Co.	Cuyahoga	541511		30

See the footnotes and sources at the end of the last table.

TABLE A1c: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES – TELECOMMUNICATIONS

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* Adelphia Communications Corp.			670	
Adelphia Communications Corp.	Cuyahoga	51322		70
Adelphia Communications Corp.	Cuyahoga	51322		300
Adelphia Communications Corp.	Licking	51322		100
Adelphia Communications Corp.	Ross	51322		200
* Alltel Corp.			1,803	
Alltel Corp.	Summit	51331		300
Alltel Communications, Inc.	Ashtabula	51331		100
Alltel Communications, Inc.	Hardin	51331		20
Alltel Communications, Inc.	Summit	51331		100
Alltel Communications, Inc.	Summit	51331		100
Alltel Communications, Inc.	Licking	513322		74
Alltel Communications, Inc.	Mahoning	513322		250
Alltel Ohio, Inc.	Belmont	51331		30
Alltel Ohio, Inc.	Lucas	513322		168
* AT&T Corp./AT&T Corp.	Franklin	51331		700
* AT&T Wireless Services, Inc.			180	
AT&T Wireless Services, Inc.	Cuyahoga	513322		150
AT&T Wireless Services, Inc.	Hamilton	513322		30
Block Communications, Inc.			653	
Buckeye CableSystem	Lucas	51322		600
Buckeye CableSystem/Toledo Area Telecommunications	Lucas	51322		20
Erie County Cablevision, Inc.	Erie	51322		33
* Cincinnati Bell, Inc.			3,125	
Cincinnati Bell, Inc.	Hamilton	51331		2,000
Cincinnati Bell, Inc.	Hamilton	51331		1,000
Cincinnati Bell, Inc.	Hamilton	513322		125
* CenturyTel, Inc./CenturyTel Midwest-Michigan	Lorain	51331		29
* Cox Communications, Inc.	Cuyahoga	51322		130
* FirstEnergy Corp./First Communications LLC	Summit	51331		100
MCI and subsidiaries[3]			275	
MCI Subsidiary	Cuyahoga	51331		130
MCI Subsidiary	Hamilton	51331		70
MCI Subsidiary	Lucas	51331		25
MCI Subsidiary	Cuyahoga	513322		50
* Nextel Communications, Inc.	Franklin	513322		20
* Qwest Communications International, Inc.			1,100	
Qwest Communications	Franklin	51331		600
Qwest Communications	Franklin	513322		500

TABLE A1c: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES – TELECOMMUNICATIONS

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* SBC Communications, Inc.			5,801	
ADT Security Services, Inc.	Montgomery	51331		150
Ameritech	Fayette	51331		20
Ameritech Corp.	Lawrence	51331		20
Ameritech Publishing, Inc.	Summit	51331		50
Ameritech Services, Inc.	Cuyahoga	51331		20
Cingular Wireless LLC	Cuyahoga	513322		50
Cingular Wireless LLC	Hamilton	513322		23
SBC Ameritech Services, Inc.	Muskingum	51331		25
SBC Communications, Inc.[5]	Cuyahoga	51331		4,343
SBC Communications, Inc.	Franklin	51331		1,100
* Sprint Corp./Sprint Directory			1,025	
Sprint Directory	Richland	51331		350
Sprint Directory	Richland	51331		500
Sprint Directory	Richland	51331		75
Sprint Directory/Sprint Communications Co. LP	Franklin	51331		30
Sprint Spectrum LP	Warren	513322		70
* Time Warner, Inc.[6]			1,277	
Time Warner Cable	Allen	51322		125
Time Warner Cable	Franklin	51322		500
Time Warner Cable	Montgomery	51322		80
Time Warner Cable	Montgomery	51322		300
Time Warner Cable	Richland	51322		50
Time Warner Cable NE Ohio	Summit	51322		80
Time Warner Entertainment Co. LP	Miami	51322		50
Time Warner Entertainment Co. LP	Preble	51322		33
Time Warner Telecom	Franklin	51331		29
Time Warner Telecom	Butler	513322		30
* Verizon Communications, Inc.			1,507	
Verizon Communications, Inc.	Marion	51331		180
Verizon Communications, Inc.	Scioto	51331		25
Verizon Communications, Inc.	Wood	51331		100
Verizon North, Inc.	Marion	51331		125
Verizon North, Inc.	Medina	51331		30
Verizon North, Inc.	Montgomery	51331		25
Verizon North, Inc.	Carroll	513322		25
Verizon Wireless	Tuscarawas	51331		25
Verizon Wireless	Cuyahoga	513322		25
Verizon Wireless	Cuyahoga	513322		50
Verizon Wireless	Cuyahoga	513322		25

TABLE A1c: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES – TELECOMMUNICATIONS

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* Verizon Communications, Inc. (continued)				
Verizon Wireless	Cuyahoga	513322		25
Verizon Wireless	Franklin	513322		501
Verizon Wireless	Franklin	513322		25
Verizon Wireless	Hamilton	513322		25
Verizon Wireless	Hancock	513322		25
Verizon Wireless	Knox	513322		25
Verizon Wireless	Licking	513322		25
Verizon Wireless	Lorain	513322		30
Verizon Wireless	Lucas	513322		50
Verizon Wireless	Montgomery	513322		30
Verizon Wireless	Montgomery	513322		20
Verizon Wireless	Stark	513322		30
Verizon Wireless	Summit	513322		25
Verizon Wireless/Airtouch Cellular	Cuyahoga	513322		36
* XO Communications, Inc./XO Communications LLC			155	
XO Communications LLC	Cuyahoga	51331		40
XO Communications LLC	Franklin	51331		115

See the footnotes and sources at the end of the last table.

TABLE A1d: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES - TECH CLUSTER

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* Abbott Laboratories	Franklin	54171		75
* AK Steel Corp.	Butler	54171		150
* Akzo Nobel, Inc./Flexsys America LP	Summit	54171		70
* Alstom, SA/Alstom Power, Inc.	Hamilton	54133		35
* American Electric Power Co., Inc.	Franklin	54138		70
* Ashland, Inc./Ashland Specialty Chemical Co.	Franklin	54171		1,200
Battelle Memorial Institute			3,208	
Battelle Memorial Institute	Cuyahoga	54171		52
Battelle Memorial Institute	Franklin	54171		3,000
Battelle Memorial Institute	Madison	54171		50
Battellepharma, Inc.	Franklin	54171		51
Velocys, Inc.	Union	54171		55
* CDI Corp./CDI Engineering Solutions	Hamilton	54133		220
* CH2M Hill/CH2M Hill Ohio, Inc.	Montgomery	54133		40
* Crompton Corp./Dublin Technical Center	Franklin	54171		69
* CSX Transportation. Inc.	Medina	54133		21
* Dana Corp./Torque & Traction	Lucas	54138		100
* Diebold, Inc.	Stark	54171		800
* DuPont-Dow Elastomers LLC	Summit	54138		45
* E.On AG			175	
Degussa Flavors	Hamilton	54171		150
Degussa Corp.	Summit	54138		25
* Eaton Corp./Eaton Fluid Power Hydraulic	Lucas	54133		150
* Energizer Holdings, Inc./Everyready Battery Co.	Cuyahoga	54171		600
* Ferro Corp.	Cuyahoga	54171		75
* FirstEnergy Corp.	Summit	54138		25
* Flowserve Corp.	Montgomery	54171		60
* General Dynamics Corp.	Montgomery	54133		35
* General Electric Co., Inc.			320	
GE Aircraft Engines	Adams	54138		265
GE Energy & Environmental Research	Wayne	54133		25
GE Industrial Systems Engineering	Hamilton	54133		30
* Goodrich Corp.			75	
Goodrich Corp.	Cuyahoga	54171		15
L-3 Communications Avionics	Franklin	54133		60
* Goodyear Tire & Rubber Co.	Summit	54171		200
* Great Lakes Chemical Corp./WIL Research Laboratories	Ashland	54171		314
* Harris Corp.	Warren	54171		250
* Hitachi-Volvo AB/Euclid-Hitachi Heavy Equipment[1]	Cuyahoga	54133		100

TABLE A1d: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES - TECH CLUSTER

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* Honda			2,500	
Honda R & D America, Inc.	Union	54171		2,000
Transportation Research Center	Logan	54138		500
* Honeywell International, Inc./Honeywell Corp.	Wood	54171		100
* Illinois Tool Works, Inc./FEG Corp.	Miami	54171		200
* Jacobs Engineering Group, Inc./Sverdrup Technology, Inc.	Greene	54133		100
Kendle International, Inc.	Hamilton	54171		500
* Lockheed Martin Corp.	Greene	51421		45
* MeadWestvaco Corp.			190	
MeadWestvaco Corp.	Montgomery	54133		20
MeadWestvaco Corp.	Montgomery	54133		30
MeadWestvaco Corp.	Ross	54171		140
* Michelin/Michelin N. America, Inc.	Summit	54171		60
* Millennium Chemicals, Inc./Millennium Petrochemicals, Inc.	Hamilton	54171		40
NASA: John H. Glenn Research Center	Cuyahoga	54171		6,114
* Nestle			325	
Nestle USA, Inc.	Franklin	54138		100
Nestle USA, Inc./Nestle R & D Center Ohio	Union	54171		225
* Northrop Grumman Corp.			500	
Northrop Grumman Corp.	Cuyahoga	54133		250
Northrop Grumman Information	Cuyahoga	54171		250
Noveon, Inc.	Cuyahoga	54171		700
* Owens Corning	Licking	54171		400
* Parker Hannifin Corp.			160	
Parker Hannifin Corp.	Lake	54133		110
Parker Hannifin Corp.	Lake	54138		50
* Procter & Gamble Co.			3,350	
Health Care Research Center	Warren	54171		2,500
Procter & Gamble Co.	Hamilton	54171		850
* Rockwell Automation, Inc.			1,540	
Rockwell Automation, Inc.	Cuyahoga	54133		1,500
Rockwell Automation, Inc.	Cuyahoga	54133		40
* Saint-Gobain Co./NorPro	Summit	54138		70
* Science Applications International Corp.	Greene	54171		400
* Shaw Group, Inc./Shaw Environmental/Infrastructure	Hamilton	54133		100
* Sherwin-Williams Co.	Cuyahoga	54171		300
* Siemens Corp.			62	
Siemens Dematic Corp.	Hamilton	54133		22
Siemens Energy & Automation	Hamilton	54133		40
* Timken Co.	Stark	54171		300

TABLE A1d: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES - TECH CLUSTER

Parent/Company/Division	County	Primary NAICS (1997)	Jobs Subtotal	Jobs Site
* URS Corp.			235	
URS Corp.	Hamilton	54133		100
URS Corp.	Summit	54133		100
URS Greiner Woodward Clyde	Montgomery	54133		35
U.S. Environmental Protection Agency	Hamilton	54138		2,000

See the footnotes and sources at the end of the last table.

