IMPACT OF HIGH TECHNOLOGY INDUSTRY ON THE ARIZONA ECONOMY

Final Report

Submitted to:

The Governor's Arizona Science and Technology Council
and
The Governor's Strategic Partnership for Economic Development

October 1995

Alberta Charney
Julie Leones[1]

[1] Drs. Charney and Leones are, respectively, researchers with the Economic and Business Research Program (College of Business and Public Administration) and the Department of Agricultural and Resource Economics and Arizona Cooperative Extension (College of Agriculture) at The University of Arizona.

ACKNOWLEDGMENTS

The authors wish to thank numerous individuals and organizations for making this project possible. Our thanks to Governor Fife Symington and to the Governor's Strategic Partnership for Economic Development and the Governor's Arizona Science and Technology Council which sponsored this project and raised the funds necessary to pay for it. We are also grateful to the organizations and businesses which provided their generous financial support. In particular, we thank the following: Arizona Electronics Association; Apollo Group, Inc.; Arizona Public Service Company; Hughes Missile Systems; Intel Corporation; Inter-Tel, Inc.; Lansdale Semiconductor, Inc.; MechTronics of Arizona, Inc.; Medtronic Micro-Rel, Inc.; Meyer, Hendricks, Victor, Osborn, and Maledon; MicroAge, Inc.; Motorola, Inc.; Pillar Financial; Quarles and Brady; SGS - Thompson Microelectronics, Inc.; Simula, Inc.; Snell and Wilmer; Tally Defense Systems; Three-Five Systems, Inc.; Tiffany & Hoffman; and Tucson Electric Power.

We wish to extend special thanks to Frank Plencner, Executive Director of the Governor's Strategic Partnership for Economic Development, and Jack Haenichen, Co-Chair of the Governor's Arizona Science and Technology Council, for their support and willingness to allow us the time necessary to do a complete and thorough study of the high technology industry.

Without the cooperation of high technology firms and their willingness to provide us with confidential and difficult to assemble information, this study could not have been completed. We received extraordinary cooperation from firms involved in Optics and Electronic Components. We also had tremendous cooperation from several of the high technology organizations in Arizona. The Arizona Software Association and the Center for Software Excellence provided membership lists and the latter organization also provided the results of a member survey that it had conducted. The American Electronics Association of Arizona offered its support by encouraging members to respond to our questionnaire.

We wish to thank Bill Tompkin of the Arizona Department of Commerce for his assistance, encouragement and support throughout this project and Mobin Qaheri, also of the Arizona Department of Commerce, for his comments on our proposal and questionnaire, and for his assistance in documenting past ADOC high technology studies and for his comments on the first draft of this study.

We thank Dr. Bruce Beattie of the Department of Agricultural and Resource Economics for reviewing the first draft of this report. The authors extend thanks to our respective departments and colleges for their technical and support services. Pia Montoya, Database Manager, and Valerie Rice, Librarian in the Economic and Business Research Program, provided assistance with secondary data collection. Kitty Stoops, Administrative Assistant in the Economic and Business Research Program, and Loretta Cosgrove, Accounting Specialist, in the Department of Agricultural and Resource Economics, provided bookkeeping and purchasing services. Connie McKay, Administrative Assistant in the Department of Agricultural and Resource Economics, organized mailing lists and printed numerous sets of mailing labels.

We are grateful to Linda Phipps, the graphics artist in the College of Agriculture, who, on very short notice, provided the layout of this final report.

Finally, we wish to thank our student research assistants. W. Alex Moseley helped us assemble our mailing lists, kept track of our respondents, made telephone contacts with firms to increase our response rates, assisted us with data summaries and graphics, and was consistently willing and eager to go out of his way to make the project a success. Valerie Ralph entered survey data and did the first rounds of data editing. Her attention to detail and her efficient handling of the data were of tremendous help to us.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Among states and cities that actively recruit businesses to relocate, high technology firms are coveted. There is good reason for this. First and foremost, the high technology industry offers high quality jobs. High technology firms often offer high wages, attractive benefit packages and opportunities for advancement. In addition, high technology firms tend to be export oriented and make important contributions to the balance of trade. For states like Arizona that have a dynamic and growing high technology cluster, information on high technology businesses is important to guide policy decisions and educate the public about the nature and contributions of this industry.

This study represents is an in-depth look at the economics of high technology businesses. The study included use of existing secondary data available from government sources (the most recent year available was usually 1992) and use of information from a survey of firms in the high technology industry (information from this survey was for 1994).

High technology appears to be a lot like ‘quality’: people know it when they see it, but it is not easy to define. A large number of alternative definitions were identified during the course of this study. Some of the important characteristics used in these definitions include a high percentage of employees working as engineers, scientists, mathematicians and computer specialists, a high percentage of total sales spent on research and development, a high level of product sophistication, a high percentage of sophisticated components in the product or service, and high employment growth rates. Some studies arbitrarily selected certain sectors as ‘high technology.’

In this study, a consensus approach was used to identify manufacturing sectors (i.e., a sector was included if it was identified under five or more different high technology definitions as being high tech) and professional judgment was used to identify service sectors. The sectors included a variety of chemicals, aircraft, missiles, ordnance and engines, computers, communications equipment and electronic components, scientific instruments (all of SIC 38), computer software and services and physical research services.

Under this definition, there were over 95,000 high technology jobs in Arizona in 1994. The largest employer is the electronic component and computer sector (46,545 jobs). The next largest are aircraft and missiles (18,597 jobs), instruments (16,903 jobs) and computer and research services (10,779 jobs). The high technology industry paid $4.36 billion in employee compensation in 1994 and generated $5.931 billion in value added (i.e., direct contribution to Gross State Product). The industry paid an estimated $250 million in state taxes. In addition, the high technology industry exported an estimated $5.369 billion in goods and services from Arizona in 1994. In terms of percent of state totals, the high technology industry directly provided 4.8 percent of all jobs in the state, it generated 6.8 percent of total Gross State Product and provided 63 percent of total foreign exports from Arizona in 1994.

Through the multiplier effect (i.e., through purchases made in Arizona by high technology businesses and their employees), the high technology industry had a total economic impact of 180,261 jobs (9 percent of Arizona’s employment), $6.498 billion in employee compensation and $9.546 billion in total value added (11 percent of Arizona’s GSP). High technology firms purchased many products and services from each other (estimated at $1.79 billion). The total tax revenue impacts of the industry were $609 million.

The high technology industry in Arizona paid an average of $45,800 in employee compensation (this includes wages and all benefits). The average payroll per employee in the high technology industry is $38,376 which is 75% higher than average payroll per employee across all Arizona industries. In addition, high technology firms spent an average of $900 per employee on training in 1994. The high technology workforce contains a significant share of Ph.D. scientists and engineers in the state. Overall, 35 percent of all employees in the industry have a four-year college degree or higher.

High technology firms make substantial investments in research and development. On average, high technology firms spend from 6 to 8 percent of total sales on research and development. More than 28 percent of the survey firms spend 13 percent or more of total sales on research and development. Twenty percent of the high tech workforce is involved in research and development. Approximately 87 percent of research funding came from internal sources. Another 10 percent came from the U.S. Department of Defense.

The high technology industry grew rapidly in Arizona from 1972 to 1987. Employment nearly doubled and real payroll increased at a rate of 5.6 percent per year. The total number of establishments more than tripled. However, high technology declined in Arizona from 1987 through 1992. Employment fell by 11 percent and payroll by 13 percent.

1992 was the trough of a recession in Arizona and it also marks the beginning of declining defense spending. From 1992 to 1994, the high technology industry regained much of what it had lost during the last recession. Employment grew almost 13 percent and payroll increased by slightly more than this from 1992 to 1994.

The high technology industry has grown significantly in importance as a share of Arizona's economy, even during the 1987 to 1992 period. Several high technology sectors are better represented in Arizona than in the U.S. as a whole. These well-represented sectors include electronics and electronic components, where employment in Arizona is 31 percent higher than it is for the entire U.S.; aircraft and parts which is 24 percent higher; guided missiles, space vehicles and parts which is 43 percent higher; search and navigation equipment (23 percent higher) and process control instruments (95 percent higher). Employment in other high technology sectors in Arizona tends to be lower than for the nation as a whole.

Arizona's high technology industry is very export oriented. While only 7 percent of high technology sales were made in Arizona, 59 percent were to the rest of the U.S. and 34 percent were to foreign customers in 1994. Europe and Asia (particularly Japan) were the most important foreign markets for Arizona's high technology exports.

Arizona's high technology industry depends on the U.S. Department of Defense for approximately 25 percent of its total sales. Approximately two-thirds of all high technology sales are custom-made for the buying firm. The high technology industry's largest customer typically represents 24 percent of total sales and the five largest customers average 49 percent of total sales. These figures indicate that high technology firms are highly dependent on orders of a few large buyers. This is especially true for aerospace and missiles, instrument and chemical manufacturers.

As mentioned earlier, Arizona's high technology firms buy from and sell to each other in significant amounts. The survey results indicate that 48 percent of surveyed firms purchase from the 14 largest high tech firms and 53 percent sell to the 14 largest high tech firms in Arizona. Almost one-third of the survey firms indicated that one or more of the 14 largest high technology firms was one of their five largest customers. Buyer-seller relations are not the only type of relationship that exists between high technology firms. Thirty-five percent of surveyed firms purchase important components that are available from only one supplier located outside of Arizona. Another 32 percent are involved in joint research and development ventures and 26 percent share development or engineering resources with firms outside of Arizona. With other firms located in Arizona, 20 percent share development or engineering resources, 20 percent are involved in joint research and development ventures and 15 percent of the surveyed high technology firms buy key inputs available from only one seller.

Some of the risks and challenges that Arizona's high technology industry faces are related to continuing declines in defense spending and the significant amount of buying and selling that goes on within the industry. One risk of dependence on defense contracts is fluctuations in numbers of jobs depending on the number and type of defense contracts won. As overall defense spending levels off or declines, those high technology firms most dependent on defense contracts are likely to shrink, go out of business, look for alternative markets for their products, or begin diversifying their product line.

The high technology industry as a whole is very dynamic. New high technology sectors are emerging even as others face declining or more competitive markets. A challenge faced by the state is to encourage the emergence of new high technology sectors, particularly through availability of venture capital and support of research and development and at the same time maintain a business environment that allows mature sectors to retain their competitive edge. Another risk of relying too heavily on any one industry is that a downturn in that industry can be devastating to the entire state economy. This is especially true for industries that do have strong buyer-seller relationships with local firms outside of the industry. So, while strong buyer-seller relations between high technology firms and other firms in the state can have important benefits during growth periods, during contractions they can lead to serious declines in total economic activity.

Arizona Department of Commerce should track high technology employment carefully and should consider a survey of firms every five years. What happens in the high technology industry has serious implications for the availability of high-skill, high-paying jobs in Arizona.

HIGHLIGHTS

An understanding of the economics of high technology industry is important to state policy makers and to Arizona citizens:

- a much higher component of Arizona's manufacturing is high technology than is found nationally
- high technology manufacturing and high technology services provides a significant proportion of the high wages jobs available in the state
- high technology accounts for 63 percent of Arizona's foreign exports.

High technology consists of the following industries in Arizona (shown is the percent of high technology employment, by major group):

- electronic components and computers (49%)
- aircraft and missiles (20%)
- scientific instruments (including optics) (18%)
- computer software and services (8%)
- research services (3%).
- chemicals (including biotechnology products) (2%)

The estimated direct contribution of high technology industry to Arizona's economy in 1994 was enormous:

- 95,099 jobs (4.8 percent of total state employment)
- $4.360 billion in employee compensation
- $5.369 billion in foreign exports, an estimated 63 percent of total Arizona exports
- $6.626 billion in total expenditures on goods and services, of which $2.862 billion is spent in Arizona
- $1.202 billion spent on construction from 1990 to 1994
- $5.931 billion in value added to the state economy, which is 6.8 percent of Gross State Product (GSP = $86.699 billion)
- $250 million paid in state taxes.

The total economic impact of the high technology industry in 1994, including direct, indirect and induced impacts are:

- 180,261 jobs (9 percent of Arizona's employment)
- $6.498 billion in employee compensation
- $9.546 billion in total value added impacts, which is 11 percent of Arizona's Gross State Product
- $609 million in state taxes, of which 73% is retained by the state and the rest is shared with cities and counties.

High technology business grew rapidly from 1972 through 1987:

- Employment more than doubled, increasing from 49,426 to 95,304 jobs
- Real payroll increased by 5.6 percent per year
- The number of establishments more than tripled.

High technology declined in Arizona from 1987 through 1992:

- Employment declined by 11 percent (by 11,000 jobs)
- Real payroll fell by over 13 percent (adjusted for inflation)
- The number of establishments continued to show strong growth.

High technology employment grew between 1992 and 1994:

- employment estimates for 1994 suggest that high technology business grew by almost 13 percent between 1992 and 1994, or 6.2 percent annually
- 1994 estimated employment of 95,099 is almost as high as 1987 levels
- high technology industry payroll is estimated to have grown by 6.9 percent annually between 1992 and 1994 to $3.699 billion.

The high technology sectors that are more strongly represented in Arizona than the U.S. and have substantial employment are:

- Semiconductors and related devices (16,357 jobs)
- Printed circuit boards (2,665 jobs)
- Electronic connectors (785 jobs)
- Electronic components, other (2,765 jobs)
- Guided missiles and space vehicles (6,064 jobs)
- Space vehicle equipment, other (1,750 jobs)
- Aircraft engines and engine parts (7,500 jobs)
- Aircraft parts and equipment (4,345 jobs)
- Search and navigation equipment (8,059 jobs)
- Process control instruments (1,986 jobs).

The following high technology sectors are under-represented in Arizona when compared to the U.S.:

- high technology chemicals
- computer and office equipment
- high technology services, such as computer software and research
- ordnance.

High technology firms were surveyed:

- 613 questionnaires were distributed
- 15.7 percent responded
- 82 percent response rate for 17 largest high technology firms
- respondents represented 55 percent of all high technology jobs.

Survey results indicated the following regarding organization:

- 58 percent of survey firms began operations since 1980
- 71 percent of sample firms, representing 11 percent of jobs in the industry, began in Arizona
- 67 percent of survey firms operate out of a single location.

The Arizona's high technology industry has strong relationships with other Arizona firms:

- 20 percent share development or engineering resources
- 20 percent are involved in joint research & development ventures
- 15 percent buy important materials or components available from only one seller in Arizona
- 52 percent of surveyed firms have special relationships with other firms in Arizona.

Arizona's high technology industry has strong business relationships with firms outside of Arizona:

- 35 percent of surveyed firms purchase important materials or components that are available from only one seller outside of Arizona
- 32 percent are involved in joint research and development ventures
- 26 percent share development or engineering resources
- 56 percent of surveyed firms have special relationships with firms outside of Arizona.

Arizona's large high technology firms have strong relationships with other high technology firms:

- 48 percent of all surveyed firms purchase inputs from the 14 largest Arizona high technology firms
- 53 percent of survey firms indicate they sell to or are input suppliers to the 14 largest high technology firms.

Arizona's high technology firms are heavily involved in research and development (R&D):

- 20 percent of all employees in the industry work in R&D
- overall, survey firms spend 6-8 percent of total sales on R&D
- more than 28 percent of survey firms spend 13 percent or more on R&D
- 87 percent of research funding came from internal sources

- 10 percent of research funding came from the U.S. Department of Defense
- 28 percent of survey firms acquired technology from for-profit Arizona entities
- 20 percent acquired technologies from universities or research facilities in Arizona.

High technology firms' final sales are distributed worldwide:

- 7 percent of high technology sales are in Arizona
- 59 percent are to the rest of the U.S.
- 34 percent of total sales are foreign exports
- Europe is the largest overseas buyer of Arizona high technology products.