TABLE A1e: LEADING AND NOTABLE# COMPANIES IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES - TOTALS FOR THOSE WITH ESTABLISHMENTS IN MORE THAN ONE CLUSTER

Company	Total Jobs
* Alltel Corp.	1,803
* AT&T Corp.	755
Battelle Memorial Institute	3,236
* CenturyTel, Inc.	179
* Computer Associates International, Inc.	224
* Dana Corp.	250
* Diebold, Inc.	1,662
* Eaton Corp.	400
* Emerson Electric Co.	1,600
* Energizer Holdings, Inc.	700
* FirstEnergy Corp.	125
* General Electric Co., Inc.	1,338
* Goodrich Corp.	145
* Honeywell International, Inc.	400
* Lockheed Martin Corp.	645
MCI and subsidiaries[3]	1,100
* NCR Corp.	3,035
* Northrop Grumman Corp.	1,370
* Parker Hannifin Corp.	300
* Rockwell Automation, Inc.	2,156
* Saint-Gobain Co.	270
* SBC Communications, Inc.	6,801
* Science Applications International Corp.	430
* Siemens Corp.	467
* Time Warner, Inc.[6]	1,777
* Verizon Communications, Inc.	1,514

Notes: # - "Leading and Notable" is not used as an evaluative term; generally, it refers to companies employing at least 500 people or companies on Fortune's U.S. 1,000 or global 500 lists.
* - A Fortune U.S. 1000 or global 500 company.
1 - A joint venture between Hitachi and Volvo AB. Both are global 500 firms.
2 – From Niquette (2003); formerly MDDA Panasonic (Harris, 2003a).
3 - WorldCom/MCI is in bankruptcy and is changing its name to MCI.
4 – Employment is expected to increase by 260 jobs with the consolidation of operations from other states (Office of Strategic Research, 2004).
5 – The employment figure is from Crain's (2003).
6 - AOL is being dropped from the name.

Sources: Conroy (2003), Crain's (2003), Dayton Business Journal (2004), Google (2003), Harris (2003a, 2003b), Honeywell Sensotec (2003), Hoover's (2003), LexisNexis (2003), Niquette (2003), Office of Strategic Research (2004), Royal Philips Electronics (2004).

TABLE A2: EXPANSIONS AND ATTRACTIONS IN OHIO'S ADVANCED ELECTRONICS AND RELATED INDUSTRIES, 2000-2002

Year	Parent/Company/Division	County	NAICS Code	Product	New or Expanded	Total Invested	Jobs	Space (Sq. Ft.)
2000	Accelent Systems, Inc.	Summit	541511	Internet software	New		10	25,000
2000	Actron Manufacturing	Cuyahoga	334519	Auto test equipment	New	$2,750,000	15	90,000
2000	Adelphia Business Solutions	Franklin	51331	Telecommunications	New	$10,000,000	50	
2000	Alabanza Corp.	Jefferson	51419	Internet services	Expanded	$5,750,000	290	
2000	Alltel Co.	Summit	51331	Telecommunications	New			40,000
2000	Alpha Micron	Portage	54138	Liquid crystal displays	Expanded	$1,000,000		
2000	Alta Analytics	Franklin	541511	Fraud detection software	New		58	17,000
2000	American Systems Consulting/ASCI	Franklin	51419	Web services	New		130	25,000
2000	APSCO	Lake	334412	Circuit boards	Expanded	$5,700,000	140	40,000
2000	Argent/ABR Infocom	Cuyahoga	513322	Telecommunications	Expanded	$20,000,000		
2000	AT&T	Jefferson	51331	Telecommunications	New	$1,500,000		24,000
2000	AT&T	Summit	51331	Telecommunications	Expanded	$1,272,000		
2000	AuGRID of Nevada	Summit	334411	Thin CRTs	New	$1,500,000	45	45,000
2000	Battelle	Franklin	54171	R&D	Expanded	$3,500,000		11,200
2000	Broadwing IT Consulting	Hamilton	51331	Telecommunications	Expanded		42	39,000
2000	Clear Channel Communications	Cuyahoga	51311	Broadcasting	New			60,000
2000	Colo.com	Cuyahoga	51419	Internet services	New	$15,000,000	10	28,000
2000	Community ISP	Lucas	514191	Internet services	Expanded	$10,400,000	70	
2000	CompuServe	Franklin	514191	Internet services	Expanded	$16,470,000	55	
2000	Computer Associates International	Franklin	541511	Software	New		63	
2000	Computer Associates International	Warren	541511	Software	Expanded	$1,000,000	53	37,000
2000	Compuware	Cuyahoga	541512	E-commerce software	New		55	21,000
2000	CoreComm	Cuyahoga	51333	Operations center	New	$10,000,000	25	20,000
2000	CoreComm	Franklin	51334	Telecommunications	New			23,000
2000	Digineer, Inc.	Warren	541511	Software	New	$8,200,000	155	40,000
2000	DotCom Technologies	Summit	541511	E-business services	New	$1,250,000	177	
2000	D-Termination Wire	Ashtabula	334419	Cable harnesses	Expanded	$1,200,000	50	35,000
2000	Eclipse Networks	Hamilton	541511	Software	Expanded	$250,000	100	
2000	Electro Controls/Dickman	Shelby	334419	Electronic equipment	New	$1,125,000	55	33,250
2000	EPIC Technologies	Huron	334418	Electronic tire monitoring systems	Expanded		55	
2000	Eviciti Corp.	Hamilton	541511	E-commerce software	New		99	15,000
2000	Fisher Data Products	Montgomery	334519	Electronic equipment	New	$681,000	10	20,000
2000	FORESIGHT Corp.	Franklin	541511	Software	Expanded	$493,000	100	
2000	fourth channel, Inc.	Franklin	51419	Web industrial catalogs	New	$2,600,000	180	30,000
2000	Future Controls Corp.	Ashtabula	334512	Temperature controls	Expanded	$840,000	25	33,800
2000	GE Aircraft Engines	Hamilton	54171	Aircraft engines	Expanded		90	
2000	Genuity	Franklin	51419	Internet services	New		65	
2000	Giage Ltd.	Hamilton	541511	Software	Expanded	$750,000	60	10,000
2000	Hana Microdisplay Group	Summit	334119	Video display monitors	Expanded	$12,000,000	157	
2000	Heapy Engineering	Montgomery	54133	Engineering services	New	$3,000,000		30,000
2000	Horizon Computer Solutions	Ross	541511	Software products	New		70	
2000	HSR Business to Business	Hamilton	51419	Internet services	Expanded		25	60,000
2000	iMotors.com	Butler	514191	Internet services	New	$1,000,000	100	185,000

TABLE A2: EXPANSIONS AND ATTRACTIONS IN OHIO'S ADVANCED ELECTRONICS AND RELATED INDUSTRIES, 2000-2002

Year	Parent/Company/Division	County	NAICS Code	Product	New or Expanded	Total Invested	Jobs	Space (Sq. Ft.)
2000	Information Alternatives	Hamilton	541512	Software	New	$1,050,000		8,000
2000	Inservco, Inc.	Lorain	334419	Nuclear imagining parts	Expanded		140	
2000	Integrated Marketing Technology	Medina	51421	Data processing	Expanded	$2,700,000	25	44,000
2000	Interactive Information Services	Cuyahoga	541511	Web software	Expanded		90	
2000	itelligence	Hamilton	541512	Computer consultants	Expanded	$244,000	140	
2000	iwidgets	Hamilton	334111	Computers	Expanded	$15,000,000		12,000
2000	Keithley Instruments	Cuyahoga	334515	Testing equipment	Expanded		50	
2000	KnowToday	Hamilton	514199	Internet research engines	New	$400,000	86	
2000	Lastar.com	Montgomery	51419	Internet services	Expanded		100	
2000	Liebert Corp.	Lawrence	334513	Electronic controls	New	$6,400,000	428	194,000
2000	Logical Worldwide	Hamilton	541511	Software	New	$2,000,000		
2000	LogiKeep	Franklin	541511	Network security software	Expanded		53	10,000
2000	marchFIRST	Franklin	541511	Internet software	Expanded	$1,800,000	250	24,000
2000	Marconi Communications	Lorain	33422	Telecommunications eqpt	New			110,000
2000	Marconi Communications	Lorain	33422	Telecommunications eqpt	New			100,000
2000	McLeod USA	Franklin	51331	Phone switching facility	New	$1,500,000		20,000
2000	McLeod USA	Cuyahoga	51331	Telecommunications	New		7	22,400
2000	Medpace LLC	Hamilton	54171	Medical research	New	$600,000	36	30,000
2000	Microsoft Corp.	Hamilton	5112	Software	Expanded			22,000
2000	Mustang Dynamometer	Summit	334519	Measuring devices	Expanded		65	40,000
2000	National Patient Analytical	Richland	334513	Instruments	Expanded	$1,000,000		5,000
2000	Nestle USA	Cuyahoga	54138	Frozen foods	Expanded	$2,600,000	40	
2000	Netrex Connects	Cuyahoga	541511	Web software	New	$1,100,000	54	53,000
2000	Nextel Communications	Franklin	513322	Cellular Communications	New			37,000
2000	Node Com	Cuyahoga	51331	Telecommunications	New	$5,000,000	20	17,000
2000	Noteworthy Medical Systems	Cuyahoga	541511	Software	Expanded		60	10,000
2000	Pathlore Software Corp.	Franklin	541511	Software	Expanded	$460,000	50	
2000	PCS I	Cuyahoga	541511	Software	Expanded		50	
2000	PECO II	Crawford	33421	Communication equipment	Expanded	$12,750,000	255	144,000
2000	PerifiTech	Portage	334119	Computer components	New	$1,490,000	15	30,000
2000	Phontonics, Inc.	Wood	33422	Flat panel display parts	Expanded	$4,500,000	76	
2000	Photonic Integration Research	Franklin	334419	Fiber-optic circuits	Expanded			20,000
2000	Photonic Integration Research	Franklin	334419	Fiber-optic circuits	New	$3,000,000		62,000
2000	Pinnacle Data Systems	Franklin	334412	Circuit boards	Expanded			56,000
2000	Polymer Development/Akron Rubber	Summit	54138	Product testing	New	$860,000	22	28,000
2000	Punch Components	Allen	33431	TV tube rimbands	New	$6,900,000	70	50,000
2000	PurchasingFirst.com	Franklin	541511	Supply chain management	New		123	27,000
2000	RC Olmstead	Franklin	541511	Computer software	New	$1,000,000		18,000
2000	Revere Group Ltd.	Cuyahoga	51421	e-business services	Expanded	$150,000	61	
2000	Ricera	Lake	54138	Biomed research	Expanded	$9,200,000	51	5,100
2000	Schmidt Vogel Consulting America	Hamilton	541512	Computer consultants	New		140	
2000	Scott Technologies	Cuyahoga	334510	Safety equipment	Expanded	$1,100,000		
2000	Shiplogix, Inc.	Summit	514199	Web-based logistics	New		100	

TABLE A2: EXPANSIONS AND ATTRACTIONS IN OHIO'S ADVANCED ELECTRONICS AND RELATED INDUSTRIES, 2000-2002

Year	Parent/Company/Division	County	NAICS Code	Product	New or Expanded	Total Invested	Jobs	Space (Sq. Ft.)
2000	Sierra Lobo	Erie	54138	Mfg testing	New	$1,400,000	30	12,000
2000	SmartPipes	Franklin	51419	Web services	New	$11,700,000	354	80,000
2000	SMARTworks.com	Montgomery	51419	Internet services	New			25,700
2000	Software Management Group	Hamilton	541511	Telecommunications software	New	$500,000	55	9,200
2000	Spotlight Solutions, Inc.	Warren	541511	Software	New	$1,800,000	100	13,000
2000	Star-Bak	Franklin	33431	Streaming media box	New		12	22,000
2000	Switch & Data Facilities	Hamilton	514191	ISP facilities	New			23,000
2000	Synchrony Communications	Hamilton	51419	Internet	New		80	25,000
2000	TelePlace, Inc.	Cuyahoga	513322	Telecommunication networks	New	$10,000,000		
2000	Telesource Corp.	Cuyahoga	51331	Telephone services	New	$5,400,000	90	80,300
2000	Therm-O-Disc	Richland	334512	Temperature controls	Expanded	$1,500,000		
2000	Thinkronize	Hamilton	541511	Internet software	New		24	24,000
2000	Thomson Learning, Inc.	Warren	514191	On-line services	Expanded	$19,288,000	140	
2000	TL Industries	Wood	334512	Temperature controls	Expanded	$6,000,000	70	
2000	TMW Systems	Cuyahoga	541511	Software for trucking	New	$1,400,000	15	23,000
2000	Total Link	Montgomery	513322	Telecommunications	New	$2,500,000	190	
2000	UNICON International, Inc.	Franklin	541511	Software	New	$1,300,000	80	
2000	URS Greiner	Franklin	54133	Engineers	New			60,000
2000	URS Greiner	Hamilton	54133	Engineers	New			22,000
2000	ZoomTown.com, Inc.	Hamilton	51419	Internet services	Expanded	$80,500,000	15	
Subtotals: 2000						$365,323,000	6,596	2,654,950
2001	A Novo Broadband	Delaware	33422	Broadcast equipment	New		50	70,000
2001	Aesco Electronics	Summit	334418	Circuit assembly	New	$2,500,000		59,000
2001	Audiopack Technologies	Cuyahoga	33422	Communications systems	New	$1,300,000	20	51,000
2001	Ball Aerospace Technologies	Greene	54171	Electronic tracking	Expanded		75	
2001	Bulldog/JBS Technologies	Jefferson	33429	Car alarms	Expanded	$1,100,000	80	48,000
2001	Capital Communications	Delaware	5133	Telecommunications	New	$1,000,000		8,000
2001	Cardinal Commerce	Lake	541512	Web design	Expanded	$3,000,000		
2001	Chohesia Corp	Montgomery	541511	Engineering software	Expanded		50	
2001	Cintech Solutions, Inc.	Hamilton	51419	Web services	New	$1,200,000	80	40,000
2001	Cintech Systems	Hamilton	541511	Telecommunications software	Expanded	$1,200,000	80	23,000
2001	ComDoc	Franklin	541512	Computer systems	New	$500,000	50	25,000
2001	Datadvantage Corp.	Cuyahoga	5112	Software - op ctr	New	$2,000,000		30,000
2001	Datadvantage Corp.	Cuyahoga	5112	Software	New	$3,000,000	75	50,000
2001	Eaton Corp	Lake	54171	R&D	Expanded	$6,000,000		20,000
2001	Environmental Quality Management	Hamilton	54133	Engineering services	Expanded	$3,400,000	25	35,000
2001	Girindus America	Hamilton	54171	Biopharmaceutical R&D	New	$6,900,000	25	52,000
2001	goneHome.com	Stark	51419	Internet services	New	$675,000	307	
2001	Heiland Electronics	Cuyahoga	334417	Electronic assemblies	Expanded	$1,250,000		
2001	Hyland Software	Cuyahoga	5112	Software	New	$4,500,000	80	73,600

TABLE A2: EXPANSIONS AND ATTRACTIONS IN OHIO'S ADVANCED ELECTRONICS AND RELATED INDUSTRIES, 2000-2002

Year	Parent/Company/Division	County	NAICS Code	Product	New or Expanded	Total Invested	Jobs	Space (Sq. Ft.)
2001	iMedd, Inc.	Franklin	54171	Biotechnology	New	$16,300,000		20,000
2001	International Paper Co.	Clermont	54171	Paper technology	New	$11,700,000	260	85,000
2001	LeadScope, Inc.	Franklin	541511	R&D Software	Expanded	$3,000,000	68	
2001	LexisNexis	Montgomery	514191	Information services	Expanded		300	
2001	Liebert Corp.	Lawrence	334513	Electronic controls	Expanded	$9,400,000	300	68,000
2001	MedPlus	Hamilton	5112	Software	Expanded	$3,000,000		40,000
2001	Monsanto	Darke	54171	Seed research	New	$600,000	50	12,000
2001	NeoMed Technologies	Cuyahoga	334510	Diagnostic eqpt	New	$6,000,000	50	
2001	Nextel	Hamilton	513322	Cellular telecommunications	New	$2,000,000	80	18,500
2001	Nisman-Rozgonyi/EMX	Cuyahoga	334413	Sensors	New	$2,500,000	27	28,000
2001	North American Science Associates	Wood	54171	Medical device R&D	New	$6,500,000	25	52,000
2001	Paraspinal Diagnostic Corp.	Franklin	54171	Medical research	New	$650,000	75	8,000
2001	Powell Electrical Manufacturing	Stark	334417	Electronic parts	Expanded	$1,800,000	20	
2001	Pro Terra Environmental	Franklin	54171	Environmental services	New	$1,200,000		10,000
2001	Quark Biotech	Cuyahoga	54171	Biotech	New	$3,400,000	50	
2001	Sawyer Research/NDK	Lake	334419	Cultured quartz	Expanded	$31,500,000		8,000
2001	SBC - Ameritech	Cuyahoga	513322	Telecommunications	Expanded	$1,500,000		
2001	SBC - Ameritech	Cuyahoga	513322	Telecommunications	Expanded	$1,250,000		
2001	Schulman Associates IRB	Hamilton	54171	Reviews medical R&D	New	$2,100,000	8	36,000
2001	Secure Interiors	Franklin	541513	Computer protection	New	$2,000,000	80	
2001	Software Architects	Hamilton	541511	IT	New		60	11,400
2001	Spectra-Tech Manufacturing	Clermont	334412	Circuit boards	Expanded	$1,200,000	19	18,000
2001	Sprint Communications	Cuyahoga	51331	Telecommunications	Expanded	$1,200,000		4,000
2001	Sprint Communications	Seneca	51331	Telecommunications	Expanded	$1,700,000		
2001	Sprint Communications	Hamilton	513322	Telecommunications	Expanded	$1,000,000		4,000
2001	Thinkpath	Montgomery	54133	Engineering	Expanded	$3,000,000		
2001	Thorson Baker Associates	Summit	54133	Engineers	Expanded	$1,000,000		
2001	Ultryx Corp.	Delaware	541511	Software	Expanded		105	
2001	USA Cellular	Franklin	513322	Telecommunications	New	$1,000,000	30	14,000
2001	Velocys	Union	54171	Research	New	$2,000,000		22,000
2001	Winstar	Franklin	51333	Call center	Expanded	$2,300,000		
Subtotals: 2001						$160,325,000	2,604	1,043,500
2002	Aelita Software	Franklin	541512	Software	Expanded	$610,000	60	10,000
2002	CDO Technologies/VALU PAC	Hamilton	541511	Software	New	$7,000,000	200	40,000
2002	Cisco Systems	Summit	541512	Computer systems	Expanded	$5,900,000	80	70,000
2002	CMS Communications	Franklin	541512	Software	Expanded	$20,300,000	50	16,000
2002	Comwavz, Inc.	Hancock	514191	Internet services	New	$5,000,000	20	30,000
2002	Diebold, Inc.	Stark	334119	ATMs	Expanded	$9,466,000		
2002	Equential Technologies	Cuyahoga	541511	Software	New	$227,000	50	10,000
2002	Genome Research	Hamilton	54171	Bio-tech research	New	$35,000,000		

TABLE A2: EXPANSIONS AND ATTRACTIONS IN OHIO'S ADVANCED ELECTRONICS AND RELATED INDUSTRIES, 2000-2002

Year	Parent/Company/Division	County	NAICS Code	Product	New or Expanded	Total Invested	Jobs	Space (Sq. Ft.)
2002	GoSof.com	Montgomery	541511	Logistics software	New		60	
2002	Liebert Corp.	Lawrence	334513	Environmental controls	Expanded	$1,000,000	16	
2002	MedPlus	Warren	541511	Software	New		250	
2002	Metro One Telecommunications	Hamilton	51333	Call center	Expanded	$305,000	123	
2002	Microsoft Corp./Great Plains	Hancock	541511	Programming	New	$10,000,000	50	42,300
2002	Panasonic	Miami	334411	Digital projection tubes	Expanded	$17,000,000		
2002	Phonetel Technologies	Cuyahoga	51333	Pay phones	Expanded		50	
2002	PowerNetGlobal	Butler	514191	Internet provider	New	$1,300,000		60,000
2002	Ross Environmental	Lorain	54133	Industrial waste	New	$4,800,000	39	35,000
2002	SBC - Ameritech	Cuyahoga	51331	Communications	Expanded	$2,000,000		39,400
2002	SBC - Ameritech	Stark	51331	Communications	Expanded	$1,000,000		
2002	Sequelle, Inc.	Washington	514191	Internet services	Expanded	$5,610,000	20	
2002	ServerTown	Butler	541519	Computer services	New	$60,000,000	50	140,000
2002	Simbionix	Cuyahoga	334510	Surgical simulators	New	$2,600,000	29	
2002	SpeedVox	Lucas	51419	Internet services	New	$1,400,000	5	
2002	Switch and Data Facilities	Franklin	51331	Network data center	New	$2,000,000		26,630
2002	TDS Telecom	Cuyahoga	51331	Telecommunications	New	$20,000,000	20	
2002	Time Warner	Trumbull	5132	Cable TV	New	$2,145,000		
2002	Time Warner - AOL	Franklin	514191	Internet services	Expanded	$1,000,000	165	
2002	Valtronic USA	Cuyahoga	334418	Medical implant chips	Expanded	$1,000,000	60	
Subtotals: 2002						$216,663,000	1,397	519,330
Grand Totals:						$742,311,000	10,597	4,217,780

Source: Office of Strategic Research (2003).

Prepared by: Office of Strategic Research, Ohio Dept. of Development. Phone 614/466-2116 (DL, 1/04).

TABLE A3: ESTABLISHMENTS AND EMPLOYMENT IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES, OHIO AND U.S., 2001

2002 NAICS Codes	Short Title (2002)	Closest 1997 NAICS Codes	Ohio Establishments	Ohio Employment	Ohio Mean per Establishment	U.S. Establishments	U.S. Employment	U.S. Mean per Establishment	Ohio as a Percent of the U.S. Establishments	Ohio as a Percent of the U.S. Employment
	Total Covered Employment		269,944	4,932,943	18.3	7,095,302	115,061,184	16.2	3.8%	4.3%
	Advanced Electronics & Related Industries		8,496	182,210	21.4	269,488	6,489,398	24.1	3.2%	2.8%
334(p)	Computers & Electronic Products (part)	Same	493	34,935	70.9	15,673	1,549,084	98.8	3.1%	2.3%
3341	Computers & Peripheral Eqpt.	Same	51	2,333	45.7	1,916	199,637	104.2	2.7%	1.2%
334111	Electronic Computers	Same	14	337	24.1	546	72,507	132.8	2.6%	0.5%
334112	Computer Storage Devices*	Same	3	23	7.7	193	33,357	172.8	1.6%	0.1%
334113	Computer Terminals*	Same	2	10	5.0	133	10,411	78.3	1.5%	0.1%
334119	Other Computer Peripheral Eqpt.	Same	32	1,963	61.3	1,044	83,362	79.8	3.1%	2.4%
3342	Communications Eqpt.	Same	38	7,361	193.7	2,200	269,498	122.5	1.7%	2.7%
33421	Telephone Apparatus	Same	9	5,865	651.7	574	86,964	151.5	1.6%	6.7%
33422	Broadcast & Wireless Communications Eqpt.	Same	20	980	49.0	1,158	153,962	133.0	1.7%	0.6%
33429	Other Communications Eqpt.	Same	9	516	57.3	468	28,572	61.1	1.9%	1.8%
3343	Audio & Video Eqpt.	Same	14	502	35.9	561	28,686	51.1	2.5%	1.7%
3344	Semiconductors & Electronic Components	Same	169	12,253	72.5	5,973	603,160	101.0	2.8%	2.0%
334411	Electron Tubes	Same	12	3,806	317.2	147	16,524	112.4	8.2%	23.0%
334412	Bare Printed Circuit Boards	Same	36	1,468	40.8	1,314	80,070	60.9	2.7%	1.8%
334413	Semiconductor & Related Devices	Same	15	1,510	100.7	1,177	225,078	191.2	1.3%	0.7%
334414	Electronic Capacitors	Same	0	0	n.a.	119	18,236	153.2	0.0%	0.0%
334415	Electronic Resistors*	Same	3	130	43.3	99	10,629	107.4	3.0%	1.2%
334416	Electronic Coils, Transformers & Inductors	Same	11	249	22.6	408	17,278	42.3	2.7%	1.4%
334417	Electronic Connectors*	Same	7	249	35.6	330	37,235	112.8	2.1%	0.7%
334418	Printed Circuit Assembly	Same	20	1,382	69.1	716	105,810	147.8	2.8%	1.3%
334419	Other Electronic Components	Same	65	3,459	53.2	1,663	92,300	55.5	3.9%	3.7%
3345(p)	NMMC Instruments (part)*	Same	221	12,486	56.5	5,023	448,103	89.2	4.4%	2.8%
334510	Electromedical Apparatus	Same	13	418	32.2	475	50,808	107.0	2.7%	0.8%
334511	Search, Detection & Navigation Instruments*	Same	19	295	15.5	668	176,444	264.1	2.8%	0.2%
334512	Automatic Environmental Controls	Same	19	2,772	145.9	329	19,781	60.1	5.8%	14.0%
334513	Industrial Process Variable Instruments	Same	51	2,742	53.8	994	41,114	41.4	5.1%	6.7%
334514	Totalizing Fluid Meters & Counting Devices	Same	11	651	59.2	203	15,561	76.7	5.4%	4.2%
334515	Electricity & Signal Testing Instruments	Same	33	1,929	58.5	769	62,447	81.2	4.3%	3.1%
334516	Analytical Laboratory Instruments	Same	17	406	23.9	595	34,877	58.6	2.9%	1.2%
334517	Irradiation Apparatus	Same	6	826	137.7	160	12,572	78.6	3.8%	6.6%
334519	Other Measuring & Controlling Devices	Same	52	2,447	47.1	830	34,499	41.6	6.3%	7.1%