Arizona's high technology industry is tied to U.S. defense spending:

- 25 percent of final or finished products are sold to the U.S. Department of Defense
- high technology services have the highest percentage of their sales to the U.S. Department of Defense.

There are many high quality jobs in the high technology industry:

- $45,800 compensation (including all benefits) per employee
- average payroll of $38,896 per employee in 1994
- average high technology pay is 75 percent higher than the average Arizona payroll per employee
- 35 percent of high technology workers have a four-year college degree or higher
- high technology spends an average of $900 per employee on training every year.

INTRODUCTION

Arizona's manufacturing sector includes a much higher component of high technology manufacturing than is found nationally. The high technology manufacturing cluster contributes a significant share of Arizona's total exports. In addition, high technology manufacturing, along with related high technology services, provides a significant proportion of the high wage jobs available in the state.

Given these attributes, an understanding of the economics of high technology industry is important to state policy makers and to Arizona citizens. In this study, a working definition of high technology industry is developed. Information was collected on the direct economic effects of the sector on the Arizona economy and important linkages between high technology industries and other sectors of the Arizona economy were identified. Then an input-output or interindustry model was used to estimate total economic effects of high technology industry on the state economy.

The present study assesses the impact of high technology business sector on Arizona's economy in terms of the number of Arizona jobs and the amount of Arizona wages that are directly or indirectly related (via the multiplier effect) to high technology businesses.

The study provides direct information on the nature of high technology businesses. In addition to information on what they buy and who they buy it from, the study also provides information on total expenditures, capital investments made in the state, expenditures on worker education and training, etc.

The study provides new insights into the structure and dynamics of the high technology industry by assessing growth rates and the relative size of various components of the high technology industry in Arizona and in the U.S., and by identifying the high tech components in which Arizona tends to specialize relative to the U.S.

The impact of Arizona's high technology industry is discussed within the context of Arizona's broader economy by comparing the impact with other economic measures, such as total employment, manufacturing employment, and Arizona's total wage and income figures. The quality of high technology jobs is assessed relative to jobs in other segments of Arizona's economy.

OVERVIEW

This report consists of several sections. The final definition of high technology business used in this study of Arizona is contained in the section HIGH TECHNOLOGY BUSINESS IN ARIZONA. A literature survey and discussion of the definition of high technology business is in Appendix A, DEFINING HIGH TECHNOLOGY BUSINESS.

The following section, ARIZONA'S HIGH TECHNOLOGY EMPLOYMENT FROM 1972 TO 1992, provides a brief analysis of Arizona's high technology industry over time. Location quotients are used in ARIZONA VS. THE U.S. ECONOMY to identify which industries have a stronger representation in Arizona than they do in the U.S. as a whole.

The section entitled IMPACT MODEL DESCRIPTION describes the model used to estimate economic impacts and explains the modifications that were made to the base model. IMPACT RESULTS provide more detailed information on the direct, indirect and induced impacts of high technology industry on the Arizona economy. Impacts are described in terms of employment, employee compensation, value added, and tax revenue.

The main results from the survey, including information on the organization of high technology industry, research and development activity, expenditures, marketing, and workforce issues appear in SURVEY RESULTS. Appendix E, SURVEY METHODOLOGY, provides a description of how the survey was conducted, firm lists used, and sampling methodology.

The important findings of this research effort are highlighted in SUMMARY AND CONCLUSIONS.

HIGH TECHNOLOGY BUSINESS IN ARIZONA

The first task of this study was to establish criteria for identification of firms in the high technology industry in Arizona. The researchers reviewed the existing academic literature on the definition of and identification of high technology industry firms. The comparatively small body of academic literature on this topic includes several alternative definitions of high technology industry, most of which are limited to the manufacturing sector only. A detailed discussion of alternative definitions of high technology is provided in Appendix A.

In this study, we utilized a "consensus" definition of high technology for manufacturing sectors and have utilized a "professional judgment" definition of high technology for service industries. This consensus definition appears in the last column of Appendix A, Table A-1. Prior to selecting the "consensus" definition, we examined the alternative definitions in Table A-1 for Arizona. We found that the industries in Arizona that are considered high technology by most researchers and lay people in Arizona easily fall within the "consensus" group of sectors derived from Table A-1. For our definition of high technology manufacturing sectors, we selected those that occurred in at least five of the definitions. The one exception to this is SIC 369 which did not exist prior to 1987. The reason it was included was that virtually all of 369 was moved from communications equipment (366). Communications equipment was identified as high tech in all of the 12 classifications in Table A-1.

In analyzing alternative definitions of high technology, we found that the selection of a definition for Arizona is less critical than it may be for some states. We analyzed all the definitions in Table A-1 and computed high technology employment based on each of these definitions. With the exception of the growth definition (Column II), Phillip's Arbitrary definition (Column VII), and the combined criteria of research and development (Column VIII), employment levels fall within a range that is only 3 percent less than and 11 percent more than the consensus definition employment.[2] The reason for this is that Arizona's high technology manufacturing employment is concentrated in a relatively small number of sectors that tend to be universally recognized as high technology industries. (This can be seen in Table A-1 employment figures).

For services, we utilized the SIC codes and definitions and selected those associated with software development and research and development.

[2] The growth definition resulted in larger employment figures. This definition excludes some sectors that clearly should be included, e.g., office computing machines, but includes fabricated metals, which in Arizona is mostly construction-related, such as sheet metal work for air ducts. The Phillips' definition and the definition that combines the R & D and occupational criteria both exclude space vehicles and guided missiles, which appears to be a significant oversight.

Table 1. High Technology Definitions.

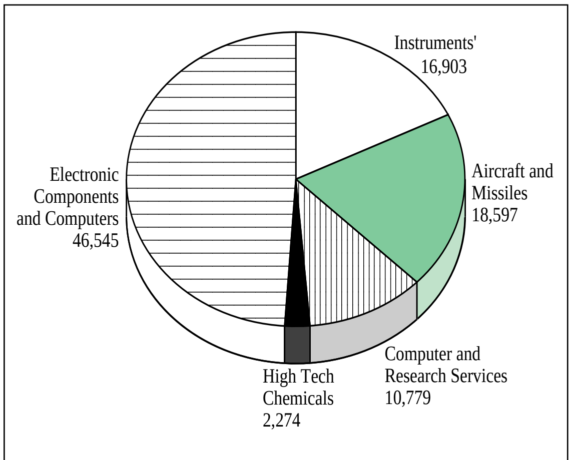
SIC Code	Industry Description	No. of 1992 Jobs
281	Industrial Inorganic Chemicals	249
282	Plastics Materials and Synthetic Resins, Rubber, Cellulosic and Other Manmade Fibers, Except Glass	207
283	Drugs	1,170
286	Industrial Organic Chemicals	0
289	Miscellaneous Chemical Products	411
348	Ordnance and Accessories, Except Vehicles and Guided Missiles	510
351	Engines and Turbines	15
357	Computer and Office Equipment Electronic Computers; Computer Storage Devices; Computer Terminals; Computer Peripheral Equipment; Calculating and Accounting Machines; Office Machines Not Elsewhere Classified	2,843
362	Electrical Industrial Apparatus	690
366	Communications Equipment Telephone and Telegraph Apparatus; Radio and Television Broadcasting & Communication Equipment; Communication Equipment, not elsewhere classified.	4,539
367	Electronic Components and Accessories Electron Tubes; Printed Circuit Boards; Semiconductors and Related Devices; Electronic Capacitors; Electronic Resistors, Electronic Coils, Transformers and Other Inductors; Electronic Connectors; Electronic Components, not elsewhere classified.	31,660
369	Miscellaneous Electrical Machinery, Equipment and Supplies Storage Batteries; Primary Batteries; Electrical Equipment for Internal Combustion Engines; Magnetic and Optical Recording Media; Electrical Machinery, Equipment & Supplies, not elsewhere classified.	1,452
372	Aircraft and Parts Aircraft; Aircraft Engines and Engine Parts, Aircraft Parts and Auxiliary Equipment, not elsewhere classified.	12,113
376	Guided Missiles and Space Vehicles and Parts	5,340
38	Scientific Instruments Measuring, Analyzing, and Controlling Instruments; Photographic, Medical, and Optical Goods; Watches and Clocks	14,655
7371	Computer Programming Services	2,168
7372	Prepackaged Software	1,459
7373	Computer Integrated Systems Design	1,375
7379	Computer Related Services, not elsewhere classified	830
8731	Commercial Physical and Biological Research	651
8733	Noncommercial Research Organizations	703
8734	Testing Laboratories	1,362
	TOTAL JOBS	84,402

Engineering services (SIC 871) were not included because close examination of firms in this category revealed that the bulk of these firms are involved in construction and other non-high technology activities. Table 1 provides a detailed list and description of the high technology sectors that we used for this study of Arizona, along with an estimate of Arizona's 1992 high technology employment.[3]

The bulk of Arizona's high technology employment is in only six or seven of the categories listed in Table 1 (also see Figure 1). Electronic components and accessories sector, combined with the related computer and office equipment and miscellaneous electrical equipment and supplies and communications equipment represents almost half

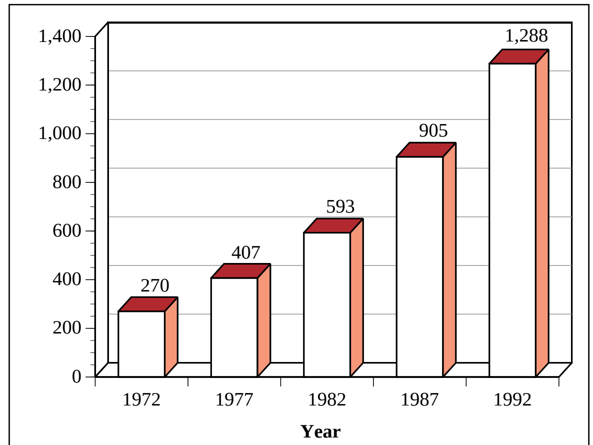
[3] Employment estimates for 1992 in Table 1 are based on a combination of a) *County Business Patterns*, 1992, b) information derived from the present survey, c) *Arizona Daily Star* 200, a list of the largest employers in southern Arizona, d) *Arizona Republic*'s list of 100 largest employers in Arizona, and e) information provided by the Arizona Department of Commerce.

Figure 1. 1994 High Technology Industry Employment by Sector.



Source: The University of Arizona High Technology Study.

Figure 2. Number of High Technology Industry Establishments.



Source: The University of Arizona High Technology Industry Study, figures based on County Business Patterns.

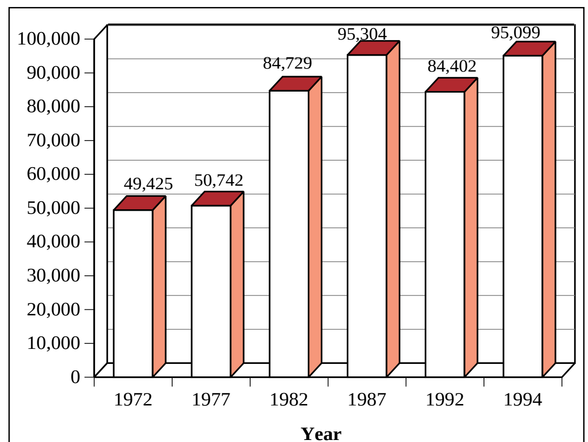
(49 percent) of Arizona's high technology employment. Scientific instruments and high technology chemicals (such as drugs) represent about 20 percent of the total and the defense-related sectors of ordnance, aircraft and parts, and guided missiles represents 20 percent. High technology services, represented by computer programming, integrated systems design and research and testing facilities represent about 11 percent of total high technology jobs in Arizona.

The SIC categories do not necessarily group industries the way the industries themselves would choose to be grouped or clustered. Also, some of the smaller young high technology industries in the state are subsumed under broader SIC categories. For example, biotechnology is found primarily under high technology chemicals, and specifically under drugs (SIC 283). Optics are a subset of the scientific instruments category and found predominantly under optical instruments and lenses (SIC 3827). Environmental technology is contained in various manufacturing sectors and in research and testing services. Industry groups may also involve a great deal of overlap as the same firm may produce goods or services that fit into several industry clusters. In contrast, the SIC categories are exclusive. Each firm is included under only one category.

ARIZONA'S HIGH TECHNOLOGY EMPLOYMENT FROM 1972 TO 1994

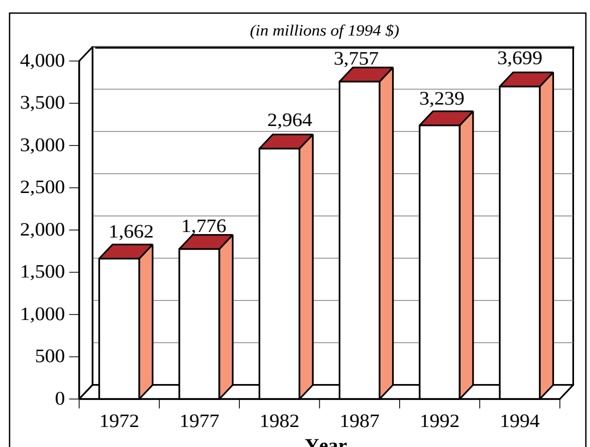
Figures 2, 3, and 4 show the change from 1972 through 1994 in Arizona's high technology

Figure 3. High Technology Industry Employment.



Source: The University of Arizona High Technology Industry Study, figures based on County Business Patterns.

Figure 4. High Technology Industry Payroll.



Source: The University of Arizona High Technology Industry Study, figures based on County Business Patterns.

employment, payroll (in 1994 dollars), and the number of establishments, respectively.[4]

Growth in high technology business was substantial from 1972 through 1987. Employment more than doubled during these years, increasing from 49,426 to 95,304 jobs (an annual compound growth rate of almost 4.5 percent.) Real payroll (in 1994 dollars) also showed substantial growth during these years, increasing from $1.66 billion to $3.76 billion (an annual compound growth rate of 5.6 per year). The number of establishments more than tripled over this period.

However, business activity in high technology showed a decline between 1987 and 1992. Employment declined by over 11 percent (from 95,304 jobs to 84,402 jobs) and real payroll (in 1994 dollars) fell by over 13 percent. This fall was despite the continued strong growth in the number of establishments during this five-year period.

The decline from 1987 to 1992 appeared to be concentrated in the following three sectors: computer and office equipment (SIC 357); communications equipment (SIC 366); and aircraft and parts (SIC 372). The decline in these sectors was substantial to result in an overall loss of over 11,000 jobs since there was continued growth in several of the other sectors, e.g., electronic components and accessories (SIC 369), scientific instruments (SIC 38), and high technology services (SICs 7371, 7372, 7373, 7379, 8731, 8733, 8734).

Part of the reason for the decline in employment in SICs 357, 366 and 372 was due to the U.S. Department of Commerce redefining its Standard Industrial Classification (SIC) Codes. For example, part of SIC 366 was shifted to SIC 38, and to 369, both of which are high technology SICs. This change would show a decline in communications equipment (SIC 366) and a corresponding increase in scientific instruments (SIC 38) and in miscellaneous electrical equipment (SIC 369), but would not explain any of the 11,000 job loss in the overall high technology group.

Other changes in SIC codes between 1987 and 1992 could contribute to the measured decline in high technology. For example, part of aircraft and parts (SIC 372) that dealt with fluid power valves, fluid powerhouse fittings, fluid power pumps and motors, and fluid power cylinders and actuators were shifted to non-high technology sectors (SICs 349 and 359). In addition, part of electrical industrial apparatus (SIC 362) and part of electronic components and accessories (SIC 367) were shifted to SIC 3548 (welding apparatus) and SIC 3264 (porcelain electric supplies), respectively, also non-high technology sectors.[5] It is not known for certain how much of the 11,000 decline in jobs is due to these SIC code changes. However, we do not believe that these SIC codes changes contribute significantly to explaining the decline in reported high technology jobs.