TABLE A3: ESTABLISHMENTS AND EMPLOYMENT IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES, OHIO AND U.S., 2001

2002 NAICS Codes	Short Title (2002)	Closest 1997 NAICS Codes	Ohio Establishments	Ohio Employment	Ohio Mean per Establishment	U.S. Establishments	U.S. Employment	U.S. Mean per Establishment	Ohio as a Percent of the U.S. Establishments	Ohio as a Percent of the U.S. Employment
	Subtotal: Computer Services Cluster		3,798	59,712	15.7	133,725	2,171,902	16.2	2.8%	2.7%
5112	Software Publishers	Same	291	9,789	33.6	10,353	353,344	34.1	2.8%	2.8%
518	ISPs, Search Portals & Data Processing		544	13,340	24.5	19,460	531,275	27.3	2.8%	2.5%
5181	ISPs & Search Portals	51419	241	3,491	14.5	10,172	213,734	21.0	2.4%	1.6%
518111	Internet Service Providers*	514191	234	2,991	12.8	9,608	202,142	21.0	2.4%	1.5%
518112	Web Search Portals*	514199(p)	7	500	71.4	564	11,592	20.6	1.2%	4.3%
51821	Data Processing & Related Services	51421	303	9,849	32.5	9,288	317,541	34.2	3.3%	3.1%
5415	Computer Systems Design & Related Services	Same	2,876	35,898	12.5	100,852	1,254,805	12.4	2.9%	2.9%
541511	Custom Computer Programming	Same	1,155	14,885	12.9	43,557	538,674	12.4	2.7%	2.8%
541512	Computer Systems Design	Same	1,157	15,945	13.8	37,243	538,673	14.5	3.1%	3.0%
541513	Computer Facilities Mgt.	Same	52	2,176	41.8	1,607	71,342	44.4	3.2%	3.1%
541519	Other Computer Related Services	Same	512	2,892	5.6	18,445	106,116	5.8	2.8%	2.7%
61142	Computer Training	Same	87	685	7.9	3,060	32,478	10.6	2.8%	2.1%
517	Telecommunications		1,781	42,303	23.8	49,554	1,466,609	29.6	3.6%	2.9%
5171	Wired Telecommunications Carriers	51331	1,102	27,645	25.1	27,509	905,518	32.9	4.0%	3.1%
5172	Wireless Telecommunications Carriers	51332	399	7,866	19.7	11,610	256,558	22.1	3.4%	3.1%
517211	Paging Services	513321	140	1,861	13.3	3,900	72,452	18.6	3.6%	2.6%
517212	Cellular & Other Wireless Carriers	513322	259	6,005	23.2	7,710	184,106	23.9	3.4%	3.3%
5173	Telecommunications Resellers	51333	68	1,335	19.6	2,475	59,941	24.2	2.7%	2.2%
5174	Satellite Telecommunications	51334	20	211	10.6	737	21,259	28.8	2.7%	1.0%
5175	Cable & Other Program Distribution	51322	169	5,147	30.5	5,805	204,426	35.2	2.9%	2.5%
5179	Other Telecommunications	51339	23	99	4.3	1,418	18,907	13.3	1.6%	0.5%
	Subtotal: Tech Cluster		2,424	45,260	18.7	70,536	1,301,803	18.5	3.4%	3.5%
54133	Engineering Services	Same	1,854	31,659	17.1	53,763	859,691	16.0	3.4%	3.7%
54138	Testing Laboratories	Same	241	4,694	19.5	5,474	98,422	18.0	4.4%	4.8%
54171	Physical, Engineering & Biological Research	Same	329	8,907	27.1	11,299	343,690	30.4	2.9%	2.6%

Note: * - the employment figure for Ohio is estimated or incorporates estimates; eqpt. - equipment; n.a. - not available, not applicable; NMMC - Navigational, Measuring, Medical, Control; p - part of.

Source: U.S. Bureau of the Census (2003a, 2003b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development, (DL, 9/03).

Table A4: Comparing Census and Labor Statistics Data for Ohio

NAICS Code: Industry Name	Establishments Number	Establishments Percent of U.S.	Employment Number	Employment Percent of U.S.
Advanced Electronics and Related Industries Total				
Census Bureau	8,496	3.2%	182,210	2.8%
Bureau of Labor Statistics	10,540	3.2%	180,986	2.8%
334p: Computers & Electronic Products (part)				
Census Bureau	493	3.1%	35,035	2.2%
Bureau of Labor Statistics	621	3.1%	37,108	2.2%
3341: Computers & Peripheral Eqpt.				
Census Bureau	51	2.7%	2,333	1.2%
Bureau of Labor Statistics	53	2.3%	3,709	1.3%
3342: Communications Eqpt.				
Census Bureau	38	1.7%	7,361	2.7%
Bureau of Labor Statistics	72	2.5%	8,755	3.7%
3343: Audio & Video Eqpt.				
Census Bureau	14	2.5%	502	1.7%
Bureau of Labor Statistics	12	1.6%	203	0.4%
3344: Semiconductors & Electronic Components				
Census Bureau	169	2.8%	12,253	2.0%
Bureau of Labor Statistics	184	2.6%	10,581	1.6%
3345: Navigational Measuring, Medical, Control Instruments (part)				
Census Bureau	221	4.3%	12,586	2.8%
Bureau of Labor Statistics	303	4.1%	13,894	3.0%
5112: Software Publishers				
Census Bureau	291	2.8%	9,789	2.8%
Bureau of Labor Statistics	196	1.7%	3,645	1.4%
5171: Wired Telecommunications Carriers				
Census Bureau	1,102	4.0%	27,645	3.1%
Bureau of Labor Statistics	752	3.8%	22,482	3.1%
5171: Wired Telecommunications Carriers				
Census Bureau	1,102	4.0%	27,645	3.1%
Bureau of Labor Statistics	752	3.8%	22,482	3.1%

Table A4: Comparing Census and Labor Statistics Data for Ohio

NAICS Code: Industry Name	Establishments Number	Establishments Percent of U.S.	Employment Number	Employment Percent of U.S.
5172: Wireless Telecommunications Carriers				
Census Bureau	399	2.7%	7,866	2.2%
Bureau of Labor Statistics	219	2.5%	4,641	2.3%
5173: Telecommunications Resellers				
Census Bureau	68	2.7%	1,335	2.2%
Bureau of Labor Statistics	211	2.5%	3,382	1.6%
5174: Satellite Telecommunications				
Census Bureau	20	2.7%	211	1.0%
Bureau of Labor Statistics	26	2.4%	61	0.3%
5175: Cable & Other Program Distribution				
Census Bureau	169	2.9%	5,147	2.5%
Bureau of Labor Statistics	188	5.0%	6,240	5.0%
5179: Other Telecommunications				
Census Bureau	23	1.6%	99	0.5%
Bureau of Labor Statistics	23	4.0%	533	5.7%
5181: ISPs & Search Portals				
Census Bureau	241	2.4%	3,491	1.6%
Bureau of Labor Statistics	403	2.8%	6,253	3.6%
5182: Data Processing & Related Services				
Census Bureau	303	3.3%	9,849	3.1%
Bureau of Labor Statistics	311	2.3%	5,678	1.8%
5415: Computer Systems Design & Related Services				
Census Bureau	2,876	2.9%	35,898	2.9%
Bureau of Labor Statistics	4,667	3.2%	45,623	3.6%
All Other Services Combined				
Census Bureau	2,511	3.4%	45,945	3.4%
Bureau of Labor Statistics	2,920	3.4%	45,305	3.2%

Source: U.S. Bureaus of the Census (2003A, 2003B) and Labor Statistics (2003).

TABLE A5: ESTABLISHMENTS AND EMPLOYMENT IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES IN 2001, FOR OHIO AND COUNTIES

	Industry Total		Manufacturing		Service Total		Computer Services		Telecommunication		Tech Cluster	
Area Name	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment
Ohio*	8,496	182,167	493	34,892	8,003	147,275	3,798	59,712	1,781	42,303	2,424	45,260
Adams	7	40	1	10	6	30	1	10	3	10	2	10
Allen	52	759	1	143	51	616	14	92	20	286	17	238
Ashland	13	439	1	33	12	406	3	20	7	43	2	343
Ashtabula	33	401	4	143	29	258	12	57	9	176	8	25
Athens	30	269	2	10	28	259	12	63	9	43	7	153
Auglaize	15	162	0	0	15	162	4	43	7	43	4	76
Belmont	26	160	1	10	25	150	5	34	13	66	7	50
Brown	11	74	0	0	11	74	3	20	5	43	3	11
Butler	178	1,694	10	225	168	1,469	98	614	20	309	50	546
Carroll	5	76	0	0	5	76	1	33	3	33	1	10
Champaign	4	53	0	0	4	53	0	0	3	43	1	10
Clark	32	194	2	10	30	184	11	103	9	33	10	48
Clermont	105	4,308	7	104	98	4,204	48	3,641	17	176	33	387
Clinton	16	422	2	333	14	89	9	46	4	33	1	10
Columbiana	28	319	1	33	27	286	6	30	8	33	13	223
Coshocton	13	85	0	0	13	85	3	20	5	43	5	22
Crawford	14	762	1	666	13	96	2	20	7	33	4	43
Cuyahoga	1,486	36,031	89	4,696	1,397	31,335	718	11,341	277	8,587	402	11,407
Darke	14	103	1	10	13	93	2	20	7	43	4	30
Defiance	21	152	0	0	21	152	8	76	10	66	3	10
Delaware	163	2,152	11	360	152	1,792	92	806	28	666	32	320
Erie	24	232	3	33	21	199	5	43	6	66	10	90
Fairfield	59	320	5	89	54	231	38	143	6	33	10	55
Fayette	5	40	0	0	5	40	1	10	3	20	1	10
Franklin	1,316	39,388	54	7,991	1,262	31,397	667	14,418	303	10,298	292	6,681