A more likely explanation is that several downsizings of large high technology firms took place between 1987 and 1992. The following firms announced downsizing plans during this period: IBM, McDonnell Douglas Helicopter, Intel, Hughes Missiles, Bull HN Information Systems, Honeywell (Commercial Flight Systems Group and Aviation Systems Division), Motorola's Government Electronics Group, Digital Equipment Corp, Loral Defense Systems, Intertec Aviation (closure, move to Dallas), AG Communications Systems Corporation, AlliedSignal Aerospace Company (Garrett Auxiliary Power Division, Garrett Engine Division, Garrett Fluid Systems).[6] These layoffs amounted to over 15,000 employees.

However, some of these same firms as well as other high technology firms announced expansions or consolidations that would have provided additional jobs over this same five-year period:

[4] Data for 1992 is identical to that in Table 2. All remaining data for Figures 1, 2, and 3 are from the County Business Patterns, 1972, 1977, 1982, 1987. County Business Patterns was used rather than the Economic Census because the 1992 Census of Manufacturing for Arizona had not yet been released at the time this study was written. The 1994 figures are estimates based on the employment estimates presented in Table 1.

[5] Source: Standard Industrial Classification Manual, 1987. Executive Office of the President, Office of Management and Budget, for sale by National Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 Order PB87-100012.

[6] Announced business cuts and layoffs taken from the business press. The *Arizona Republic*, *Phoenix Business Journal* and *What's New in Arizona* publications were monitored. The compilation of business cuts and layoffs are courtesy of The Forecasting Project, Economic and Business Research Program, College of Business and Public Administration, The University of Arizona.

Hughes Missiles, Garrett General Aviation, TRW, Honeywell, Motorola, McDonnell Douglas, AlliedSignal, and Loral Corporation. These announced expansions total approximately 8,500 jobs. Thus, based on publicly available information, downsizing of large firms can explain a significant portion of the decline in high technology jobs loss in Arizona, but not all of it. Underlying causes of job loss included a decrease in defense spending, the recession of the early 1990's and the increase in competition in the computer industry.

In the survey, firms were asked to provide their employment figures for March 1994 and for five years previous, March 1989. Comparing 1994 employment to 1989 employment for the survey firms reveals that employment in 1994 was 9 percent lower than in 1989. While firms with fewer than 100 employees grew by 33 percent over this period, employment at medium-sized firms declined by 9 percent and at large firms (over 1,000 employees) by 11 percent.

The 1987-1992 period can be characterized as a very volatile period for high technology business in Arizona. Small firms continued to be created; some large firms downsized or consolidated; and some large firms grew or experienced large swings in employment.

Although precise employment and payroll figures are not available for 1994, employment and payroll estimates for 1994 reveal that high technology business has shown strong growth between 1992 and 1994. Employment is estimated to have grown almost 13 percent during this period, which is approximately a 6.2 annual compound growth rate. Similarly, real payroll (measured in 1994 dollars) is estimated to have grown 6.9 percent annually since 1994.

The contraction in high technology business during the 1987 to 1992 period, followed by strong growth from 1992 through 1994 mirrors the overall performance of the Arizona economy.

Despite the significant loss in employment between 1987 and 1992, there is some evidence that Arizona's *dependence* on high technology business continued to expand even during that time. Appendix B shows the share of Arizona's Gross State Product represented by 71 economic sectors. The sectors in italics include high technology firms, i.e., only part of each sector in italics are high technology businesses. The most recent detailed data available are for 1992.

The bulk of electronic and other electric equipment is high technology, including communications equipment (4,539 jobs), electronic components and accessories (31,660 jobs) and miscellaneous electrical machinery (1,452 jobs). This sector grew from 2.1 percent of Arizona's economy in 1977 to 4.7 percent in 1992. Although this sector's share shows a strong underlying growth trend, there is some volatility, with the sector reaching a high of 5.3 percent of Arizona's share in 1990, falling back to 4.7 by 1992.

All of instruments and related products is considered high technology business. This sector's share of the Arizona economy has also shown a strong upward trend over time, increasing 160 percent from 1977 to 1992.

Other transportation equipment in Arizona is predominantly defense-related, consisting of aircraft and parts (12,113 jobs) and guided missiles and space vehicles (5,340 jobs). This sector rose from 2.2 percent of Arizona's economy in 1977 to a high of 3.2 percent in 1991, but fell back to 2.7 percent in 1992.

Only a very small portion of fabricated metal products is high technology, i.e., ordnance and accessories is 510 jobs out of 9,998 jobs in the whole sector. Most of fabricated metals is construction related, which accounts for the volatile nature of this sector in Appendix B.

Similarly, only a small portion of industrial machinery and equipment is considered to be high technology (1,481 out of 12,491 jobs), thus it is difficult to draw conclusions regarding high technology business in this sector from Appendices B and C.

About 42 percent of chemicals is high technology and this sector, although relatively small (4,610 jobs in chemicals), has doubled as a share of Arizona's economy (0.3 percent to 0.6 percent).

High technology services are very small portions of their respective service category, i.e., high technology computer and data processing services is only 6.8 percent of business services and research and testing services is only 8.3 percent of other services. Thus, the very strong growth trends in business services and other services cannot be used to make any conclusions about the growth in sector share of their high technology components.

ARIZONA VS. THE U.S. ECONOMY

Appendix D illustrates which of Arizona's economic sectors are better represented in Arizona than in the U.S. as a whole. Table 4 utilizes a concept known as the *location quotient* to measure whether each economic sector is comparatively stronger in Arizona than it is in the U.S. or whether it is weaker. A location quotient for each sector in Arizona is computed by dividing each sector's share of the total Arizona economy by the corresponding sectoral share in the U.S. Thus if a location quotient is greater than 1 for a particular sector, then that sector has a stronger representation in Arizona than it does for the U.S. as a whole. If a location quotient is equal to 1, then that sector is equally important in Arizona as it is in the U.S. and if a location quotient in Arizona is less than 1, the sector is less important in Arizona than it is in the U.S.

Appendix D provides a list of industries in Arizona. Some are reported at the 1-digit SIC level (e.g., AGRICULTURAL SERVICES, FORESTRY & FISHING), some at the 2-digit SIC level (food and kindred products, SIC 20), some at the 3-digit SIC level (copper ores, SIC 102), and some at the 4-digit level (electron tubes, SIC 3671). Various levels of detail were retained in this table because some sectors are of more or less interest for this particular study and for Arizona, in general, and because all high technology sectors are reported at the same detail as their definition, i.e., at the 3-digit or 4-digit levels.

In Appendix D, all high technology sectors are designated with an asterisk (*) in front of the industry descriptions given in the first column and SIC codes are given in the second column. Arizona 1992 employment from *County Business Patterns* is in the third column.[7] Several of the employment figures have a double asterisk (**) beside them, indicating that County Business Patterns could not disclose exact employment figures. Thus the employment figures denoted by (**) in Appendix C are the midpoint of the employment *range* reported by *County Business Patterns*.

The last column in Appendix C is the location quotient for each sector. Interpretation of location quotients is quite straightforward. The agricultural services sector has a location of 2.63, which means that agricultural services is 2.63 times more important in Arizona than it is in the U.S. as a whole. Specifically, the location quotient says that the agricultural services sector in Arizona (as a share of total Arizona employment) is 2.63 times larger than it is in the U.S. (as a share of total U.S. employment). The location quotient for copper ores is 32, which means that this sector is 32 times more important in Arizona than it is in the U.S. as a whole. Other non-high technology sectors with location quotients of interest are tourism-related sectors, e.g., hotels and other lodging places (SIC 70, location quotient of 3.12), eating and drinking places (SIC 58, location quotient of 3.75) and a variety of other retail sectors (SIC 52 through 59, retail trade in total had a location quotient of 2.15), and amusement and recreation services (SIC 79, location quotient of 1.96). Sectors dependent on high population growth rates also have high location quotients in Arizona. Construction-related sectors demonstrate location quotients over 1, (i.e., construction, SIC 15 has a location quotient of 1.33), real estate (SIC 65, location quotient of 1.52). In addition, several business services have high location quotients. Services to buildings (SIC 734, location quotient of 2.21) and personnel supply services (location quotient of 2.15).

Unlike location quotients for agricultural services, construction, retail trade, and services, the location quotient for manufacturing is less than 1 (i.e., .55). However, several sectors in manufacturing have much higher location quotients. Among the high technology sectors, Arizona is substantially under represented in high technology chemicals (SICs 281, 282, 283, 386, and 289) and ordnance (SIC 348). Two high technology components of industrial machinery and equipment (SICs 351 and 357) represent a smaller share of Arizona's employment than they do in the U.S. While this is not surprising for engines and turbines (SIC 351), it is somewhat surprising for SIC 357, which is the computer and office equipment sector.

[7] Note that the Arizona 1992 employment figures presented in Appendix D are taken directly from County Business Patterns. Thus, they may not be consistent with the 1992 employment figures present in Table 1, which were derived from a variety of sources. Since the 1992 Census of Manufacturers were not available at the time this final report was prepared, the authors had to rely on County Business Patterns for 1992 to obtain a consistent set of employment figures for all sectors for both the U.S. and Arizona.

Arizona is also under represented in high technology services. Virtually all of the computer-related high technology services (SICs 7371, 7372, 7273, and 7379) have location quotients substantially less than one. In addition, Arizona has substantially fewer workers, as a share of its economy than the U.S. in commercial and noncommercial research facilities and testing laboratories (SICs 8731, 8733, and 8743).

Although scientific instruments (instruments and related products, SIC 38) represents substantial employment in Arizona (over 13,000 jobs), the overall category is only 70 percent as important as it is in the United States as a whole. Within SIC 38, only two subsectors are more important in Arizona than in the U.S., namely search and navigation equipment (SIC 381) and process control instruments (SIC 3823).

Arizona is substantially represented in several of the high technology sectors within the transportation equipment sector (SIC 37). Aircraft and parts (SIC 372) is 24 percent larger than it is for the U.S. as a whole. Within aircraft and parts, both aircraft engines and engine parts (SIC 3724) and aircraft parts and equipment, n.e.c. (SIC 3728) are strong sectors for Arizona, with location quotients of 2.50 and 1.12, respectively.

Guided missiles, space vehicles and parts (SIC 376) is 43 percent larger than other states in the U.S., on average. Two of the three subsectors of guided missiles have stronger representation in Arizona than other states, i.e., guided missiles and space vehicles (SIC 3761) and space vehicle equipment, n.e.c. (SIC 3769).

Arizona's electronic and other electronic equipment (SIC 36) sector is 31 percent larger as a share of Arizona's economy than it is for the United States. Although not all of this 2-digit sector is defined to be high technology for purposes of this study, several of its subsectors are. In particular, the electronic components and accessories sector (SIC 367) is extremely strong in Arizona, when compared to the U.S., as well as several of its subsectors. Overall, the electronic components and accessories sector is 2.69 times more important in Arizona than it is in the U.S. The most important subsector, both in terms of its location quotient (4.11) and its employment level (over 16,000 jobs), is semiconductors and related devices (SIC 3674). Several other subsectors are more strongly represented in Arizona than the U.S.: electron tubes (SIC 3671) with a location quotient of 1.39; printed circuit boards (SIC 3672) with a location quotient of 2.63; electronic coils and transformers (SIC 3677) with a location quotient of 1.61; electronic connectors (SIC 3678) with a location quotient of 1.56; and electronic components, n.e.c. (SIC 3679) with a location quotient 1.50.

IMPACT MODEL DESCRIPTION

To estimate what effect the high technology industry has on the overall economy of Arizona, we used an input-output or interindustry model of the Arizona economy. The advantage of such a model is that it can provide detailed information on many different sectors. The drawback of an input-output model is that it is a very simple model based on assumptions that may not be very realistic. Among those assumptions are that industries create products using fixed proportions of inputs. This means that when relative prices of inputs change, the model does not have the capability to allow producers to change their input mix.

Input-output models can be run to estimate multipliers, or what are known as direct, indirect and induced impacts or effects. In this case, the direct effects are the employment, employee compensation, and value added generated directly by the high technology industry. Indirect impacts are the employment, employee compensation and value added that result from other firms in a state economy selling to the high technology industry. Induced effects or impacts are the employment, compensation and value added, created as workers in the high technology industry and workers in industries that sell to high technology industry spend their wages and salaries in Arizona.

The input-output model we used is called IMPLAN (Input-Output Model for Planning and Analysis). It was originally designed by the U.S. Forest Service. It was further developed at the University of Minnesota, and currently, the model and the data sets necessary to run the model are being maintained and improved by a private firm. The 1990 IMPLAN model was used in this study. The model provides a snapshot of the Arizona economy at one point in time. The impacts it estimates are medium run impacts (i.e., impacts that might be expected to occur within five years of a shock to the economy). The model breaks the state economy into 528 sectors with the most detail in manufacturing and lesser detail in service-oriented sectors.

The model was adjusted in the following ways. First, all estimated direct effects were deflated to 1990 dollars prior to entering into the model which is based on 1990 data. After running the model, the impact estimates were inflated to 1994 dollars. In addition, 50 of the 528 regional purchase coefficients were modified to better reflect trade patterns in Arizona. Regional purchase coefficients are simply that portion of local demand for goods and services from a specific industry that is met by industry within the state.

Another challenge with using the IMPLAN model is that it does not calculate induced effects in a way that reflects the difference in average wages across industries. This means that for a high wage industry such as high technology industry, induced effects would be significantly underestimated. Consequently, we developed a method for estimating correct induced effects using IMPLAN.

Table 3. Employment Impacts by Sector.

	Direct	Indirect	Induced	Total
		(number of jobs)		
Agriculture	0	110	523	634
Mining	0	43	14	56
Construction	0	1,180	802	1,982
High Tech Manufacturing	84,320	0	193	84,513
Other Manufacturing	0	2,827	1,784	4,611
TCPU	0	2,514	2,077	4,592
Trade	0	8,848	19,986	28,834
Fire	0	1,579	6,581	8,160
High Tech Services	10,779	0	221	11,440
Other Services	0	12,682	23,198	35,440
Total	**95,099**	**29,783**	**55,379**	**180,261**

	Direct	Indirect	Induced	Total
		(percentages)		
Agriculture	0	0	1	0
Mining	0	0	0	0
Construction	0	4	1	1
High Tech Manufacturing	89	0	0	47
Other Manufacturing	0	9	3	3
TCPU	0	8	4	3
Trade	0	30	36	16
FIRE	0	5	12	5
High Tech Services	11	0	0	6
Other Services	0	43	42	20
Total	**100%**	**100%**	**100%**	**100%**

IMPACT RESULTS

The estimated impacts for Arizona's high technology industry are presented in Table 2. The first row of the table includes the estimated direct effects or impacts of high technology industry. This included 95,099 jobs generated, $4.360 billion in employee compensation and $5.931 billion in value added. The second row contains the indirect effects of the high technology industry including 29,783 jobs, $.8 billion in employee compensation and $1.3 billion in value added. The indirect effects may look somewhat low. Part of the reason for this is that high technology firms buy large amounts of their materials and supplies from other high technology firms. Arizona high technology firms bought an estimated $1.79 billion in goods and services from each other. These purchases have been reflected in the direct effects and can not be counted in the indirect effects. This explains why the indirect effects in high technology manufacturing and high technology services are zero in Table 3.

Table 2. Economic Impacts of High Technology Industry.

	Employment	Employee Compensation	Value Added
	(jobs)	*(in billions $)*	*(in billions $)*
Direct	95,099	4.360	5.931
Indirect	29,783	.815	1.315
Induced	55,379	1.323	2.301
Total	**180,261**	**$6.498**	**$9.546**

The third row of Table 2 contains the induced effects, including 55,379 jobs, $1.3 billion in employee compensation and $2.3 billion in value added. The induced effects for this industry are quite substantial because of the high level of compensation in the industry. The final row is the total impact or the sum of the direct, indirect and induced effects.