TABLE A5: ESTABLISHMENTS AND EMPLOYMENT IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES IN 2001, FOR OHIO AND COUNTIES

	Industry Total		Manufacturing		Service Total		Computer Services		Telecommunication		Tech Cluster	
Area Name	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment
Fulton	17	106	0	0	17	106	6	63	6	33	5	10
Gallia	5	43	0	0	5	43	0	0	4	33	1	10
Geauga	96	556	8	259	88	297	50	168	8	43	30	86
Greene	220	5,500	11	303	209	5,197	96	3,018	14	43	99	2,136
Guernsey	15	227	1	33	14	194	4	20	6	100	4	74
Hamilton	1,039	25,302	37	1,666	1,002	23,636	477	9,755	202	6,795	323	7,086
Hancock	48	1,047	3	333	45	714	14	453	21	127	10	134
Hardin	13	124	1	10	12	114	4	40	6	54	2	20
Harrison	2	10	0	0	2	10	0	0	2	10	0	0
Henry	9	91	0	0	9	91	2	20	6	61	1	10
Highland	8	106	0	0	8	106	4	30	3	43	1	33
Hocking	10	73	0	0	10	73	5	43	4	20	1	10
Holmes	9	56	0	0	9	56	4	16	3	20	2	20
Huron	23	555	4	333	19	222	5	53	7	143	7	26
Jackson	5	43	0	0	5	43	0	0	5	43	0	0
Jefferson	29	187	1	10	28	177	6	53	14	101	8	23
Knox	18	89	0	0	18	89	5	33	8	33	5	23
Lake	210	3,802	23	2,109	187	1,693	88	408	21	202	78	1,083
Lawrence	11	106	0	0	11	106	4	30	5	66	2	10
Licking	77	1,447	6	632	71	815	35	167	16	308	20	340
Logan	18	782	3	33	15	749	2	20	7	43	6	686
Lorain	125	1,274	8	338	117	936	56	171	27	589	34	176
Lucas	324	5,659	19	432	305	5,227	120	1,211	72	1,623	113	2,393
Madison	18	226	0	0	18	226	7	43	8	20	3	163
Mahoning	136	1,894	5	278	131	1,616	51	511	35	685	45	420
Marion	30	656	1	0	29	656	10	409	11	153	8	94

TABLE A5: ESTABLISHMENTS AND EMPLOYMENT IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES IN 2001, FOR OHIO AND COUNTIES

	Industry Total		Manufacturing		Service Total		Computer Services		Telecommunication		Tech Cluster	
Area Name	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment
Medina	128	854	8	74	120	780	62	346	20	176	38	258
Meigs	3	30	0	0	3	30	0	0	1	10	2	20
Mercer	8	63	0	0	8	63	1	10	6	43	1	10
Miami	42	1,598	6	1,418	36	180	12	40	6	66	18	74
Monroe	7	40	0	0	7	40	2	10	2	20	3	10
Montgomery	544	10,635	40	2,177	504	8,458	255	3,864	81	1,145	168	3,449
Morgan	4	43	0	0	4	43	0	0	3	33	1	10
Morrow	6	43	0	0	6	43	2	10	4	33	0	0
Muskingum	27	311	4	33	23	278	6	53	10	178	7	47
Noble	2	20	1	10	1	10	0	0	1	10	0	0
Ottawa	19	105	0	0	19	105	5	19	8	43	6	43
Paulding	4	43	2	33	2	10	0	0	2	10	0	0
Perry	7	53	0	0	7	53	0	0	5	43	2	10
Pickaway	11	96	0	0	11	96	5	20	2	33	4	43
Pike	6	43	0	0	6	43	1	10	5	33	0	0
Portage	75	868	6	208	69	660	41	207	4	33	24	420
Preble	7	73	2	10	5	63	2	20	3	43	0	0
Putnam	16	1,519	2	1,428	14	91	4	29	9	52	1	10
Richland	71	3,260	9	2,357	62	903	19	96	28	676	15	131
Ross	23	874	0	0	23	874	5	10	8	809	10	55
Sandusky	22	225	0	0	22	225	8	73	6	66	8	86
Scioto	19	230	2	10	17	220	3	20	12	167	2	33
Seneca	18	136	1	33	17	103	3	30	9	33	5	40
Shelby	15	124	1	10	14	114	7	38	3	33	4	43
Stark	190	2,344	11	511	179	1,833	70	565	41	730	68	538
Summit	557	8,266	38	1,268	519	6,998	266	3,177	83	1,825	170	1,996

TABLE A5: ESTABLISHMENTS AND EMPLOYMENT IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES IN 2001, FOR OHIO AND COUNTIES

	Industry Total		Manufacturing		Service Total		Computer Services		Telecommunication		Tech Cluster	
Area Name	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment	Estab-lishments	Employ-ment
Trumbull	79	2,108	3	33	76	2,075	31	468	23	1,428	22	179
Tuscarawas	31	286	1	10	30	276	7	43	10	138	13	95
Union	21	759	2	33	19	726	10	30	3	20	6	676
Van Wert	9	63	0	0	9	63	2	10	5	43	2	10
Vinton	4	30	0	0	4	30	1	10	1	10	2	10
Warren	143	3,585	7	1,514	136	2,071	84	1,574	17	197	35	300
Washington	28	171	4	41	24	130	4	21	7	43	13	66
Wayne	50	1,082	2	333	48	749	19	460	14	176	15	113
Williams	15	401	4	305	11	96	2	20	6	66	3	10
Wood	87	1,579	9	457	78	1,122	35	549	18	156	25	417
Wyandot	8	50	1	10	7	40	3	20	3	10	1	10
Unknown+	5	53	0	0	5	53	3	33	2	20	0	0

Note: * - County employment figures will not sum to the state total because every county incorporates at least one midrange estimate of employment. County estimates of manufacturing, telecommunications and tech cluster jobs tend to be a little low, while county estimates of computer services jobs tend to be a little high. The net effect is that county estimates of industry jobs tend to be a little low.

+ - Insufficient information to locate in a specific county.

Sources: U.S. Bureau of the Census (2003a, 2003b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development (DL, 9/03).

TABLE A6: EMPLOYMENT AND PAY IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES, OHIO AND U.S., 2001

2002 NAICS Codes	Short Title (2002)	Closest 1997 NAICS Codes	Ohio Employ-ment	Ohio Estimated Annual Payroll (000)	Ohio Mean Pay per Worker	U.S. Employ-ment	U.S. Estimated Annual Payroll (000)	U.S. Mean Pay per Worker	Ohio Mean as a Percent of U.S. Mean
	Total Covered Employment		4,932,943	$156,868,166	$31,800	115,061,184	$3,989,086,323	$34,669	91.7%
	Advanced Electronics & Related Industries		182,310	$9,376,975	$51,434	6,494,791	$391,284,231	$60,246	85.4%
334(p)	Computers & Electronic Products (part)	Same	35,035	$1,363,507	$38,918	1,554,477	$82,922,013	$53,344	73.0%
3341	Computers & Peripheral Eqpt.	Same	2,333	$93,039	$39,880	199,637	$11,372,337	$56,965	70.0%
334111	Electronic Computers	Same	337	$10,756	$31,917	72,507	$4,316,960	$59,539	53.6%
334112	Computer Storage Devices*	Same	23	D	n.a.	33,357	$1,806,202	$54,148	n.a.
334113	Computer Terminals*	Same	10	D	n.a.	10,411	$425,507	$40,871	n.a.
334119	Other Computer Peripheral Eqpt.	Same	1,963	$81,018	$41,273	83,362	$4,823,668	$57,864	71.3%
3342	Communications Eqpt.	Same	7,361	$286,909	$38,977	269,498	$16,175,149	$60,020	64.9%
33421	Telephone Apparatus	Same	5,865	$214,172	$36,517	86,964	$5,789,793	$66,577	54.8%
33422	Broadcast & Wireless Communications Eqpt.	Same	980	$51,079	$52,121	153,962	$8,859,028	$57,540	90.6%
33429	Other Communications Eqpt.	Same	516	$21,658	$41,973	28,572	$1,526,328	$53,420	78.6%
3343	Audio & Video Eqpt.	Same	502	$19,921	$39,683	28,686	$1,005,565	$35,054	113.2%
3344	Semiconductors & Electronic Components	Same	12,253	$408,116	$33,307	603,160	$28,296,971	$46,915	71.0%
334411	Electron Tubes	Same	3,806	$130,745	$34,352	16,524	$644,533	$39,006	88.1%
334412	Bare Printed Circuit Boards	Same	1,468	$40,040	$27,275	80,070	$2,583,134	$32,261	84.5%
334413	Semiconductor & Related Devices	Same	1,510	$62,684	$41,513	225,078	$15,016,106	$66,715	62.2%
334414	Electronic Capacitors	Same	0	$0	n.a.	18,236	$559,341	$30,672	n.a.
334415	Electronic Resistors*	Same	130	D	n.a.	10,629	$314,016	$29,543	n.a.
334416	Electronic Coils, Transformers & Inductors	Same	249	$7,261	$29,161	17,278	$459,695	$26,606	109.6%
334417	Electronic Connectors*	Same	249	D	n.a.	37,235	$1,340,390	$35,998	n.a.
334418	Printed Circuit Assembly	Same	1,382	$34,648	$25,071	105,810	$4,005,786	$37,858	66.2%
334419	Other Electronic Components	Same	3,459	$121,944	$35,254	92,300	$3,373,970	$36,554	96.4%
3345(p)	NMMC Instruments (part)*	Same	12,586	$555,522	$44,138	453,496	$26,071,991	$57,491	76.8%
334510	Electromedical Apparatus	Same	418	$21,718	$51,957	50,808	$2,812,578	$55,357	93.9%
334511	Search, Detection & Navigation Instruments*	Same	295	D	n.a.	176,444	$11,054,301	$62,650	n.a.
334512	Automatic Environmental Controls	Same	2,772	$73,469	$26,504	19,781	$691,772	$34,972	75.8%
334513	Industrial Process Variable Instruments	Same	2,742	$137,303	$50,074	41,114	$1,935,477	$47,076	106.4%
334514	Totalizing Fluid Meters & Counting Devices	Same	651	$22,352	$34,335	15,561	$629,088	$40,427	84.9%
334515	Electricity & Signal Testing Instruments	Same	1,929	$102,010	$52,882	62,447	$4,267,812	$68,343	77.4%
334516	Analytical Laboratory Instruments	Same	406	$19,007	$46,815	34,877	$2,037,237	$58,412	80.1%
334517	Irradiation Apparatus	Same	826	$51,772	$62,678	12,572	$829,657	$65,992	95.0%
334519	Other Measuring & Controlling Devices	Same	2,447	$108,475	$44,330	34,499	$1,638,072	$47,482	93.4%

TABLE A6: EMPLOYMENT AND PAY IN ADVANCED ELECTRONICS AND RELATED INDUSTRIES, OHIO AND U.S., 2001

2002 NAICS Codes	Short Title (2002)	Closest 1997 NAICS Codes	Ohio Employ-ment	Ohio Estimated Annual Payroll (000)	Ohio Mean Pay per Worker	U.S. Employ-ment	U.S. Estimated Annual Payroll (000)	U.S. Mean Pay per Worker	Ohio Mean as a Percent of U.S. Mean
	Subtotal: Computer Services Cluster		59,712	$3,683,972	$61,696	2,171,902	$153,572,896	$70,709	87.3%
5112	Software Publishers	Same	9,789	$782,941	$79,982	353,344	$36,954,665	$104,586	76.5%
518	ISPs, Search Portals & Data Processing		13,340	$823,115	$61,703	531,275	$30,597,719	$57,593	107.1%
5181	ISPs & Search Portals	51419	3,491	$346,310	$99,201	213,734	$15,109,489	$70,693	140.3%
518111	Internet Service Providers*	514191	2,991	D	n.a.	202,142	$14,409,578	$71,284	n.a.
518112	Web Search Portals*	514199(p	500	D	n.a.	11,592	$699,911	$60,379	n.a.
51821	Data Processing & Related Services	51421	9,849	$476,805	$48,412	317,541	$15,488,230	$48,776	99.3%
5415	Computer Systems Design & Related Services	Same	35,898	$2,053,539	$57,205	1,254,805	$84,675,882	$67,481	84.8%
541511	Custom Computer Programming	Same	14,885	$894,605	$60,101	538,674	$36,851,309	$68,411	87.9%
541512	Computer Systems Design	Same	15,945	$893,865	$56,059	538,673	$37,107,143	$68,886	81.4%
541513	Computer Facilities Mgt.	Same	2,176	$118,956	$54,667	71,342	$4,342,484	$60,869	89.8%
541519	Other Computer Related Services	Same	2,892	$146,113	$50,523	106,116	$6,374,946	$60,075	84.1%
61142	Computer Training	Same	685	$24,377	$35,587	32,478	$1,344,630	$41,401	86.0%
517	Telecommunications		42,303	$2,152,822	$50,891	1,466,609	$78,256,598	$53,359	95.4%
5171	Wired Telecommunications Carriers	51331	27,645	$1,537,252	$55,607	905,518	$50,210,483	$55,449	100.3%
5172	Wireless Telecommunications Carriers	51332	7,866	$348,294	$44,278	256,558	$13,367,882	$52,105	85.0%
517211	Paging Services	513321	1,861	$67,328	$36,178	72,452	$3,487,646	$48,137	75.2%
517212	Cellular & Other Wireless Carriers	513322	6,005	$280,966	$46,789	184,106	$9,880,236	$53,666	87.2%
5173	Telecommunications Resellers	51333	1,335	$59,207	$44,350	59,941	$3,217,934	$53,685	82.6%
5174	Satellite Telecommunications	51334	211	$7,596	$36,000	21,259	$1,491,568	$70,162	51.3%
5175	Cable & Other Program Distribution	51322	5,147	$197,296	$38,332	204,426	$8,766,780	$42,885	89.4%
5179	Other Telecommunications	51339	99	$3,177	$32,091	18,907	$1,201,951	$63,572	50.5%
	Subtotal: Tech Cluster		45,260	$2,176,674	$48,093	1,301,803	$76,532,724	$58,790	81.8%
54133	Engineering Services	Same	31,659	$1,500,081	$47,382	859,691	$49,388,522	$57,449	82.5%
54138	Testing Laboratories	Same	4,694	$166,782	$35,531	98,422	$4,216,324	$42,839	82.9%
54171	Physical, Engineering & Biological Research	Same	8,907	$509,811	$57,237	343,690	$22,927,878	$66,711	85.8%

Note: * - the employment figure for Ohio is estimated or incorporates estimates; eqpt. - equipment; n.a. - not available, not applicable; NMMC - Navigational, Measuring, Medical Control; p - part of.

Source: U.S. Bureau of the Census (2003a, 2003b).

Prepared by: Office of Strategic Research, Ohio Dept. of Development, (DL, 9/03).

TABLE A7: VALUE-ADDED IN MANUFACTURING BY STATE: 1997-2001 AVERAGES (in millions)

Area Name \ NAICS Codes	334	3341	3342	3343	3344	3345	3346
United States	$256,655.7	$43,811.7	$53,104.0	$2,851.0	$92,419.6	$59,416.7	$5,052.6
Alabama	$1,953.7	$797.7	$372.5	$0.0	$329.4	$184.0	$269.9
Alaska	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Arizona	$13,067.6	$131.9	$696.5	$0.0	$10,217.7	$1,864.3	$0.0
Arkansas	$476.0	$0.0	$0.0	$110.3	$157.4	D	$0.0
California	$71,794.6	$15,882.2	$17,631.6	$373.1	$22,921.8	$13,376.4	$1,609.5
Colorado	$5,335.8	$1,796.7	$418.1	$0.0	$1,311.3	$1,789.4	$0.0
Connecticut	$2,426.1	$85.5	$579.0	$0.0	$726.6	$1,013.9	$60.3
Delaware	$237.1	$0.0	$0.0	$0.0	$0.0	$236.8	$0.0
District of Columbia	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Florida	$7,677.7	$284.8	$2,726.3	$0.0	$1,707.4	$2,864.8	$59.6
Georgia	$1,703.6	$302.4	D	D	$262.4	$366.8	$160.2
Hawaii	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Idaho	$3,384.8	D	$0.0	$0.0	$1,957.3	$0.0	$0.0
Illinois	$8,584.5	$432.4	$4,560.6	$147.5	$1,019.3	$2,071.9	$352.9
Indiana	$2,168.8	$0.0	$474.7	$210.8	$787.5	$489.0	$188.4
Iowa	$1,483.3	$47.3	D	$0.0	D	D	$0.0
Kansas	$572.2	$0.0	$0.0	$0.0	$79.2	$352.0	$0.0
Kentucky	$1,259.4	D	$0.0	$0.0	$121.0	$103.0	$0.0
Louisiana	$160.0	$0.0	$54.1	$0.0	$0.0	$0.0	$0.0
Maine	$696.9	$0.0	$158.4	$0.0	$484.2	$0.0	$0.0
Maryland	$3,049.9	$150.2	$1,232.5	$0.0	$128.5	$1,546.8	$0.0
Massachusetts	$15,766.6	$2,707.5	$4,805.5	$341.1	$2,847.0	$4,985.8	$79.6
Michigan	$2,596.6	$109.1	$126.2	$126.8	$428.4	$1,562.2	$243.9
Minnesota	$6,371.0	$1,420.0	$668.5	$0.0	$1,181.2	$2,964.2	$124.3
Mississippi	$289.7	$0.0	D	$0.0	$74.9	$0.0	$0.0
Missouri	$1,729.6	$0.0	$148.8	$0.0	$1,057.8	$419.9	$0.0
Montana	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Nebraska	$796.6	$0.0	$513.3	$0.0	$117.3	$159.1	$0.0
Nevada	$278.9	$0.0	$0.0	$0.0	$74.2	$168.5	$0.0
New Hampshire	$3,621.1	$1,870.1	$684.9	$0.0	$985.2	$860.9	$0.0
New Jersey	$4,068.5	$148.2	$1,080.1	$0.0	$990.0	$1,741.8	$92.4

TABLE A7: VALUE-ADDED IN MANUFACTURING BY STATE: 1997-2001 AVERAGES (in millions)

Area Name \ NAICS Codes	334	3341	3342	3343	3344	3345	3346*
New Mexico	$8,532.6	$0.0	$23.8	$0.0	D	D	$0.0
New York	$9,062.9	$1,372.0	$1,547.1	$0.0	$3,336.2	$2,604.6	$156.3
North Carolina	$5,733.9	D	$1,755.7	$0.0	$1,974.3	$427.6	D
North Dakota	$220.0	$0.0	$0.0	$0.0	$109.5	$0.0	$0.0
Ohio	$4,988.3	$435.3	$2,175.3	$0.0	$800.0	$1,523.7	$0.0
Oklahoma	$2,176.1	D	D	$0.0	D	$258.9	$0.0
Oregon	$10,562.9	$1,099.3	$242.6	$0.0	$7,958.9	$1,153.1	$0.0
Pennsylvania	$7,890.5	$260.9	$708.0	D	$4,608.1	$1,726.1	D
Rhode Island	$645.0	$0.0	$37.4	$0.0	$149.2	$349.1	$0.0
South Carolina	$1,310.6	$81.0	$0.0	$2.0	$626.3	$142.9	D
South Dakota	$2,543.4	D	$0.0	$0.0	D	$0.0	$0.0
Tennessee	$1,388.1	$0.0	$55.7	$240.0	$175.8	$383.2	$0.0
Texas	$25,398.5	$7,072.0	$5,324.7	$61.0	$9,446.5	$3,227.0	$490.5
Utah	$1,689.5	D	$94.3	$0.0	$310.3	$793.9	$0.0
Vermont	D	$0.0	$0.0	$0.0	D	D	$0.0
Virginia	$3,629.7	$699.3	$1,134.2	$0.0	$715.3	$984.3	$0.0
Washington	$4,998.6	$582.7	$294.7	$111.5	$933.5	$3,026.1	$97.1
West Virginia	$51.4	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Wisconsin	$2,708.9	$344.2	$0.0	$0.0	$595.9	$1,675.5	$0.0
Wyoming	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Notes: * - Magnetic and optical media (NAICS 3346) is not part of the advanced electronics industry. It is included here only to show how small a part of a part of computers and electronics (NAICS 334) it is--about two percent. Consequently, any discussion of advanced electronics based on NAICS 334 data is only minimally distorted. D - Data suppressed to maintain confidentiality. Averages for the six industry groups may not sum to the total for two reasons: (1) data may not have been available for all five years, and (2) some establishments may not have been classified in a group. In this regard, "$0.0" does not necessarily mean that the industry was absent from the state. It may have been present, but was too small to be covered by the survey.

Source: U.S. Bureau of the Census (2003).

Prepared by: Office of Strategic Research, Ohio Dept. of Development (DL, 2/04).

TABLE A8: CAPITAL EXPENDITURES IN MANUFACTURING BY STATE: 1997-2001 AVERAGES (in millions)

Area Name \ NAICS Codes	334	3341	3342	3343	3344	3345	3346
United States	$24,486.0	$2,782.1	$3,677.0	$198.8	$13,862.4	$3,239.2	$726.3
Alabama	$162.5	$22.6	$34.1	$0.0	$30.1	$10.4	$65.2
Alaska	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Arizona	$1,406.5	$10.1	$44.4	$0.0	$1,270.4	$73.6	$0.0
Arkansas	$26.1	$0.0	$0.0	$5.1	D	$6.2	$0.0
California	$5,835.3	$897.7	$1,354.1	$23.6	$2,544.5	$746.0	$269.4
Colorado	$795.8	$157.5	$42.0	$0.0	$364.0	$232.4	$0.0
Connecticut	$185.5	$3.6	$35.4	$0.0	$94.8	$45.6	$10.2
Delaware	D	$0.0	$0.0	$0.0	$0.0	D	$0.0
District of Columbia	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Florida	$561.1	$22.1	$114.3	$0.0	$274.3	$141.0	$7.9
Georgia	$117.0	$17.3	$35.2	D	D	$16.7	$23.3
Hawaii	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Idaho	$816.5	D	$0.0	$0.0	D	$0.0	$0.0
Illinois	$720.7	$25.5	$455.3	$6.2	$76.5	$106.9	$50.3
Indiana	$166.8	$0.0	D	$13.9	$55.9	$38.2	$29.1
Iowa	$95.6	$5.9	D	$0.0	D	D	$0.0
Kansas	$56.6	$0.0	$0.0	$0.0	D	$39.3	$0.0
Kentucky	$91.2	D	$0.0	$0.0	D	$5.6	$0.0
Louisiana	$23.2	$0.0	D	$0.0	$0.0	$0.0	$0.0
Maine	$127.2	$0.0	$17.5	$0.0	$108.4	$0.0	$0.0
Maryland	$195.3	$8.4	$63.2	$0.0	$16.5	$104.4	$0.0
Massachusetts	$1,005.9	$170.5	$233.2	$24.6	$287.2	$279.7	$10.9
Michigan	$159.0	$4.4	$7.6	$2.9	$53.0	$73.0	$18.1
Minnesota	$608.6	$268.8	$29.4	$0.0	$150.9	$152.4	$7.0
Mississippi	$21.6	$0.0	D	$0.0	D	$0.0	$0.0
Missouri	$123.5	$0.0	$11.4	$0.0	$81.0	$25.8	$0.0
Montana	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Nebraska	$45.1	$0.0	$26.5	$0.0	$5.9	$12.3	$0.0
Nevada	D	$0.0	$0.0	$0.0	D	D	$0.0
New Hampshire	$242.3	$13.3	$61.5	$0.0	$110.3	$55.7	$0.0
New Jersey	$392.8	$12.1	$133.9	$0.0	$143.8	$94.0	$8.0