The bottom line is that the high technology industry provides 4.8 percent of all jobs in Arizona directly and generates another 4.2 percent of all jobs indirectly and through induced effects. The total employment impact of 180,261 represents 9 percent of all jobs in Arizona in 1994. Likewise, the $5.931 billion in value added from high technology industry results in $9.546 billion in total value added impacts in Arizona. These value added impacts are 11 percent of the Gross State Product.

In addition to jobs, compensation and value added, high technology business directly and indirectly contributed to state revenues. Based on survey data, high technology businesses directly paid approximately $250 million in state taxes. Additional revenues are generated as workers spend their paychecks. Workers employed in high technology industries as well as workers in related and induced sectors paid an estimated $359 million in state taxes. These state taxes include income taxes, sales taxes, motor fuel taxes, other vehicle related taxes, and state property taxes. Of the $359 million, approximately $263 million is retained by the state; the additional $96 million is distributed to Arizona cities and counties.[8]

In estimating impacts for any industry, it is important to use the appropriate multiplier for a given direct effect. For example, to estimate employment impacts, we need to start with total employment in high technology industry and use the employment multiplier. Similarly with value added, and employee compensation.

Likewise, if you are interested in the impacts of high technology industry, you must calculate a multiplier for the entire industry and not for each subsector of the industry. The larger the industry you are looking at, the smaller the multiplier is likely to be. So, for example, the employment multiplier for high technology industry is 1.9, however, the employment multiplier for one subsector of the industry, such as computers, is likely to be significantly higher (probably in the range of 2.2 to 2.8). The reason for this is that as the size of the industry increases, the percentage of total purchases that industry members make from each other increases. As purchases in the industry increase, the indirect effects decline because there is less spent on goods provided by businesses in the state that are outside of the industry. For this reason, the size of a multiplier is not necessarily a good indicator of a particular sector's importance.

Some of the best indicators of the importance of a sector are its direct share of exports, employment and Gross State Product and its total employment and value added impacts as a percent of total employment and Gross State Product. In all of these measures, high technology industry is quite large.

There are subtle differences between some of measures of economic impact that may not be apparent. For example, employee compensation is not the same as total payroll, although they are related. Employee compensation includes more of the benefits received by employees than does total payroll (for example, such benefits as retirement and pension plans, health and life insurance, etc.).

Similarly, gross output and value added by the industry are very different. Gross output can be thought of as the total sales or gross receipts of an industry, while value added represents the difference between the industry's gross receipts and the materials and supplies purchased in order to produce industry output. Value added can be thought of as a form of net receipts; it is net of what is referred to as intermediate inputs (i.e., inputs produced by other firms, as opposed to primary inputs such as labor and capital).

One of the most common measures of total economic activity in a state is the Gross State Product (GSP), which is basically comparable to the Gross Domestic Product at the national level. However, the GSP really reflects the value added to the economy by each industry, NOT the gross receipts or total output of each industry. By only including value-added, no double counting occurs (i.e., the integrated circuits produced in Arizona are not counted by the electronic component industry and again by the computer manufacturers and again by computer retailers - they are only counted by the integrated circuit producers). Thus, in an impact analysis, it is only appropriate to compare Gross State Product to value added.

[8] Induced revenue impacts are computed using the Revenue Impact Model developed by Alberta H. Charney and Craig M. Horn for the Arizona Department of Commerce.

SURVEY RESULTS

This is a particularly long section of the report because of the large amount of data collected through the survey. It has been organized to parallel the sections in the survey questionnaire. These sections include: industry organization, research and development, expenditures, marketing, employment, and finance.

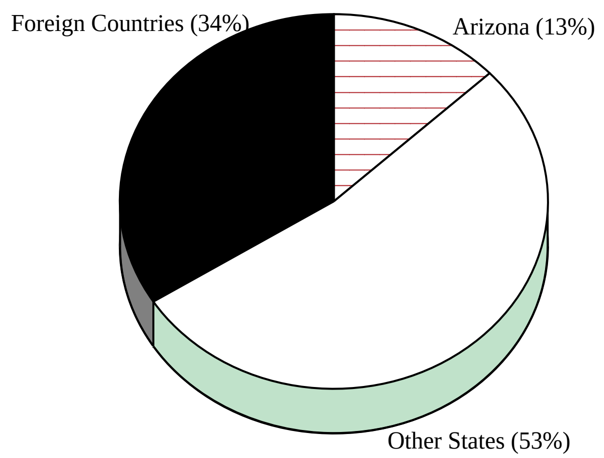
Table 4. When Survey Firms were Established.

	Number Established	Per cent	No. Established in AZ	Per cent
Prior to 1951	12	13	3	3
1951-1959	3	3	9	9
1960's	13	14	8	8
1970's	17	18	20	21
1980's	35	38	41	43
1990-1994	13	14	14	15
Total	**93**	**100%**	**95**	**100%**

Many of the research questions that we had concerning the high technology industry were not easy to answer using secondary data sources alone. Consequently a survey was conducted as part of this research project. Details concerning how the survey was conducted are provided in Appendix E. A copy of the questionnaire is in Appendix F.

Overall response rate for the survey was 15.7 percent. However, because of an 82 percent response rate among the largest firms, a large share (55 percent) of total industry employment is captured in the survey.

Figure 5. Location of Branch Facilities.



INDUSTRY ORGANIZATION

The high technology industry is characterized by a large number of young firms. Fifty-eight percent of the sample firms began operations in Arizona in the past 15 years (since 1980) and 52 percent of the sample firms did not exist in any state or country prior to 1980 (Table 4). Despite their relatively young age, 63 percent of the facilities described by the survey firms had been located somewhere other than their current location. Seventy percent of the firms that relocated moved from another location in Arizona (26 percent of the firms did not indicate where they had moved from). Seventy-one percent of the survey firms began in Arizona. These predominantly smaller firms provided an estimated 11 percent of total jobs in the industry.

Over two-thirds of the survey firms operated out of a single location. Seventeen percent had branch plants in Arizona but headquarters located in another state. Six percent were headquartered in Arizona but had no other Arizona facilities and 8 percent had both headquarters and other facilities in Arizona. Of the 870 branches that the survey firms operated, 13 percent are in Arizona, 53 percent are in other states and 34 percent are in other countries (Figure 5).

Several questions in the survey asked firms to describe some of the relationships within their business and between their business and other businesses. One of the first questions concerned where decisions about hiring workers and purchasing inputs were made. Overall, for those firms that had more than one location, 23 percent indicated that hiring decisions were made at the company headquarters and 26 percent indicated that purchasing decisions were made at company headquarters (Figure 6). Forty-two percent and 35 percent respectively indicated that hiring and purchasing decisions were made at individual facilities or branch plants. A large percentage (35 percent for hiring and 39 percent for purchasing) of the firms indicated that these decisions were made at both locations.

Figure 6. Where Purchasing and Hiring Decisions are Made in Multilocation Firms.

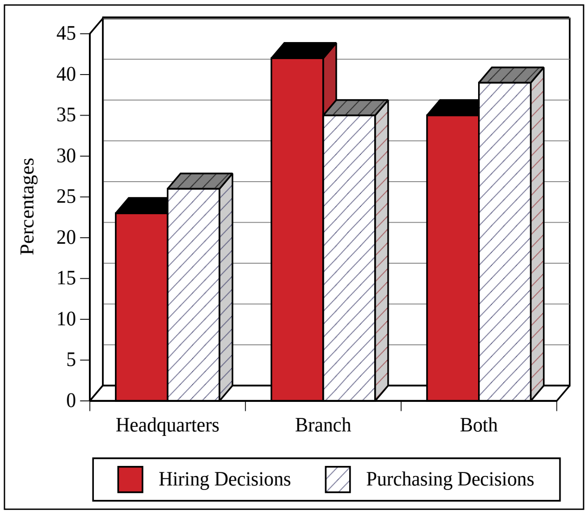


Table 5. Percentage of Firms Involved in New Forms of Business Relations.

Type of Relationship	Involved with AZ firm	Involved with Non-AZ firm
	(percentages)	
Exclusive subcontractor to	16	19
Exclusive buyer of inputs	14	12
Key inputs available from 1 seller	15	35
Product bundling with	7	19
Joint R&D ventures	20	32
Share development or engineering resources	20	26
License your technology to	10	21
Buy technology licenses from	9	19
Other	10 %	
Number of firms reporting	81	

A variety of business relationships exist between high technology firms and other firms. In addition, because high technology industries use very sophisticated inputs that are often custom-made for specific end products, questions were asked about subcontracting and licensing agreements. The responses of the sample firms are presented in Table 5. Some of the most common relationships are that a firm is purchasing key inputs that are available from only one seller who is located outside of Arizona, or that the firm is involved in joint R & D ventures with a firm outside of Arizona or that the firm shares development or engineering resources with a firm outside of Arizona. Although the percentage of firms involved in any one of these special relationships with other firms is low, over two-thirds of the firms were involved in one or more of these relationships. Those firms with special relationships with other firms were involved in an average of four different types of relationships.

Another issue related to business relations is the buyer-seller relationships within and between high technology industry sectors. For the sample firms, a large number of these relationships existed between the largest firms in the high technology sector and all high technology firms. Overall, 48 percent of the surveyed firms indicated that they purchased inputs from one of 14 large firms. Fifty-three percent indicated that they sell to or are input suppliers to these 14 firms. The 14 large firms listed were Alcatel Information Systems, AlliedSignal, Bull Worldwide Information Systems, Burr-Brown, Digital Equipment, IBM (Adstar), Intel, AT&T Network Cable Systems. McDonnell Douglas Helicopter Division, Microage, Motorola, Honeywell, Hughes Missile, and TRW Vehicle Safety Systems.

Ten percent of all survey firms indicated that the 14 large firms were among their five largest input suppliers. However, on the other side of the relationship 31 percent of all survey firms indicated that one or more of these large firms was among their five largest customers in terms of dollar value of sales. The implications of this are that the largest high technology firms, in addition to providing a large share of employment and value added in the industry, are also important purchasers of products from other high technology firms in the state. While these large firms are also suppliers of inputs to almost half of all high technology firms in Arizona, they do not tend to be among the five largest suppliers to these firms.

RESEARCH AND DEVELOPMENT

Approximately 20 percent of all employees in the high technology industry are believed to work in research and development. This varies somewhat by sector and by the size of the firm, as evident in Table 6. In particular, a high percentage of workers in electronic components and computers and computer software and services are involved in R & D. As might

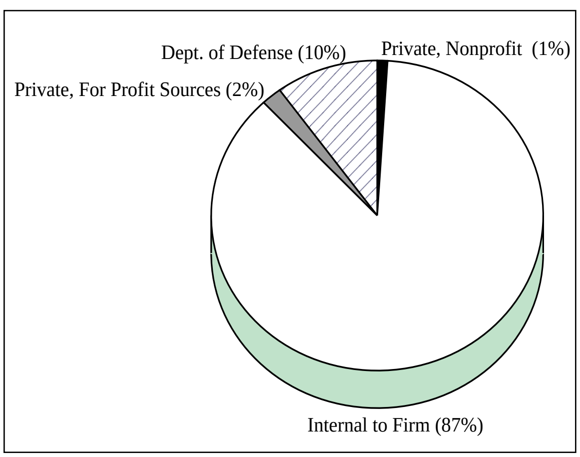
Table 6. Percentage of Workers in R & D to Total Workers by Sector and Firm Size.

Sector	All Firms	Small Firms	Medium Firms	Large Firms
Electronic Components and Computers	17	11	13	18
Aerospace, Instruments and Chemicals	22	16	7	25
High Technology Services	22	24	30	NA
Total	**20%**	**15%**	**18%**	**20%**

Table 7. Research and Development Expenditures as a Percentage of Total Sales.

	Number firms	Percent
Less than 1%	14	16
1-3%	13	15
4-5%	10	12
6-8%	12	14
9-12%	13	15
13-25%	15	17
Greater than 25%	9	11
Total	**86**	**100%**

Figure 7. Sources of Research and Development Funds.



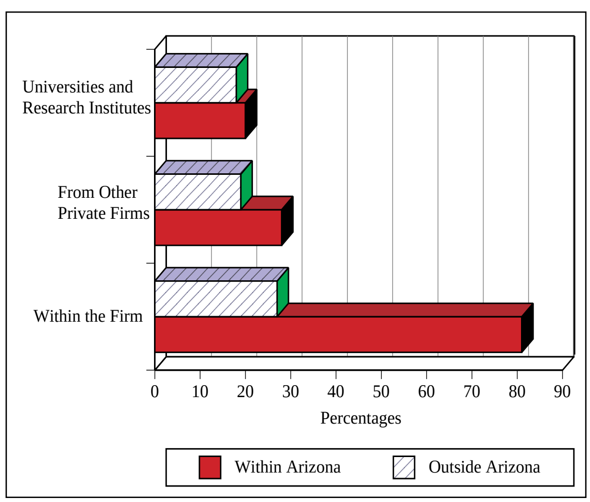
be expected, the share of employees involved in R & D is larger for large firms (with more than 1,000 employees) than for medium and small sized firms (Table 6). In the case of aerospace, missiles, instruments and chemicals, small firms had a higher percentage of employees working in R & D than medium firms. In the other sectors, small firms had the smallest share of workers in R & D.

The median size of R & D expenditures as a percentage of total sales is approximately 6-8 percent for the survey firms. The distribution of firms according to their R & D expenditures was similar for small compared to medium and large firms. In particular, almost 28 percent of the survey firms spent 13 percent or more of total sales on R & D. On the other end of the spectrum, 16 percent spent less than 1 percent of total sales on R & D (Table 7).

Firms relied heavily on internal sources of funds for their research. Eighty-seven percent of all research funding for the survey firms came from internal sources. The next most significant source was U.S. Department of Defense which provided approximately 10 percent of funding for research (Figure 7).

In addition to doing their own research, firms have the option of acquiring technology from other sources. Eighty-one percent of the survey firms indicated that they rely on sources of technology within the firm. However, 28 percent of the survey firms indicated that they acquired technology from private for-profit entities in Arizona and 20 percent acquired technologies from universities or research facilities (Figure 8). Small and medium-sized firms tend to be less likely to develop technology within the firm than large firms. Smaller firms also tend to be more

Figure 8. Sources of Technology for High Technology Survey Firms.



likely to acquire technologies in Arizona rather than outside it.

Firms were also asked about whether they had facilities that either were ISO-9000 certified or that met ISO-9000 standards. About 13 percent of the facilities run by the survey firms were ISO-9000 certified. Another 38 percent of the facilities meet ISO-9000 standards although they are not certified (Table 8). ISO-9000 refers to the quality standards set by the International Standards Organization in Switzerland. Meeting these standards is often required for a company to bid on large public and private contracts in Europe and elsewhere. Certification is done at the facility not the firm level.

Table 8. Percentage of Facilities with ISO 9000 Certification or Following ISO Standards.

	Number Certified	Percent	Number Meeting Standards	Percent
Yes	13	13	37	38
No	89	87	49	62

Table 9. Expenditures by High Technology Industry.

Expenditure Category	Amount	Percent of Total
	(in billions of $)	
Wages and Benefits	4.360	40
Materials and Supplies	3.635	33
Equipment	1.517	14
Buildings and Land	0.307	3
State Taxes	0.250	2
Utilities	0.215	2
Other[1]	0.702	6
Total	$10.986	100%

[1] This includes federal taxes, transfer payments, and other expenses.

EXPENDITURES

The estimated expenditures of high technology industry in several broad categories are presented in Table 9. Some of the major expenditures are on wages and benefits ($4.36 billion or 40 percent of total expenditures) and on materials and supplies ($3.635 billion or 33 percent of total expenditures). Smaller expenditure categories include $250 million paid in state taxes, $215 million spent on utilities and $702 million in miscellaneous spending. Of these total expenditures, 60 percent or $6.592 billion were made in Arizona (Table 10). The total materials and supplies alone purchased in Arizona were valued at $1.418 billion in 1994. This represents approximately 39 percent of all materials and supplies purchased by high technology firms.

Table 10. Arizona Expenditures as a Percentage of Total Expenditures by Category.

Category	In Arizona	Outside Arizona	In Arizona	Outside Arizona
	(percent)		*(billions of $)*	
Total[1]	**60%**	**40%**	**$6.592**	**$4.394**
Equipment	29	71	0.440	1.077
Materials & Supplies	39	61	1.418	2.217
Other	33	67	0.232	0.470

[1] Includes all expenses described in the previous table. However, expenses occurred outside Arizona in only 3 categories of expense.

Over the past five years, high technology industry has spent an estimated $1.202 billion on construction. An estimated 17 percent of all capital equipment in the industry was purchased in the past one year, 56 percent was purchased in the past five years and 87 percent has been purchased in the last 10 years.

MARKETING

High technology firms are important contributors to international exports from Arizona. High technology foreign exports from

Table 11. Percentage of Sales by Destination.

Sector	Sold to: AZ	CA	Rest of U.S.	Mexico	Japan	Rest of Asia	Europe	Other
Electronic Components & Computers	2	3	57	2	8	11	18	1
Aerospace, Instruments & Chemicals	7	4	57	2	3	7	12	8
High Technology Services	31	1	50	0	1	7	9	2
High Technology Industry Total	**7%**	**3%**	**56%**	**2%**	**5%**	**9%**	**14%**	**4%**

Table 12. Destination of Arizona Exports, by Sector, 1993.[a]

	Chemicals SIC-28	Fab. Metal Prod. (incl. Ordnance) SIC-34	Industrial Mach (incl. Computers) SIC-35	Electronic Equipment SIC-36	Trans. Equip. Aerospace SIC-37	Instruments SIC-38	Electronic Equipment & Computers SIC35+36	Aerospace, Instruments & Chemicals OTHER	TOTAL
					(percent)				
World	100	100	100	100	100	100	100	100	100
Canada	15	7	8	5	7	11	6	8	6
Mexico	33	77	29	10	32	6	14	32	17
Japan	18	1	6	14	1	5	12	3	11
EUROPE	21	6	33	26	25	55	28	29	28
Rest of ASIA	9	8	18	43	32	20	37	25	35
Other	3	1	6	2	3	3	3	3	3
					(in millions of $)				
	SIC-28	**SIC-34**	**SIC-35**	**SIC-36**	**SIC-37**	**SIC-38**	**SIC35+36**	**OTHER**	**TOTAL**
World	78.9	247.6	831.4	3,224.1	1,160.0	426.4	4,055.6	1,912.8	9,945.1
Canada	12.1	16.0	66.2	173.6	77.1	47.0	239.7	152.3	619.6
Mexico	26.3	192.2	241.2	329.1	378.9	26.6	570.3	623.9	1,738.3
Japan	14.2	1.5	50.8	453.8	12.9	21.2	504.7	49.8	1,044.9
EUROPE	16.6	14.0	276.0	843.7	290.0	232.3	1,119.7	553.0	2,775.9
Rest of ASIA	7.0	20.9	143.8	1,373.1	369.6	85.2	1,516.9	482.7	3,509.4
Other	2.7	2.9	53.4	50.8	31.4	14.2	104.2	51.2	257.0

[a] Export data is only available at the 2-digit SIC level. Only portions of all of these 2-digit sectors (except 39) are high technology.
Source: Derived from the National Trade Data Base, University of Massachusetts, MISER Files

Arizona were approximately $5.369 billion in 1994.[9] This represents an estimated 63 percent of total foreign exports from the state. Only approximately 7 percent of total sales in the high technology industry remains in the state of Arizona. Other important export markets are described in Table 11. Basically, about 59 percent of total sales remain in the U.S. in states other than Arizona. Of the remaining 34 percent that is exported overseas, 14 percent is sent to Europe and 14 percent is exported to Asia. These represent two of the largest markets for high technology products from Arizona. Japan alone is a market for roughly 5 percent of total high technology exports from Arizona. As might be expected, high technology services sell a higher percentage of their services within the United States, but still have exports totaling 18 percent of total sales. The electronic components and computers sector is the most export-oriented with 38 percent of total sales abroad.

Note that the export estimates based on the survey differ somewhat from published export data for Arizona. Table 12 presents the destination of Arizona exports, by 2-digit sector for 1993. The percentages of exports going to Mexico and the Rest of Asia in Table 12 are substantially higher than the percentages of exports going to these regions as reported by survey firms and reported in Table 11. The reason for this is that survey firms reported distribution of *the sale of final products* but Table 12 reports the value of all shipments leaving the state for these destinations. Thus, Table 12 includes

[9] This estimate is based on the University of Massachusetts MISER files and information from the Arizona Department of Commerce, International Trade Office, not on information from the survey.

shipments of components or intermediate goods to Mexico and Rest of Asia that are destined for further assembly, not for final sale. The difference in the percentages of exports reflect the maquiladora operations in Mexico and off-shore assembly in parts of Southeast Asia.

The percentage of total sales of inputs or components versus final products varies significantly by sector (Table 13). Research services and aerospace and missiles tended to have a larger percentage of sales in final products. Overall, 45 percent of high technology sales were of inputs or components and 55 percent were of final products.

Table 13. Percentage of Sales that are Inputs Versus Final Products.

Sector	Inputs	Final Products
Electronic Components & Computers	78	22
Aerospace and Missiles	34	66
Instruments	62	38
Chemicals	95	5
Computer Software & Services	67	33
Research Services	18	82
Total	**45%**	**55%**

For those firms that sold inputs or components, 78 percent were sold based on formal subcontracts with the buying firms (Table 14). The high technology service sectors tended to rely more on informal purchasing agreements (representing about 55-66 percent of their total sales) than on formal subcontracts. Over 88 percent of total sales of inputs or components were made to large firms with more than 1,000 employees (Table 15). Only high technology chemicals and services tended to sell a large percentage of their inputs/components to small and medium-sized firms.

Table 14. Percentage of Sales by Type of Purchasing Agreement.

Sector	Formal Subcontracts	Informal Purchasing Agreements	Other
Electronic Components & Computers	77	23	0
Aerospace and Missiles	94	0	6
Instruments	88	11	1
Chemicals	67	33	0
Computer Software & Services	42	54	4
Research Services	45	55	0
Total	**78%**	**20%**	**2%**

Table 15. Percentage of Sales of Inputs by Size of Purchasing Firm.

Sector	Small Firms (less than 100 workers)	Medium Firms (101 to 1,000 workers)	Large Firms (over 1,000 workers)
Electronic Components & Computers	2	9	89
Aerospace and Missiles	0	1	99
Instruments	2	5	93
Chemicals	24	27	49
Computer Software & Services	21	1	78
Research Services	20	24	56
Total	**4%**	**8%**	**88%**

For those firms that sold final or finished products to the end users of that product, almost a quarter were sold to the U.S. Department of Defense (Table 16). Although this percentage may be lower than if this survey had been conducted 10 years ago, it still indicates a significant dependency on defense contracts in Arizona's high technology industry. See

Table 16. Percentage of Sales of Final Products to Government.

Sector	U.S. Military Dept. of Defense	Non-Military Federal Agencies	All Other Customers
Electronic Components & Computers	27	2	71
Aerospace and Missiles	29	1	70
Instruments	11	4	85
Chemicals	0	1	99
Computer Software & Services	55	36	9
Research Services	1	2	97
Total	**24%**	**4%**	**72%**

Table 17. Arizona Prime Contract Awards.

Fiscal Year	Contract Awards Real $ 1994
	(in thousands)
1992	2,055,509
1991	2,731,774
1985	3,360,500
1979	1,440,179
1975	1,699,664
1974	1,535,668

Derived from: U.S. Department of Defense, Prime Contract Awards; Balancing the Books: Military Spending in Arizona by Nina Mohit; and The Rise of Military-Industrial Spending in Arizona 1970-1972 by Davis A. Tansik and R. Bruce Billings.

Table 18. Percentage of Sales in Customized Versus Standardized Products/Service.

Sector	Custom Made For the Buying Firm	Standardized Product
Electronic Components & Computers	55	45
Aerospace and Missiles	100	0
Instruments	81	19
Chemicals	71	29
Computer Software & Services	26	74
Research Services	32	68
Total	**66%**	**34%**

Table 19. Average Percentage of Sales to Largest Customers.

Sector	Sales to Largest Customer	Sales to Five Largest Customers
Electronic Components & Computers	21	46
Aerospace and Missiles	36	57
Instruments & Chemicals	18	52
Computer Software & Services	31	40
Research Services	12	22
Total	**24%**	**49%**

Table 17 for real defense contracts in Arizona for various years from 1971 to 1992. The highest percentage of sales of final products to the U.S. Military are for high technology services, aerospace and missiles and electronic components and computers. Clearly, the U.S. Department of Defense is not only an important customer for firms in aerospace and missiles, but also for other producers of high technology products and services.

Almost two-thirds of the value of all high technology products and services are custom-made for the buyer. Virtually all products in the aerospace and missiles sector are custom-made (Table 18).

In addition, sales in the high technology industry are fairly concentrated. On average, almost one-fourth of a high technology firm's sales are to its largest customer. Almost half of all the firm's sales are to its five largest customers (Table 19). This would indicate that major buyers of high technology products and services have significant bargaining power.

EMPLOYMENT

Direct employment in the high technology industry as defined here was approximately 95,099 in 1994. The high technology industry is a high-wage employer in Arizona, with an average payroll of $38,896 per employee. Not surprisingly, the industry is a major employer of engineers, scientists, computer specialists and professionals (Figure 9). Over a quarter of all doctoral scientists and engineers estimated to work in the state of Arizona are employed in the high technology industry.[10]

Over a third of the high technology workers have a four year college degree or higher (Figure 10). A large percentage of the work force is involved in research and development as mentioned earlier (Figure 11). Approximately 20 to 25 percent of the total high technology work force is involved in research and development work. However, over half of all employees in the high technology industry have at most a high school degree.

Per employee wages and salaries by occupation are presented in Table 20. Several of the largest high technology firms did not provide information on this question, hence, it reflects more of the average pay per employee for small and medium-sized firms. Drawing on secondary data sources, the average payroll per employee for Arizona in 1992 was $21,925 (1992 County Business Patterns). The average payroll per employee for high technology industry was $38,376 per employee in 1992. We estimate that payroll per employee was

[10] Based on National Science Foundation figures on doctoral scientists and engineers in Arizona in 1991 and survey data.

Figure 9. Employment in High Technology Industries by Occupation.

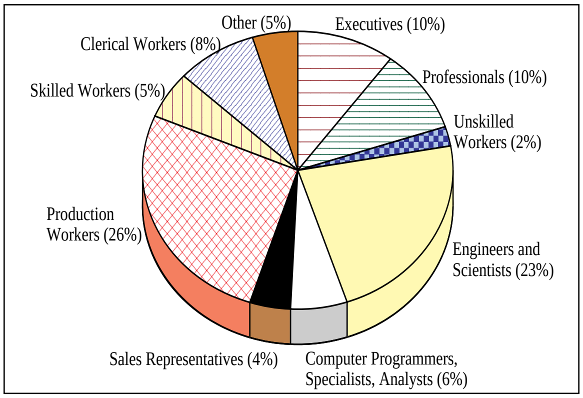


Figure 10. Education and Attainment of High Technology Industry Employees.

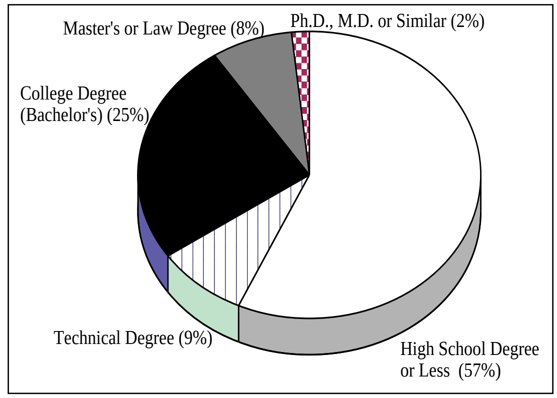


Figure 11. Distribution of Employment by Task or Department.

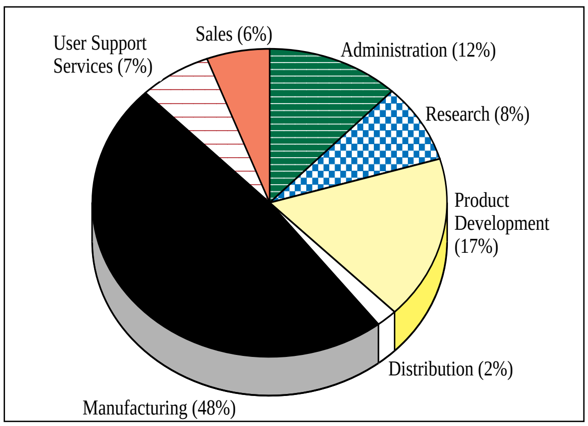


Table 20. Payroll Per Employee by Occupation.

Occupation	Payroll per Employee ($)
Executives and Managers	57,220
Professionals (lawyers, accountants, etc.)	46,351
Engineers, Scientists and Mathematicians	50,759
Computer Programmers, Specialists and Analysts	46,268
Sales Representatives	24,750
Skilled Workers (mechanics, craftsman and machinists)	28,477
Production Workers (assemblers, fabricators, operators)	28,168
Unskilled Workers (material handlers, laborers)	14,825
Clerical Workers	32,492
All Workers	37,000

$38,896 in 1994. Our survey results indicate wages and salaries per employee of $37,000. High technology industry provides high wages to its employees compared to other industries in Arizona.

Several of the largest high technology firms in Arizona are noted for their employee training programs. Motorola is especially well known for its employee education and training programs. High technology firms spend an average of $900 per employee on training each year. Fifty-three percent of this was spent on in-house training. Total employee training expenditures by high technology firms were estimated at $86 million in 1994. The highest training expenditure is for in-house or on-the-job training. For 12 percent of the firms responding to this question, it was the only type of training indicated. The next highest expenditure for training was generally for sending employees to seminars, meetings and workshops. The third and fourth highest expenditures were for providing incentives/support for employees to complete additional course work or degrees and to bring in consultants to train employees.

FINANCE

Only two questions were asked in this section: How would you rate the availability of start-up and expansion financing for your firm? These questions evoked more written comments than any other question. Sixty-one percent of the survey firms indicated that availability of financing for start up was poor

Figure 12. Availability of Financing for Start-Up.

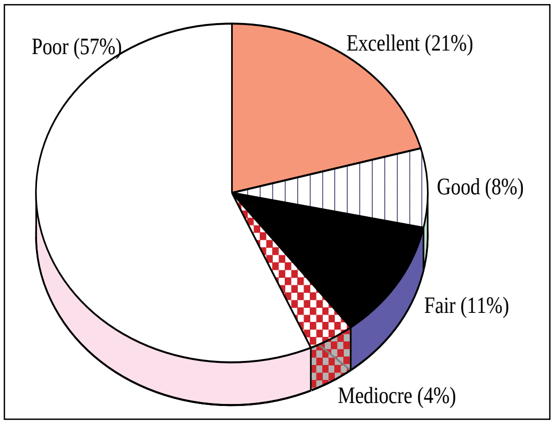
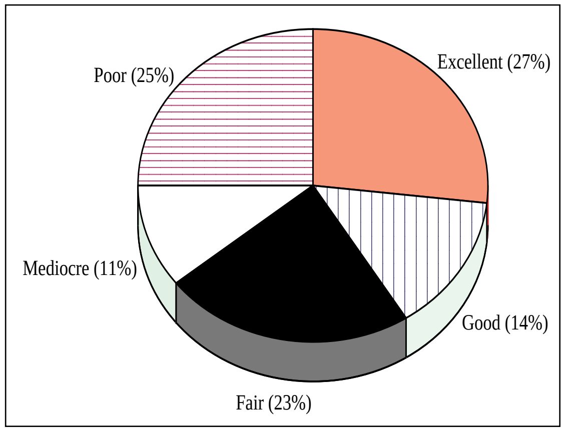


Figure 13. Availability of Financing for Expansion.



to mediocre versus 29 percent who rated it as excellent or good. Only 36 percent rated availability of funds for expansion as poor to mediocre versus 41 percent who rated availability of funds for expansion as excellent or good (Figures 12 and 13).