TABLE A8: CAPITAL EXPENDITURES IN MANUFACTURING BY STATE: 1997-2001 AVERAGES (in millions)

Area Name \ NAICS Codes	334	3341	3342	3343	3344	3345	3346
New Mexico	$691.7	$0.0	$1.4	$0.0	$674.7	$13.3	$0.0
New York	$808.8	$125.5	$98.8	$0.0	$461.3	$94.6	$26.8
North Carolina	$422.9	$49.2	$119.9	$0.0	$204.5	$18.1	$30.8
North Dakota	$19.7	$0.0	$0.0	$0.0	$13.1	$0.0	$0.0
Ohio	$266.0	$32.5	$61.6	$0.0	$87.0	$76.7	$0.0
Oklahoma	$141.8	$24.5	D	$0.0	$23.4	$9.0	$0.0
Oregon	$1,862.9	$239.4	$23.4	$0.0	$1,512.5	$79.8	$0.0
Pennsylvania	$696.6	D	$47.6	D	$466.3	$83.5	$39.1
Rhode Island	$39.5	$0.0	D	$0.0	$18.5	D	$0.0
South Carolina	$153.7	$4.0	$0.0	$0.1	$117.3	$9.9	D
South Dakota	$87.6	D	$0.0	$0.0	D	$0.0	$0.0
Tennessee	$74.7	$0.0	$2.4	$30.1	$17.8	$14.4	$0.0
Texas	$3,103.5	$206.7	$300.4	$5.5	$2,342.9	$159.4	$61.1
Utah	$313.9	D	D	$0.0	$31.2	$33.4	$0.0
Vermont	D	$0.0	$0.0	$0.0	D	D	$0.0
Virginia	$430.9	$47.3	$139.9	$0.0	$184.5	$43.7	$0.0
Washington	$597.9	$40.0	$19.7	$8.3	$365.3	$155.4	$14.1
West Virginia	D	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Wisconsin	$181.3	$50.3	$0.0	$0.0	$63.1	$61.5	$0.0
Wyoming	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Notes: * - Magnetic and optical media (NAICS 3346) is not part of the advanced electronics industry. It is included here only to show how small a part of a part of computers and electronics (NAICS 334) it is--about two percent. Consequently, any discussion of advanced electronics based on NAICS 334 data is only minimally distorted. D - Data suppressed to maintain confidentiality. Averages for the six industry groups may not sum to the total for two reasons: (1) data may not have been available for all five years, and (2) some establishments may not have been classified in a group. In this regard, "$0.0" does not necessarily mean that the industry was absent from the state. It may have been present, but was too small to be covered by the survey.

Source: U.S. Bureau of the Census (2003).

Prepared by: Office of Strategic Research, Ohio Dept. of Development (DL, 2/04).

NAICS CODE DEFINITIONS AND EXAMPLES

The following NAICS codes define the advanced electronics and related industries.

334(p) Computers and Electronic Products (Excluding Magnetic and Optical Media). This is the manufacturing side of the industry.

3341 Computers and Peripheral Equipment.

334111 Electronic Computers. Examples include mainframes, personal computers, laptops, workstations, and servers with associated processors, memory, storage, and input/output devices incorporated. Equipment incorporating computers (or parts thereof) are classified elsewhere, as are the parts not manufactured on the site.

334112 Computer Storage Devices. Examples include tape storage and backup units, as well as drives for floppy and hard disks, and CD-ROMs. Memory chips are classified elsewhere.

334113 Computer Terminals. Terminals are input/output devices connected with a computer for data processing. Point-of-sale terminals, monitors, and automatic teller machines are classified elsewhere.

334119 Other Computer Peripheral Equipment. Monitors, keyboards, mouses, printers, plotters, point-of-sale terminals, and automatic teller machines are examples of industry products.

3342 Communications Equipment.

33421 Telephone Apparatus. Included are telephones (both wired and cordless, except cellular), answering machines, switching and exchange equipment, modems, bridges, routers, and gateways. However, modems for computers, single-user fax modems, and the electronic components used in telephone apparatus are classified elsewhere.

33422 Broadcast and Wireless Communications Equipment. Examples include transmitting and receiving antennas, cable and satellite television equipment, global positioning system equipment, pagers, cellular phones, mobile communications equipment, radio and television broadcasting equipment. Radios, televisions, and intercoms are classified elsewhere.

33429 Other Communications Equipment. Included are fire detection and alarm systems, auto theft alarms, intercoms, and signals for pedestrian, highway, and railway traffic.

3343 Audio and Video Equipment. Examples include televisions, videocassette recorders, stereos, speakers, household video cameras, jukeboxes, amplifiers for musical instruments, and public address systems. Answering machines, photographic and photocopying equipment, phonographic needles and cartridges, and auto theft alarms are excluded.

3344 Semiconductors and Electronic Components.

334411 Electron Tubes. Examples include cathode ray tubes (i.e., picture tubes), klystron tubes and magnetron tubes (i.e., microwave generators). X-ray tubes and glass for tubes are classified elsewhere.

334412 Bare Printed Circuit Boards. Establishments in this industry print, photo-print, etch and plate interconnected pathways for electric currents on rigid and flexible boards. Establishments making the boards for such use or mounting devices on such boards are classified elsewhere.

334413 Semiconductors and Related Devices. Semiconductors are crystalline materials whose electrical conductivity is between that of an insulator and a conductor. Industry products using such materials include integrated circuits, memory chips, microprocessors, diodes, transistors, solar cells and other opto-electrical devices.

334414 Electronic Capacitors. Capacitors store electrical energy on two conductors of opposite charges separated by an insulator blocking the direct flow of electrons between the two. Capacitance may be variable or fixed. Capacitors used for power generation, heavy industrial equipment, and induction heating are excluded.

334415 Electronic Resistors. These are devices made of materials that oppose the direct flow of electrons. Resistors may be variable or fixed. Varistors, whose resistance decreases in a nonlinear fashion as the voltage increases, use semiconductors. However, rheostats are excluded.

334416 Electronic Coils, Transformers, and Inductors. Moving a magnet in a coiled conductor (such as a copper wire) will induce an electric current in the wire. Conversely, moving an electric current through a coiled wire will induce a magnetic field. Transformers consist of two or more coils in proximity so that the current in one will induce a current in the other. Transformers used in the generation, storage, transmission, distribution, transformation and utilization of electrical energy for houses and factories are excluded.

334417 Electronic Connectors. Establishments in this industry make coaxial, cylindrical, rack and panel, pin and sleeve, printed circuit, and fiber optic connectors. Establishments making plugs, bus bars, and twist-on wire connectors are excluded.

334418 Printed Circuit Assembly. Printed circuit boards with some or all of their semiconductor and electronic components inserted or mounted are output by establishments in this industry. The production of goods incorporating printed circuit assemblies are classified elsewhere.

334419 Other Electronic Components. Examples include liquid crystal displays, microwave components, the laminated boards on which circuits are printed, electronic switches, piezoelectric devices, and transducers (except pressure). Piezoelectric devices use pressure on crystals to generate electrical currents and electric currents to change the shape of crystals. Transducers convert input signals of one form into output signals of another. Microphones, speakers, doorbells, and automobile horns all use transducers.

3345 Navigational, Measuring, Medical, and Control (NMMC) Instruments.

334510 Electro-medical Apparatus. Examples include magnetic resonance imaging equipment, medical ultrasound equipment, pacemakers, hearing aids, electrocardiographs, and electro-medical endoscopic equipment. Irradiation apparatus are classified elsewhere.

334511 Search, Detection, and Navigation Instruments. Examples include flight data recorders and other aircraft instruments (except those for engines) as well as instruments for nautical systems. Sonar and radar systems are included, but global positioning system equipment is classified elsewhere.

334512 Automatic Environmental Controls. Automatic controls for heating, air-conditioning, refrigeration and appliances are included. However, industrial process controls and appliance timers are classified elsewhere. Switches for appliances, motors, and relays are excluded.

334513 Industrial Process Controls. These devices measure, display, indicate, record, transmit and control Industrial process variables such as temperature, humidity, pressure, vacuum, combustion, flow, level, viscosity, density, acidity, concentration and rotation. Medical thermometers are excluded, as are various optical instruments. Non-medical thermometers and instruments for laboratory analysis and measuring or testing electricity and electrical signals are classified elsewhere.

334514 Totalizing Fluid Meters and Counting Devices. Examples include taxi meters, parking meters and fare collection equipment, gas and water consumption meters, and motor vehicle gauges.

334515 Electricity and Signal Testing Instruments. Examples include volt, ohm and watt meters, and semiconductor testing equipment. Testing and monitoring equipment for search, detection, navigation, and communications are classified in their respective industries.

334516 Analytical Laboratory Instruments. Instruments for analyzing the physical and chemical composition of solids, liquids and gases are included here. Instruments for monitoring patients or analyzing samples from them are classified elsewhere, as are those for measuring and controlling industrial processes.

334517 Irradiation Apparatus. Equipment in this industry may be used for medical treatment or diagnosis as well as industrial and scientific research and evaluation. The radiation may be electromagnetic or subatomic particles.

334518 Watches, Clocks, and Parts. Examples include clocks, watches, time clocks, timing mechanisms for clock-operated devices, and date and time recording devices. Parts such as springs, jewels and modules are included, but glass and plastic crystals are not. Timing relays are also excluded. This industry is excluded from the report where possible.

334519 Other Measuring and Controlling Devices. Examples include aircraft engine instruments, automotive emissions testing equipment, meteorological instruments, polygraph machines, radiation detection and monitoring equipment, and non-medical thermometers.

The computer services cluster includes:

5112	Software Publishers. Establishments design software, provide documentation, assist with installation, and provide support services to customers. Reproduction is included here as long as the establishment engages in publication in the aforementioned activities. Establishments doing only one thing - designing software or providing access to it from a central host - are classified elsewhere.
518	Internet Service Providers (ISPs), Search Portals, and Data Processing.
51811	ISPs and Search Portals (1997 code: 51419).
518111	ISPs (1997 code: 514191). Establishments provide access to the Internet and generally provide services such as designing and hosting Web pages, as well as consulting on software and hardware for the Internet. However, those only publishing or broadcasting on the Internet are excluded.
518112	Web Search Portals (1997 code: part of 514199). These establishments operate Web sites that use a search engine to generates and maintain databases of Internet addresses and content. They may also provide additional services such as e-mail, auctions, and news. However, wholesaling, retailing, operating brokerages or purchasing other services using the Internet instead of older methods are classified with establishments providing those services.
51821	Data Processing and Related Services (1997 code: 51421). Services include producing specialized reports from data provided by the client, automated data processing, data entry, time-sharing on a mainframe computer, or serving as a host for a web site.
5415	Computer Systems Design and Related Services.
541511	Custom Computer Programming. Establishments write, modify, test and support software to meet the individual needs of customers.
541512	Computer Systems Design. Establishments design systems integrating hardware, software and communications technologies. They may also train and support the users of the system. Third parties may supply the hardware and software.
541513	Computer Facilities Management. Establishments providing support services are also included.
541519	Other Computer Related Services. Examples include establishments installing software and providing disaster recovery.
61142	Computer Training. Establishments train people in a variety of computer-related subjects: programming, electronics, operation, and local area network management at the trainer's, client's or a third party's facilities. Maintenance and repair schools are excluded.