Summary and Conclusions

After reviewing numerous articles on high technology, the authors chose a consensus definition for high technology business in Arizona. High technology employment is concentrated in a handful of sectors that tend to be universally recognized as high technology. Thus, the size of the high technology sector in Arizona does not vary substantially when different definitions are applied. The final selection of high technology sectors for use in this study are Standard Industrial Classifications 281, 283, 286, 289, 348, 351, 357, 362, 366, 367, 369, 372, 376, 38, 7371, 7372, 7373, 7379, 8731, 8733, and 8734.

Arizona's high technology business falls into the following six major groupings: electronic components and computers (48.9 percent of total high technology in Arizona; aircraft and missiles (19.6 percent); scientific instruments, including optics (17.8 percent); chemicals, including biotechnology products (2.4 percent); computer software and services (8.1 percent); and research services (3.2 percent). (Environmental technology is distributed throughout these other sectors.)

Arizona is not well represented in all sectors identified as high technology. Arizona is substantially under-represented in high technology chemicals, industrial machinery and equipment, and high technology services. Arizona is also under represented in scientific instruments when compared to the U.S., but two of its subsectors, search and navigation equipment and process control instruments, are more important in Arizona than in the U.S.

Aircraft and parts is 24 percent larger, and guided missiles, space vehicles and parts is 43 percent larger than they are in the U.S., respectively. The electronic and other electronic equipment sector is by far the largest high technology sector in Arizona and it is 31 percent larger as a share of Arizona's economy than it is for the U.S.

Growth in high technology business was substantial from 1972 through 1987, with employment more than doubling and payroll increasing 5.6 percent per year. High technology showed a decline between 1987 and 1992. Employment fell by 11 percent, despite a strong growth in the number of establishments. The 1987 to 1992 decline in jobs appeared to be concentrated in computer and office equipment, communication equipment and aircraft and parts. Downsizing of some of the larger firms in these high technology groups contributed significantly to this five-year loss in jobs, but does not account for all of it.

The year 1992 was the trough of the recession in Arizona. Since 1992, high technology business has shown strong growth. Based on estimated employment and payroll figures, high technology employment and real payroll have grown by 6.2 and 6.9 percent per year, respectively, between 1992 and 1994.

Based on the definitions used in this study, high technology made a direct contribution to the 1994 state economy of 95,099 jobs, which is 4.8 percent of 1994 total Arizona employment. These more than 95,000 jobs contributed more than $4.360 billion in employee compensation, which was more than $45,800 per job, including all benefits. High technology directly contributed $5.369 billion to Arizona's foreign exports (this is 63 percent of total Arizona exports) and they spent $6.626 billion, of which $2.862 was spent in Arizona. High technology constituted 6.8 percent of Arizona's Gross State Product, contributing $5.931 billion in value added. High technology industry spent $1.202 billion on construction from 1990 through 1994.

High technology business pays approximately $250 million in state taxes and workers in high technology and related businesses generate an additional $359 million in state taxes through their spending. Approximately 73 percent of these state tax revenues are retained by the state with the remainder shared with cities and counties.

The high technology industry purchases many inputs in Arizona, creating additional, indirect, impacts. Further, the workers in both the high technology industry and the industries that supply high technology industries spend the bulk of their wages in Arizona creating induced impacts. Total economic impacts associated with high technology are the sum of the direct, indirect and induced impacts. Counting all these multiplier effects, high technology business in Arizona represents 9 percent of total state employment, representing 180,261 jobs. High technology contributes, either directly or indirectly, $6.498 billion in employee compensation and represents $9.546 billion of Arizona's value added, which is 11 percent of the state's Gross State Product.

The following information is taken from a survey of firms in the industry. Of 613 surveys distributed to high technology firms, 96 valid completed surveys were returned for a response rate of 15.7 percent. This includes a census of the 17 largest firms (the response rate among largest firms alone was 82 percent). Survey respondents provide 55 percent of total jobs in the high technology industry.

The high technology industry consists primarily of young firms. Fifty-eight percent of the sample firms began operations in Arizona in the past 15 years. Over two-thirds of the survey firms operated from one location only.

High technology survey firms are involved in a variety of unique relationships with other firms. Thirty-five percent of the sample firms purchase key inputs that are available from only one seller located outside Arizona (15 percent purchase key inputs available from only one seller inside Arizona). The percentage of firms involved in joint R &D ventures was 20 percent with Arizona firms and 32 percent with firms outside Arizona. Similarly, 20 percent of the respondents share development or engineering resources with Arizona firms and 26 percent share with firms outside Arizona. Over two-thirds of the respondents had special business relationships with other firms.

High technology firms frequently buy from and sell to each other. The relationship between the largest firms and other firms is especially important in the industry. It was hypothesized that sales from respondents to the largest high technology firms would be significant. These are sales by both large and small firms to the largest high technology companies. Fifty-three percent of the responding firms sell to the largest firms and 31 percent of the these firms indicated that one or more of the large firms were among their five largest customers in terms of total sales. Interestingly, 48 percent of the sample firms purchased inputs from the large firms but only 10 percent indicated that the largest high technology firms in Arizona were among their five largest input suppliers.

High technology industries are distinguished by their high level of activity in research and product development. Approximately 20 percent of total high technology employees work in R &D and the median expenditure on R & D was 6-8 percent of total sales. Well over a quarter of the survey firms spent 13 percent or more of total sales on R & D. The survey firms rely heavily on internal sources for both funds for research and new technologies. However, the U.S. Department of Defense provided about 10 percent of research funding to the industry. Firms did turn to private for-profit entities and to universities and research institutes for some of their technology. They relied on these external sources more heavily when they were located inside of Arizona.

Only 7 percent of total sales from high technology firms stayed in Arizona. Another 59 percent is sold to other U.S. customers and 34 percent is exported. The two most important destinations for these exports are Europe and Asia.

Almost one-quarter of total sales were to the U.S. Department of Defense. Secondary data on defense contracts has declined since it peaked in the mid-1980's. However, dependence on defense contracts is still high. A large percentage of sales in high technology industry are of custom-made products. In addition, roughly one-fourth of a high technology firm's sales tend to be to its largest customer and almost half of total sales are to its five largest customers.

The high technology industry offers a significant number of high paying professional jobs. The industry is believed to employ over a quarter of all doctoral scientists and engineers in Arizona. Twenty-nine percent of all workers in high technology industry are engineers, scientists, mathematicians or computer programmers, specialists and analysts. Over a third of high technology workers have a college degree or higher. However, over half of all employees have at most a high school degree. Per employee wages averaged $37,000 in the high technology industry in 1994. According to County Business Patterns, 1992, high technology industry payroll per employee was 75 percent higher than total non-agricultural payroll per employee of $21,925.

In addition to offering high wages and benefits, high technology firms tend to make significant investments in employee training, spending an average of $900 per employee per year. Just over half of this amount was spent on in-house training. Total expenditures on training were an estimated $86 million in 1994.

Sixty-one percent of the survey firms indicated that availability of funds for start up was poor to mediocre versus 36 percent who rated availability of capital for expansion as poor to mediocre.

This study has shown that the high technology industry in Arizona either directly or indirectly through purchases from other firms and employees spending, provides approximately one out of every 11 jobs in the State of Arizona. Many high technology jobs are high quality jobs with average earnings that are 70 percent higher than the average earnings computed across all jobs in Arizona. Although the high technology industry has suffered some job losses between 1987 and 1992, the industry continued to grow in importance as a share of Arizona's economy.

Previous studies have implied that very little of the high technology industry's expenditures on materials and supplies were occurring within the State of Arizona. In contrast, this study indicates that the linkages between high technology firms in the state are strong. This study finds that the percentage of goods and services purchased within Arizona as opposed to outside has probably doubled since 1989. Not only do we find evidence of strong purchasing and selling relationships, but also of joint R & D ventures and shared expenditures on engineering and development resources.

Because the state is so dependent on high technology industry, it is critical that policy makers be aware of areas where risks for the industry may lie. First, a significant portion of this industry is defense related. Ten percent of research and development funding comes from the U.S. Department of Defense and approximately 25 percent of high technology sales are to the U.S. Department of Defense. Thus, the portion of high technology jobs associated with these sales are subject to risks associated with changes in the Federal budget. Second, although the strong relationships between high technology firms and the strong impact that high technology firms have on employment in services and trade as reflected in the induced impacts are a plus for Arizona, they are not without risk. These strong linkages suggest that if there are shocks to the high technology industry, such as severe cuts in defense spending, there will be large ripple effects resulting in severe economic losses to the state. Another area of risk has to do with the portion of high technology products and services that are custom-made (almost two-thirds) and the high concentration of sales to only a few customers. These two findings suggest that there is significant bargaining power among the buyers of high technology products and services. Consequently, high technology suppliers may be at a disadvantage in negotiating prices for their products from major buyers.

We would strongly recommend that the Arizona Department of Commerce keep close track of employment in the high technology industry over time. Occasionally a benchmark survey such as the one conducted for this study would be helpful to determine the composition of employment (i.e., between those in highly paid positions and those in less well paid positions) and to monitor linkages between high technology firms and other firms in the state. If the State of Arizona wants to encourage an increase in the number of well-paid positions in the state, paying attention to what is happening in the high technology industry is crucial.

REFERENCES

Armington, C., C. Harris and M. Odle (1983). "Formation and Growth in High Technology Business: A Regional Assessment," Business Microdata Project, The Brookings Institution, Washington D.C., September.

Arizona Department of Commerce Economic Research Unit. (1989) *High Technology in Arizona. A Market Analysis of Suppliers in Arizona and the Southwest.* Phoenix, Az, January.

Barkley, David L. (1988). "The Decentralization of High-Technology Manufacturing to Nonmetropolitan Areas," *Growth and Change*, Winter, 13-30.

Clair, Robert T. (1986). " The Labor-Intensive Nature of Manufacturing High-Technology Capital Goods," *Economic Review*, Federal Reserve Bank of Dallas, p. 17-.

Diwan, Romesh and Chandana Chakroborty (1991). *High Tech and International Competitiveness.* New York: Praeger.

Executive Office of the President of the United States (1987). Standard Industrial Classification Manual 1987. Office of Management and Budget. Washington, D.C.

Glasmeier, Amy K. (1991). *The High-Tech Potential: Economic Development in Rural America*. Rutgers, the State University of New Jersey (Center for Urban Policy Research).

Markusen, Ann H., Peter Hall and Amy Glasmeier (1986). *High Tech America: The what, how, where, and why of the sunrise industries.* Boston: Allen & Unwin.

Miller, James P. (1989). "The Product Cycle and High Technology Industry in Nonmetropolitan Areas, 1976-1980." *Review of Regional Studies* 19: 1-12.

Mohit, Nina (1986). Balancing the Books: Military Spending in Arizona, the Impact & Alternatives. A Project of the Arizona Center to Reverse the Arms Race, 1210 East Virginia Street, Phoenix, Arizona 85006, 25pp. C.

Office of Economic Planning and Development (1982), *Opportunities in Arizona for Suppliers of High Technology Manufacturers.* Phoenix, AZ.

Phillips, Bruce D. (1991). "The Increasing Role of Small Firms in the High Technology Sector: Evidence From the 1980s." *Business Economics*: January.

Riche, Richard W., Daniel E. Hecker, and John U. Burgan (1983). "High Technology Today and Tomorrow: A Small Slice of the Employment Pie." *National Labor Review.*

Tansik, David A. and R. Bruce Billings (1973). "The Rise of Military-Industrial Spending in Arizona: 1970-72," *Arizona Review*, V. 22, Nos. 6,7 (June-July,), Division of Economic and Business Research, Business and Public Administration, University of Arizona, Tucson Arizona 85721.

United States Bureau of Labor Statistics (1992). *Employment and Wages*, Annual Averages 1992, BLS Bulletin 2433. Table reported in U.S. Statistical Abstract, U.S. Department of Commerce, Bureau of the Census, 1994, Table No. 642. High Technology Industries-Summary.

United States Bureau of the Census (1992). *County Business Patterns*, 1992, Arizona, CBP-92-4. Bureau of the Census, U.S. Department of Commerce, Economics and Statistics Administration.

United States, Congress of the (1982). *Location of High Technology Firms and Regional Economic Development.* A Staff Study, prepared for the use of the Subcommittee on Monetary and Fiscal Policy of the Joint Economic Committee, Congress of the United States. U.S. Government Printing Office, Washington, June 1, 1982.

U.S. Department of Defense, Prime Contract Awards, by State, Various Years, Directorate for Information, Operations and Reports. For sale by U.S. Government Printing Office, Washington D.C. 20402 DIOR/P09-92/02.

Biographies of Principal Investigators

Alberta Charney is a tenured Research Specialist. She received her Ph.D. from the University of Illinois in Economics, with specializations in quantitative methods, public finance and regional economics. She has been at The University of Arizona since 1977. She is an expert on tax analysis, econometric model building, regional economic forecasting and impact studies. She has built numerous revenue and economic forecasting models for Arizona and its substate areas. Funding for these studies has come from the Arizona Joint Legislative Budget Committee, the Arizona Department of Transportation, the City of Tucson, Pima County, Tucson Economic Development Corporation, the Chamber of Commerce, and the National Science Foundation. She has also received funding for studies on tax policy, population estimation/projection methods, and economic impact analysis from the Arizona Department of Economic Security, the Maricopa Council of Governments, the Arizona Legislature, the Arizona Joint Select Committee on Revenues and Expenditures, the Tucson Convention and Visitors' Bureau and the University Medical Center.

Her diverse academic publications deal with transportation, taxation, econometric model building, forecasting accuracy, water allocation, migration and manufacturing location issues. Her articles have appeared in Land Economics, Journal of Regional Science, International Regional Science Review, Review of Public Data Use, Journal of Urban Economics, Logistics and Transportation Review, Quarterly Review of Economics and Business, Resources and Energy, American Journal of Agricultural Economics, Western Tax Review, Regional Studies, and in various books. Recently completed impact studies include an assessment of the economic impact of the University Medical Center, The University of Arizona, and Hughes Aircraft's recent consolidation and relocation of engineers.

Julie Leones is an assistant extension specialist in the Department of Agricultural and Resource Economics in the Economic Development area. Dr. Leones received her Ph.D. from Cornell University in Agricultural and Resource Economics with specialization in economic development and production economics. She has been at The University of Arizona for five years. She was selected as The University of Arizona extension faculty of the year for 1992. Her education and research programs have focused on general economic development issues, economic impact assessment, the regional economic impacts of recreational activity, the North American Free Trade Agreement, economics of solid waste reduction and rural labor market issues. Recent studies include assessments of the role of agriculture in the Arizona economy, of nature-based tourism in Southeastern Arizona, of agricultural tourism in Cochise County, and of the potential effects of NAFTA on agriculture. She is the editor of a quarterly publication distributed statewide entitled Community Development Issues. Her academic publications include work on issues concerning input-output analysis, landscape services sector, water conservation in agriculture, and international development issues that have appeared in American Journal of Agricultural Economics, Water Resources Bulletin, Agribusiness, Journal of the Community Development Society, Tulsa Law Journal, and in various working paper series at Cornell and The University of Arizona.

Dr. Leones recently served as chair of the Community Economics Network of the American Agricultural Economics Association and chair

APPENDIX A. DEFINING HIGH TECHNOLOGY BUSINESS

There is no consensus in the academic literature on the definition of "high tech" industries. Markusen, Hall and Glasmeier (1986) summarize and provide a brief overview of some of the alternative definitions. These and others are discussed below and summarized on Table A-1. The left-hand column lists Standard Industrial Classifications (SICs) of both high technology and non-high technology industries. SIC codes are a logical classification of firms. SIC codes are either 1-digit, 2-digit, 3-digit, or 4-digit. 1-digit SIC codes represent the eight major sectors of the economy, e.g., agriculture, construction, manufacturing, etc. 2-digit SIC codes are more detailed than the corresponding 1-digit codes. For example, SIC codes 7 and 8 represents all services. SIC code 87 is a subcomponent of SIC 8 and represents engineering and management services; SIC code 873 represents research and testing services, a subcomponent of 87; and 8731 is a subcomponent of 873 representing commercial physical research.

The first definition relates to the idea of *Product Sophistication* (Column I, Table A-11). This definition is a group of selected products of Standard Industrial Classifications (SICs) which, according to the descriptions in the SIC Manual,[11] are selected on the basis of perceived product sophistication. This "definition" was developed by the Massachusetts Division of Employment Security (MDES) for use in analysis of Massachusetts industries. Although an interesting view of high technology products, this definition lacks operational procedure and is extremely subjective. One advantage of MDES' selection of industries is that several non-manufacturing sectors are included. Several other criteria are not appropriate for non-manufacturing sectors.

Growth in Employment (Column II, Table A-1) is a widely used notion of high technology industries. This definition simply assumes that industries which grow faster than manufacturing as a whole must be high-technology. Using the employment growth data reported in Markusen, Hall and Glassmeier (1986), the industries selected are shown in Table A-1. The problems with this approach are clear. First, sectors producing very traditional products (e.g., furniture and fixtures) may be included, particularly when there is an upswing in the construction cycle. Second, because of sporadic employment changes, some very technical industries (such as those related to the defense industry) may be excluded. Third, this type of definition would alter the list of industries that would be included over time, as industry growth changes with the business cycle (and defense spending). Probably the most serious problem with using this definition, however, is that some fundamental questions regarding high technology industries cannot be answered with this approach. Specifically, researchers could not answer one of the basic questions - Do high tech industries grow faster than low technology industries? - because the definition already presumes that they do.

Research and Development Intensity (Column III, Table A-1) is also to be used as a criteria for high technology industry selection. A cited problem with using R & D intensity as a criteria for selection of industries is that it aggregates over several different types of R & D activities, e.g., basic research, applied research, development costs, etc. Table A-1 (Column III) illustrates the definition based on R & D expenditures, when selected industries are those with greater than average R & D expenditures per dollar of sales, based on a 1979 Technical Marketing Associates Report, as reported by Markusen, Hall and Glassmeier (1986).

Occupational Mix (Column IV, Table A-1) is also used as the basis for identification of high technology industries. Glasmeier (1991) and Markusen, Hall and Glasmeier (1986) utilize this approach to identify high technology industries. They use an occupational category obtained from the Occupational Employment Statistics (OES) to determine which industries contain the highest percentage of employment in the following occupations: engineers, engineering technicians, computer scientists, scientists (including chemists, geologists, physicists, and biologists), and mathematicians. Their resulting list of 29 three-digit SIC codes are also shown in Column IV.

Technology Intensity (Column V, Table A-1) examines the total technology embodied in an industry both directly (as might be measured by

[11] SIC Manual refers to the Standard Industrial Classification Handbook, Standard Industrial Classification Manual, 1987. Executive Office of the President, Office of Management and Budget. For sale by National Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 Order PB87-100012.

the R & D figures) but also indirectly through interindustry linkages such as those found in input-output tables. This definition argues that the technology intensity of U.S. manufactured products should be based on their total technology intensity, not just the technology applied by the final producer (direct technology inputs). By considering only the technology applied by the final producer in defining high tech, the technology applied in the production of intermediate inputs (indirect technology inputs) used in the production of the final goods is ignored. Using the definitions derived by Davis (1982), the industries listed in Column V result.

Arbitrary Groupings are also identified as high technology. While there may be some basic logic behind them, some studies simply select a group of industries which fit the researcher's intuitive criteria. For example, a study by the staff of the Joint Economic Committee of the Congress of the United States (1982) selected SIC codes 28, 35, 36, 37, and 38. The U.S. Department of Commerce (Column VI, Table A-1) has established a very narrow definition of high-technology equipment, which consists of office, computing, and accounting equipment; communications equipment; instruments; and electronic components (SICs 357, 366, 367 and 38). They also define a heavy industrial equipment group, a transportation group and an "other" group. Defense and space equipment are included among the "other" group along with recreational motor vehicles such as motorcycles and motor homes. Bruce Phillips (1991) identified the sectors indicated in Column VII for his study of the importance of small firms in the growth of the high technology industry.

While these basic definitions result in different sets of industries being identified as "high tech," the actual definitions used are almost infinite because some researchers use combinations of these definitions. Some use two or more of these basic definitions and combine them using either an "and" (a less inclusive approach) or an "or" (a more inclusive approach) criteria, e.g., Diwan and Chakroborty (1991), and The Brookings Institute (see Armington, Harris and Odle, 1983; Barkley, 1988; Miller, 1989). The Brookings Institute definition (Column VIII, Table 1) combines the concepts of *Research and Development* and *Occupations Mix*. To further complicate matters, not all researchers use "above average" as their criteria for selection. For example, Riche, Hecker and Burgan 1983) used 1.5 times the average as the criteria for breaking out industries. By varying the amount by which industries must exceed the manufacturing average for a given definition and by combining definitions, researchers can utilize almost an infinite number of criteria for identification of high tech industries. The U.S. Bureau of Labor Statistics allocates 3-digit SIC codes to high technology if the percent of employment involved in research and development is 50 percent above average (Column IX, Table A-1).

Arizona Department of Commerce (ADOC, formerly the Office of Economic Planning and Development, OEPAD) has used several sets of definitions of high technology in the past. Column "1," Table A-1 depicts the industries identified as high technology and related industries in their 1983 OEPAD study. A 1989 study by ADOC used a very similar list of firms.[12] Column "2," Table A-1 is the list of industries identified as high technology in a 1984 OEPAD study.[13] ADOC currently uses the list of firms identified in column 3.[14]

12 The 1989 ADOC study did not list SIC codes. Rather, it indicated the following industries: communications and aerospace equipment; electronic components; electronic and optical instruments; office and computer machines and parts; and medical electronics equipment. The present authors converted this list to SIC codes using the 1987 Standard Industrial Classification Handbook.

13 Actually, OEPAD listed 34 4-digit SIC codes. What is shown in Column 2 is the inclusive 3-digit SIC codes. Thus, Column 2 may implicitly include some subsectors that were not included in this OEPAD study.

14 Source: FAX from Mobin Qaheri, Economist at ADOC, 1994.

Table A-1. High Technology Definitions.

SIC		Industry	I. Product sophistication	II. Growth in employment	III. R & D Intensity	IV. Occupational Mix	V. Technology Intensity	VI. U.S. Dept. of Commerce	VII. Phillips - arbitrary	VIII. Brookings Institute - R & D and Occupation	IX. U.S. Bureau of Labor	1. 1983 OEPAD and 1989 ADOC	2. 1984 OEPAD	3. Current ADOC	4. Consensus
211		cigarettes									1				
25		furniture & fixtures		1											
27		printing and publishing		1											
28		chemicals		1[a]	1										
	281	industrial inorganic chemicals	1			1	1	1		1	1				1
	282	plastics & synthetic resins	1			1	1	1		1	1				1
	283	drugs	1			1	1	1		1	1				1
	284	soap				1					1				
	285	paints and varnishes				1					1				
	286	industrial organic chemicals				1		1		1	1				1
	287	agricultural chemicals				1					1				
	289	miscellaneous chemicals				1		1		1	1				1
29		petroleum refining & related		1											
	291	petroleum refining						1		1	1				
	299	misc. petro and coal products									1				
30		rubber & plastic products		1											
	303	reclaimed rubber				1									
	335	nonferrous rolling and drawing									1				
34		fabricated metals		1											
	344	fabricated structural metal products											1		
	346	metal stampings											1		
	348	ordnance, n.e.c.				1	1	1		1			1		1
	349	fabricated metal products, n.e.c.											1		
35		machinery		1											
	351	engines & turbines	1			1	1	1		1			1		1
	353	construction equipment				1		1		1					
	354	metal working machinery				1							1		
	355	special industry machinery								1			1		
	356	general industrial machinery				1		1		1					
	357	office computing machines	1		1	1	1	1	1	1	1	1	1	1	1
	359	machinery except electrical NEC											1		
36		electrical equipment		1										1	
	361	electrical transmission equipment	1			1									
	362	electrical industrial apparatus	1			1		1		1	1				1
	365	radio & TV receiving equipment				1	1	1		1					1
	366	communication equipment	1		1	1	1	1	1	1	1	1	1		1
	367	electronic components & assembly	1		1	1	1	1	1		1	1	1		1
	369	misc. electrical equipment & supplies											1		1
	371	motor vehicles and equipment									1				
	372	aircraft & parts	1		1	1	1	1		1	1	1	1	1	1
	374	railroad equipment				1									
	376	space vehicles & guided missiles	1		1	1	1	1			1	1	1		1
38		scientific instruments		1			1		1					1	1
	381	engineering; lab & sci. instruments	1		1	1		1		1	1	1	1		
	382	measuring & controlling instruments	1		1	1		1		1	1	1	1		
	383	optical instruments & lenses	1		1	1				1		1			
	384	surgical, medical, dental instruments			1	1		1		1	1				
	385	ophthalmic goods	1		1			1		1					
	386	photographic equipment			1	1		1		1	1				
	387	watches, clocks, clockwork devices			1			1		1					
39		miscellaneous manufacturing industries												1	
	737	computer programming services	1[b]					1			1				
	873	research and testing services	1					1			1		1		
	874	management and public relations	1					1		1					
	871	engineering & architectural service	1					1			1				
	899	services, n.e.c						1			1				

[a] A one in a 2-digit category such as chemicals, means that all the 3-digit areas listed below it (in this case 281-287 and 289) were included in this definition of high technology.

[b] Only the definitions in columns 1,6,8,9,11, and 12 included high technology services at all. The other definitions were strictly confined to manufacturing. Hence, some services may have qualified under other definitions presented in columns where services are blank (i.e., 2,3,4,5,7 and 10). However, in several cases, there is insufficient data for these services to confirm this with national data.

Appendix B. Arizona Gross State Product.

(percent of total economy)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Private industries	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture, forestry, and fisheries	2.8	2.4	2.4	2.7	2.7	2.5	2.0	2.1	2.3	2.3	2.6	2.7	2.3	2.4	2.7	2.6
Farms	2.1	1.8	1.8	2.1	2.1	1.8	1.4	1.5	1.7	1.6	1.9	2.0	1.7	1.7	1.8	1.7
Agricultural services, forestry, & fisheries	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.9	0.9
Mining	1.6	1.1	1.1	1.1	1.7	1.7	1.6	1.5	1.3	1.3	1.1	1.7	1.6	2.1	2.5	2.7
Metal mining	1.3	0.9	0.8	0.8	1.4	1.4	1.3	1.2	1.0	1.0	0.8	1.4	1.3	1.8	2.1	2.3
Coal mining	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
Oil and gas extraction	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nonmetallic minerals, excluding fuels	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	10.0	11.5	11.9	10.4	9.3	8.5	8.9	9.4	10.2	9.1	7.8	6.5	6.0	5.7	5.4	5.7
Manufacturing	14.7	14.5	14.9	15.5	15.5	15.7	16.3	16.4	15.2	16.1	16.7	17.2	17.3	17.4	16.9	16.0
Durable goods	11.8	11.6	12.0	12.6	12.5	12.4	13.0	13.4	12.0	12.7	13.3	13.9	13.9	14.1	13.7	12.8
Lumber and wood products	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.7	0.6	0.4	0.4	0.4	0.3
Furniture and fixtures	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Stone, clay, and glass products	0.9	1.0	1.0	0.8	0.7	0.6	0.7	0.7	0.7	0.8	0.7	0.7	0.5	0.5	0.4	0.4
Primary metal products	1.5	1.4	1.5	1.5	1.7	1.3	1.2	0.8	0.8	0.9	1.0	0.9	0.7	0.6	0.6	0.7
Fabricated metal products	0.5	0.6	0.6	0.7	0.7	0.7	0.6	0.8	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.7
Industrial machinery and equipment	3.1	2.8	2.9	2.8	2.7	2.3	2.7	2.3	2.1	1.9	2.2	2.0	2.0	1.6	1.6	1.3
Electronic & other electric equipment	2.1	2.2	2.5	3.0	3.3	3.5	4.0	4.8	3.6	4.3	4.0	4.8	4.9	5.3	4.9	4.7
Motor vehicle sand equipment	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Other transportation equipment	2.2	1.9	1.9	2.0	1.6	2.4	2.3	2.2	2.2	2.5	2.6	2.7	2.9	3.1	3.2	2.7
Instruments and related products	0.5	0.6	0.6	0.8	0.8	0.7	0.7	0.7	0.7	0.6	1.1	1.2	1.4	1.3	1.3	1.3
Misc. manufacturing industries	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.3
Nondurable goods	2.9	2.8	2.9	3.0	3.1	3.3	3.3	3.0	3.2	3.4	3.3	3.3	3.4	3.4	3.2	3.2
Food and kindred products	0.7	0.8	0.8	0.8	0.8	0.9	0.8	0.7	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.8
Tobacco manufactures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile mill products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apparel and other textiles	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Paper and allied products	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Printing and publishing	1.1	1.0	1.0	1.1	1.1	1.2	1.1	1.0	1.2	1.2	1.3	1.3	1.3	1.2	1.1	1.0
Chemicals and allied products	0.3	0.3	0.4	0.4	0.4	0.5	0.7	0.7	0.6	0.6	0.5	0.6	0.6	0.6	0.5	0.6
Petroleum and coal products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rubber & misc. plastics products	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
Leather and leather products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation and public utilities	12.4	12.0	11.5	11.7	11.7	10.5	10.6	10.3	10.2	10.1	11.0	11.5	11.0	10.7	10.0	10.2
Transportation	3.2	3.1	3.0	3.0	2.9	3.0	3.3	3.2	3.1	3.2	3.6	3.7	3.8	4.2	4.4	4.6
Railroad transportation	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7
Local and interurban passenger transit	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Trucking and warehousing	1.3	1.3	1.3	1.3	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.7	1.8
Water transportation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation by air	0.6	0.7	0.6	0.6	0.6	0.7	0.8	0.7	0.6	0.7	1.0	1.1	1.2	1.5	1.5	1.6
Pipelines, except natural gas	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0
Transportation services	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
Communications	3.1	3.1	3.0	3.3	3.5	3.6	3.6	3.4	3.3	3.2	3.3	3.3	3.3	3.5	3.7	3.7
Electric, gas, and sanitary services	6.1	5.8	5.5	5.4	5.3	3.9	3.8	3.6	3.7	3.7	4.1	4.5	3.9	3.1	1.8	2.0
Wholesale trade	4.6	4.9	4.7	4.6	5.0	5.4	5.2	5.7	5.9	6.3	6.3	5.9	6.4	6.3	6.6	6.9

Italics = Only parts of these 2-digit sectors are high technology.