The telecommunications cluster is just one major industry:

517 Telecommunications.

5171 Wired Telecommunications Carriers (1997 code: 51331). Establishments operate and maintain switching and transmission facilities providing point-to-point communications via landlines, microwaves, and satellites. Non-vocal communications are included. (The emphasis is on point-to-point communications, not wires.)

5172 Wireless Telecommunications Carriers (1997 code: 51332). Establishments operate and maintain switching and transmission facilities providing omni-directional communications via the parts of the electro-magnetic spectrum, except those involving satellites.

517211 Paging Services (1997 code: 513321). Establishments may supply and maintain the equipment. Telephone answering services are excluded.

517212 Cellular and Other Wireless (1997 code: 513322).

5173 Telecommunications Resellers (1997 code: 51333). Establishments purchase access and capacity from network owners and operators and resell to businesses and households. Satellites are excluded.

5174 Satellite Telecommunications (1997 code: 51334). Establishments provide point-to-point telecommunications to other establishments in telecommunications and broadcasting by transmitting and receiving signals via satellite(s). Resellers are included, but direct-to-home systems are excluded.

5175 Cable and Other Program Distribution (1997 code: 51322). Establishments in this industry deliver programming received from cable networks and local stations to consumers via cable or direct-to-home satellite systems. They are third parties that generally do not originate the programs.

5179 Other Telecommunications (1997 code: 51339). These establishments specialize in transmitting and receiving telemetry (readings of instruments that are some distance away) as well as tracking satellites. Radar stations are included.

The tech cluster includes:

54133 Engineering Services. Establishments are engaged in applying the laws of natural sciences and principles of engineering to design, develop and use materials, machines, instruments, structures, processes and systems. Establishments may also give advice, make plans, do inspections and provide technical advice in this regard. Establishments that design and construct buildings and highways, or supervising such projects, are excluded. Surveying, mapping, designing computer systems, and consulting about environmental issues are classified elsewhere.

54138 Testing Laboratories. Establishments perform physical, chemical, biological and other analytical tests (acoustics, vibrations, calibrations, electrical, mechanical and/or thermal). Testing may also be done on-site. Establishments doing medical, veterinary, or auto emissions tests are classified elsewhere.

54171 Physical, Engineering and Biological Research. Establishments engage in original research and development projects in fields such as agriculture, biology, botany, chemistry, computers, electronics, food, fisheries, forestry, geology, health, mathematics, medicine, oceanography, pharmacology, physics and other related subjects. Testing services are classified elsewhere.

NOTES:

1. The NAICS may list only one industry in an industry group. In such cases, the industry, the subgroup and the industry group are equivalent, and only the code with the fewest digits will be shown in any tables in this report.

2. The Bureaus of the Census and Labor Statistics disagree about the exact numbers of industry establishments and employees in Ohio. In 2001, the Census Bureau recorded over 182,000 workers in about 8,500 industry establishments in Ohio, while the Bureau of Labor Statistics (BLS) reported almost 181,000 workers in over 10,500 establishments. (See table A3). Other discrepancies, large and small, characterize every industry group. Even in the one case where the Bureaus agree on the number of establishments (23 in NAICS 5179), they disagree on number of such industry group workers in Ohio (99 vs. 533), and the corresponding percentages of U.S. that the numbers represent (1.6% vs. 4.0%, and 0.5% vs. 5.7%).

   Methodological differences between the bureaus contribute to the different frequency counts and percentages. The Census Bureau uses data it collects from several of its own programs as well as data collected by the Internal Revenue Service, the Social Security Administration, and the BLS. Census data in County Business Patterns refer to the week including March 12. BLS data are annual averages derived from quarterly tax reports submitted by employers subject to unemployment insurance laws. The states initially process the reports before sending the information to Washington. It is possible that a state agency and the Census Bureau could classify the same establishment in different industries for different reasons. Finally, the 2001 County Business Patterns data published by the Census Bureau used the 1997 NAICS, while data for the same year published by the BLS in Employment and Wages: Annual Averages used the 2002 NAICS. One difference between the two is that web search portals became a separate industry with the 2002 revisions (NAICS 518112), but was part of all other information services under the 1997 NAICS (514119). Consequently, Census data for 2001 are, *ceteris paribus*, likely to be greater than BLS data.

   Nevertheless, both data sources may be interpreted in similar ways. Census data indicate that 4.2% of non-farm private sector employment in nation is found in Ohio; BLS places 4.3% of America's non-farm employment here. In comparison, only 2.8% of the jobs in advanced electronics and related industries are located in Ohio. This means that the industry as a whole is not concentrated in the state. This is true for every industry group with the possible exceptions of cable and other program distribution (NAICS 5175) and other telecommunications (NAICS 5179). While BLS data indicate that group employment is concentrated in Ohio - at least five percent of all such jobs in America are found in Ohio, Census data indicate the opposite - less than three percent of such jobs are found in here.

Both data sources indicate that about four out of every five industry jobs in Ohio are found in the service clusters. This is slightly greater than the national average of three out of four.

3. The figure for Franklin County has been considerably diminished since then with the substantial reduction in employment at Lucent's E. Broad St. plant.

4. The figure for Putnam County has been diminished since because the Philips plant closed in December, 2002, and moved operations to Mexico (Niquette, 2003).

5. A transistor is a three-terminal semiconductor device for amplification, switching, and detection (Smith, 2003). Usually two of the terminals are close together and allow electrons to pass between them - ideally in only one direction. The third terminal is further from the first two, and resists the flow of electrons (Parker, 1984). Transistors replaced vacuum tubes because they were smaller, lasted longer (i.e., they were more reliable), and required less power - consequently producing much less heat (Bensinger, 2003: 17).

6. Silicon is a semiconductor. A semiconductor ranks between conductors and resistors in its ability to conduct an electric current. When doped with various elements, a semiconductor may be made more conductive or resistant (Parker, 1984).

7. When a computer is first turned on, the microprocessor checks itself and all of the other components to make sure they are operating correctly. It then loads the operating system. The operating system is a set of instructions controlling the inner working of the computer: recognizing input from the mouse or keyboard, keeping track of directories and files, and controlling peripheral devices. The operating system also enables the hardware to work with applications software (i.e., instructions) such as Microsoft's Excel or Word (Graham-Hackett, 2003a: 17, 28-29).

8. This procedure has not entirely disappeared. Floppy disks were used to transfer data before PCs were linked, and even now PCs are still made with a port for such disks. The only notable exception to physically transporting data in the days before networks was telemetry.

9. Rudy (2003:11) states that the network was originally developed to let scientists electronically share research papers. ARPA adopted a uniform language to handle communications over the network, enabling any computer on the network to communicate with all other network computers regardless of the computers' specific operating systems. "By applying a uniform language at an early stage, ARPA protected the network from competing languages and structures. As a result, the Internet remains a remarkably open and democratic system" (Kessler, 2003: 19).

10. Two technologies are used send signals in either wireline or wireless systems: analog and digital. Analog technology focuses on the amplitude modulation of a continuous stream of electromagnetic waves. Digital equipment first converts a continuous stream of waves into a binary code. One bit of the code indicates whether the voltage is on or off. The digital signals are reconverted at the point of reception to an analog format - an electromagnetic wave (Bensinger, 2003).

11. Switches complete connections between callers and route information from one network user to another. Packet-switched networks break a data set into packets. Some packets may be sent by one path, while other packets of the same data set may be sent to the destination via a different path.

12. System capacity is also affected by the medium of transmission. Copper wire is the slowest medium and has the least capacity for network operations. Coaxial cable is faster and has a greater capacity. However, fiber optic cable is the fastest, highest capacity "wired" medium for data transmission, including digitized audio and video. A fiber optic cable consists of hair-thin glass fibers bundled and wrapped in protective material. The fibers are the transmission medium for extremely rapid pulses of light from lasers and diodes - as opposed to slower moving electrons. (Lasers and diodes both generate light at one frequency, but only the former are in phase.) The light pulses carry data over great distances, and are unaffected by electrical interference. The only disadvantage is that fiber optic cable is the most expensive choice (Bensinger, 2003: 17-18). Despite the advantages of fiber optic cable, most of the signaling, processing, and switching still are performed electronically (Graham-Hackett, 2003b: 12). Data also could be transmitted at high speed over power lines. Hypothetical speeds are faster than either cable modem or DSL, and the infrastructure could be deployed faster, cheaper and more extensively. However, interference and competing traffic slow communications. The technology is operational in some European cities where the power grid configuration is more suitable, and is being tested in the U.S. (Amobi, 2003: 14-15).

13. Consolidation can also lead to spin-offs as these same companies seek to concentrate on long-term and high-growth opportunities in equipment manufacturing (Graham-Hackett, 2003b: 14).

14. Although broadcast television is not considered part of advanced electronics and related industries, it has been affected by the digital revolution. Achieving the detail and picture clarity of high definition TV (HDTV) requires that digitalization be used throughout whatever parts of the system are used: cable, satellite, TV station, and TV set. Many TV stations, whether cable or broadcast, and regardless of network affiliation status, transmit HDTV signals. However, only four percent of households have HDTV sets because they remain very expensive (Amobi, 2003: 18).

15. Various types of wireless communications equipment use different frequencies in the electromagnetic spectrum, but all remain in the radio range: 10 kilohertz (KHz, or 10,000 cycles per second) to 300 gigahertz (GHz, or 300 billion cycles per second). In fact, most of them remain in the radio window, the part of the radio range that can travel from space through Earth's atmosphere: six megahertz (MHz, or 6,000,000 cycles per second) to 30GHz (Parker, 1984). Examples are shown below.

Short-wave radio	5.9 - 26.1MHz;	Cellular phones	824 - 829MHz;
CB radio	26.96 - 27.41MHz;	Global Positioning Satellites	1.61 - 2.5GHz;
Cordless phones	43.69 - 50MHz;	PCS devices & other cell phones	1.85 - 1.93GHz;
Baby monitors	49.82 - 49.9MHz;	Microwave ovens	2.54GHz;
VHF TV stations (channels 2 - 6)	54 - 88MHz;	Direct-broadcast satellites	12.2 - 12.7GHz;
Remote-controlled toys	72MHz;	Geo-stationary satellites	17.7 - 30GHz;
FM radio	88 - 108MHz;	Low-Earth orbit satellites	18.8 - 19.3GHz;
VHF TV stations (channels 7 - 13)	174 - 220MHz;	Police radar	25.15GHz
Garage door openers	303.8MHz;		(Mullins, 2002).

Visible light frequencies range from 394 (red) to 789 (violet) terahertz (Parker, 1984) - about 15,667 to 31,371 times the frequency at which police radars operate.

16. A computer program operates by turning on and off within the computer certain electronic pulses. This setting of switches on and off is how software communicates instructions to the computer (Rudy, 2003).

17. There are other types of system software. Compilers and interpreters translate programs into executable code. Communications software sends data across a network. Utilities improve a computer's operational efficiency. Using packaged applications programs may mean invoking commands from a menu (e.g., in word processing) or it may mean typing instructions telling a computer about a database, where to find it, and what to do with it once it is in memory (often under specified conditions). The latter is the essence of computer programming.

18. Intel provides over 80 percent of the microprocessors for all of the PCs in the world. The combination of windows operating system and Intel processors in the same machine (Wintel) has also been moving up the chain from PCs to servers and workstations because they are now price/performance competitive with the Unix/RISC chips associated with Sun Microsystems (Graham-Hackett, 2003a: 14). RISC chips are simpler, but they run faster.

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