Appendix B (cont.)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Retail trade	13.3	13.5	13.0	12.2	12.4	13.2	13.0	13.5	13.8	14.0	13.3	13.4	13.8	13.5	13.6	13.7
Finance, insurance, and real estate	20.9	20.9	21.6	22.3	22.2	21.9	22.1	21.3	21.1	20.7	20.7	20.1	19.9	19.9	20.2	20.2
Depository institutions	3.1	3.0	3.0	3.1	3.3	3.5	3.4	3.2	3.1	3.1	3.4	2.8	2.5	2.8	2.6	2.6
Nondepository institutions	0.7	0.7	0.7	0.7	0.3	(0.4)	0.7	0.9	1.1	1.2	0.6	0.5	0.4	0.4	0.5	0.5
Holding companies & investment serv.	0.3	0.4	0.4	0.5	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.6	0.7	0.6	0.6	0.6
Insurance carriers	1.6	1.6	1.5	1.6	1.5	1.4	1.3	1.4	1.4	1.3	1.1	1.2	1.3	1.3	1.4	1.6
Insurance agents, brokers, & services	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.8	0.8	0.7
Real estate	14.5	14.5	15.3	15.6	15.5	15.8	15.1	14.3	14.1	13.7	14.0	14.2	14.2	14.0	14.4	14.2
Services	19.7	19.2	18.9	19.5	19.6	20.7	20.2	19.9	20.0	20.0	20.6	21.1	21.6	21.8	22.1	22.0
Hotels and other lodging places	2.2	2.1	1.9	1.7	1.7	1.8	1.8	1.8	1.9	1.9	2.1	2.1	2.1	2.0	2.0	2.0
Personal services	1.1	1.0	1.0	1.0	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8
Business services	2.9	2.9	3.0	3.3	3.4	3.7	4.0	4.4	4.4	4.5	3.8	4.1	4.3	4.5	4.6	4.7
Auto repair, services, and parking	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.1
Miscellaneous repair services	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.4	0.4	0.4	0.3
Motion pictures	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Amusement and recreation services	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.8	0.8	0.9	0.9
Health services	6.2	5.9	5.7	6.0	6.1	6.7	6.3	5.9	5.8	5.7	6.1	6.0	6.1	6.2	6.4	6.4
Legal services	1.6	1.6	1.5	1.5	1.5	1.7	1.5	1.5	1.5	1.5	1.5	1.6	1.5	1.5	1.4	1.4
Educational services	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Social services and membership org.	1.5	1.5	1.6	1.6	1.5	1.5	1.4	1.3	1.2	1.2	1.2	1.2	1.3	1.4	1.5	1.5
Other services	1.4	1.4	1.4	1.5	1.6	1.5	1.4	1.5	1.5	1.6	2.3	2.2	2.4	2.3	2.2	2.2
Private households	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Government	20.2	19.1	18.1	18.6	18.5	20.5	18.6	16.6	16.3	15.9	15.6	15.6	15.8	15.8	16.0	15.6
Federal civilian government	4.5	4.3	4.0	4.1	3.9	3.8	3.6	3.3	3.3	3.1	2.9	2.8	2.8	2.9	3.0	3.1
Federal military government	3.0	2.7	2.5	2.4	2.3	2.5	2.4	2.0	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.4
State and local government	12.7	12.1	11.6	12.1	12.3	14.2	12.6	11.3	11.2	11.1	11.0	11.0	11.2	11.2	11.4	11.1

Italics = Only parts of these 2-digit sectors are high technology.

Appendix C. Arizona Gross State Product.

(in millions of $1994)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Private industries	36,686	40,771	44,880	45,475	46,401	44,396	48,950	55,002	58,829	62,891	65,204	67,632	68,115	68,263	68,245	70,322
Agriculture, forestry, and fisheries	1,010	984	1,074	1,245	1,264	1,109	1,002	1,181	1,350	1,444	1,693	1,800	1,581	1,670	1,829	1,811
Farms	776	731	794	965	973	801	684	813	978	1,005	1,222	1,333	1,125	1,179	1,232	1,174
Agricultural services, forestry, & fisheries	234	253	279	279	291	308	318	368	372	438	471	467	457	491	596	637
Mining	604	464	493	485	774	758	797	801	736	840	699	1,156	1,112	1,457	1,700	1,889
Metal mining	479	356	381	360	654	630	660	654	595	655	510	941	881	1,233	1,464	1,619
Coal mining	55	63	59	73	74	85	90	97	97	128	132	160	175	175	190	217
Oil and gas extraction	25	13	14	10	8	8	7	8	8	12	12	16	14	10	7	4
Nonmetallic minerals, excluding fuels	47	34	40	42	39	34	40	43	38	46	46	40	43	39	39	50
Construction	3,655	4,670	5,319	4,712	4,309	3,773	4,361	5,165	6,013	5,749	5,087	4,402	4,103	3,864	3,710	4,038
Manufacturing	5,388	5,897	6,676	7,068	7,210	6,968	7,994	9,029	8,962	10,129	10,857	11,615	11,773	11,908	11,530	11,238
Durable goods	4,314	4,741	5,364	5,718	5,788	5,513	6,381	7,353	7,062	8,010	8,695	9,379	9,446	9,602	9,359	8,989
Lumber and wood products	204	240	267	248	234	207	254	312	308	397	429	423	284	261	245	237
Furniture and fixtures	30	42	46	59	63	59	70	86	97	93	94	93	98	98	97	106
Stone, clay, and glass products	343	425	459	386	338	252	320	408	432	506	474	446	346	326	264	277
Primary metal products	548	552	656	669	791	599	583	440	491	562	646	581	468	436	442	511
Fabricated metal products	177	231	280	300	322	308	308	417	382	387	357	371	356	363	402	471
Industrial machinery and equipment	1,138	1,161	1,292	1,294	1,237	1,002	1,299	1,246	1,258	1,209	1,430	1,323	1,359	1,126	1,065	904
Electronic & other electric equipment	766	915	1,101	1,382	1,511	1,543	1,974	2,660	2,123	2,677	2,586	3,229	3,337	3,597	3,342	3,307
Motor vehicles and equipment	57	64	72	69	57	50	47	61	73	70	76	82	81	124	137	160
Other transportation equipment	796	794	831	892	762	1,074	1,117	1,187	1,322	1,562	1,708	1,802	1,945	2,141	2,211	1,877
Instruments and related products	175	239	283	350	378	324	326	393	412	382	685	785	941	887	920	898
Misc. manufacturing industries	81	78	77	69	95	97	82	142	167	163	211	247	234	245	236	240
Nondurable goods	1,072	1,156	1,311	1,350	1,422	1,455	1,614	1,676	1,902	2,119	2,162	2,236	2,326	2,306	2,171	2,249
Food and kindred products	266	307	359	363	371	408	387	408	491	557	554	524	527	570	548	547
Tobacco manufactures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile mill products	1	3	3	5	9	9	10	9	8	12	13	13	23	26	27	31
Apparel and other textiles	94	97	103	98	91	91	100	93	98	113	102	110	120	115	112	104
Paper and allied products	91	97	97	100	106	100	106	102	106	121	119	125	108	115	121	129
Printing and publishing	415	419	471	492	511	519	556	566	691	753	836	861	898	818	729	719
Chemicals and allied products	119	140	164	171	207	207	334	363	351	369	329	385	404	410	351	433
Petroleum and coal products	18	16	21	14	13	12	13	10	12	13	20	17	10	13	12	14
Rubber & misc. plastics products	51	64	78	90	99	94	95	115	133	171	179	189	222	223	253	252
Leather and leather products	16	16	16	16	14	12	12	12	12	10	12	12	12	14	17	21
Transportation and public utilities	4,544	4,907	5,161	5,321	5,431	4,668	5,212	5,667	5,989	6,334	7,176	7,757	7,486	7,332	6,814	7,170
Transportation	1,183	1,252	1,338	1,369	1,366	1,338	1,618	1,779	1,839	2,004	2,353	2,493	2,580	2,845	3,033	3,200
Railroad transportation	176	207	210	232	245	206	265	327	329	351	427	449	410	429	496	504
Local and interurban passenger transit	179	147	151	142	137	133	137	150	158	153	162	147	150	157	153	149
Trucking and warehousing	493	534	587	604	577	558	688	755	840	877	925	964	981	1,027	1,145	1,235
Water transportation	3	3	4	4	4	5	5	5	5	8	5	7	5	7	8	7
Transportation by air	227	267	282	273	284	304	378	378	335	442	639	721	810	998	1,016	1,091
Pipelines, except natural gas	48	25	26	22	25	33	37	35	33	30	38	34	37	30	25	23
Transportation services	56	69	80	90	94	98	110	128	140	142	157	171	188	198	188	190
Communications	1,130	1,277	1,346	1,491	1,612	1,612	1,752	1,889	1,961	2,008	2,176	2,253	2,262	2,369	2,545	2,595
Electric, gas, and sanitary services	2,231	2,378	2,476	2,462	2,451	1,717	1,843	1,997	2,189	2,322	2,647	3,011	2,643	2,117	1,235	1,375
Wholesale trade	1,696	1,982	2,125	2,081	2,313	2,398	2,550	3,110	3,483	3,940	4,089	3,997	4,386	4,301	4,502	4,862

Italics = Only parts of these 2-digit sectors are high technology.

Appendix C (cont.)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Retail trade	4,888	5,486	5,841	5,563	5,739	5,845	6,342	7,410	8,118	8,805	8,653	9,056	9,394	9,235	9,252	9,645
Finance, insurance, and real estate	7,684	8,536	9,698	10,129	10,279	9,706	10,821	11,694	12,437	13,043	13,496	13,570	13,551	13,609	13,812	14,195
Depository institutions	1,135	1,205	1,338	1,427	1,529	1,573	1,656	1,762	1,846	1,920	2,239	1,894	1,700	1,894	1,753	1,812
Nondepository institutions	245	288	324	313	150	(180)	357	479	620	762	393	371	301	307	320	363
Holding companies & investment serv.	111	175	164	235	360	334	412	408	489	502	509	384	479	428	407	416
Insurance carriers	584	656	695	725	718	609	658	779	801	793	720	808	878	881	989	1,127
Insurance agents, brokers, & services	282	290	304	331	324	343	352	387	415	446	535	543	505	528	515	518
Real estate	5,325	5,923	6,873	7,097	7,199	7,024	7,387	7,880	8,266	8,619	9,101	9,573	9,688	9,574	9,827	9,960
Services	7,220	7,846	8,494	8,870	9,084	9,174	9,868	10,943	11,741	12,607	13,454	14,279	14,730	14,887	15,097	15,474
Hotels and other lodging places	808	840	864	791	772	778	895	975	1,096	1,181	1,344	1,413	1,461	1,367	1,362	1,379
Personal services	397	417	429	438	432	424	446	481	540	571	577	613	597	567	561	586
Business services	1,046	1,185	1,363	1,494	1,593	1,650	1,943	2,434	2,583	2,801	2,454	2,757	2,909	3,041	3,117	3,273
Auto repair, services, and parking	423	487	532	544	523	493	551	626	715	817	796	819	808	804	806	784
Miscellaneous repair services	140	164	170	197	179	172	193	220	187	228	198	227	252	260	247	235
Motion pictures	38	52	50	47	44	47	43	46	52	68	81	82	108	100	86	85
Amusement and recreation services	196	210	224	243	266	282	303	307	354	361	407	463	511	532	586	620
Health services	2,287	2,412	2,575	2,749	2,839	2,986	3,093	3,225	3,417	3,598	3,958	4,089	4,163	4,240	4,363	4,468
Legal services	596	637	674	703	718	741	755	810	866	948	999	1,092	1,011	1,021	982	975
Educational services	151	164	177	198	198	190	188	205	218	217	241	264	277	264	307	313
Social services and membership org.	547	625	703	714	703	659	673	695	706	736	788	840	904	959	1,037	1,078
Other services	496	553	647	676	740	672	706	821	908	977	1,504	1,503	1,601	1,597	1,520	1,545
Private households	97	99	87	78	77	78	81	97	99	107	108	117	127	133	124	133
Government	7,428	7,771	8,128	8,450	8,587	9,099	9,126	9,133	9,607	9,998	10,191	10,521	10,746	10,773	10,939	10,952
Federal civilian government	1,656	1,764	1,794	1,854	1,807	1,708	1,782	1,792	1,933	1,919	1,866	1,919	1,937	1,997	2,070	2,150
Federal military government	1,112	1,087	1,117	1,095	1,074	1,097	1,157	1,119	1,080	1,117	1,135	1,155	1,170	1,136	1,105	1,016
State and local government	4,663	4,922	5,217	5,501	5,708	6,295	6,186	6,222	6,595	6,963	7,191	7,449	7,638	7,640	7,764	7,787

Italics = Only parts of these 2-digit sectors are high technology.

Appendix D. Arizona Industry Location Quotient Analysis.

	Code	Employment	Quotient
TOTAL	———	1270126	1.00
AG. SERVICES, FORESTRY & FISHING	0	12843	2.63
MINING	1	13581	0.91
Copper ores	102	9654	32.09
Other mining	———	3927	0.27
CONSTRUCTION	15	82710	1.33
MANUFACTURING	———	176866	0.55
Food and kindred products	20	8294	0.41
Tobacco products	21	10**	0.01
Textile mill products	22	643	0.09
Apparel and other textile products	23	3992	0.47
Lumber and wood products	24	6212	0.84
Furniture and fixtures	24	3649	0.66
Paper and allied products	24	1999	0.17
Printing and publishing	27	16400	0.69
Chemicals and allied products	28	4610	0.24
* Industrial inorganic chemicals	281	375**	0.15
* Plastics materials and synthetics	282	60**	0.02
* Drugs	283	1170	0.26
Soap, cleaners, and toilet goods	284	2224	1.00
Paints and allied products	285	184	0.19
* Industrial organic chemicals	286	60**	0.02
Agricultural chemicals	287	400	0.44
* Miscellaneous chemical products	289	263	0.17
Petroleum and coal products	29	375**	0.12
Rubber and miscellaneous plastics products	30	6377	0.51
Leather and leather products	31	175**	0.17
Stone, clay, and glass products	32	5819	0.81
Primary metal industries	33	6535	0.51
Fabricated metal products	34	9998	0.45
Metal cans and shipping containers	341	175**	0.20
Cutlery, handtools, and hardware	342	643	0.32
Plumbing and heating, except electric	343	10**	0.02
Fabricated structural metal products	344	5100	0.90
Screw machine products, bolts, etc.	345	898	0.63
Metal forgings and stampings	346	826	0.19
Metal services, n.e.c.	347	1131	0.77
* Ordnance and accessories, n.e.c.	348	149	0.11
Misc. fabricated metal products	349	1112	0.27
Industrial machinery and equipment	35	12491	0.38
* Engines and turbines	351	10**	0.01
Farm and garden machinery	352	750**	0.54
Construction and related machinery	353	263	0.08
Metalworking machinery	354	2890	0.58
Special industry machinery	355	1174	0.38
General industrial machinery	356	452	0.10
* Computer and office equipment	357	1471	0.24
Refrigeration and service machinery	358	1474	0.50
Industrial machinery, n.e.c.	359	4011	0.81
Electronic and other electronic equipment	36	33533	1.31
Electric distribution equipment	361	481	0.41
* Electrical industrial apparatus	362	690	0.27
Household appliances	363	175**	0.12
Electric lighting and wiring equipment	364	979	0.42
Household audio and video equipment	365	375**	0.56
* Communications equipment	366	4539	0.89
* Electronic components and accessories	367	24815	2.69
* Electron tubes	3671	750**	1.39
* Printed circuit boards	3672	2665	2.63
* Semiconductors and related devices	3674	16357	4.11
* Electronic capacitors	3675	175**	0.68
* Electronic resistors	3676	10**	0.07
* Electronic coils and transformers	3677	356	1.61
* Electronic connectors	3678	785	1.56

* Signifies a High Technology Business
** Employment estimate, based on midpoint of range reported by County Business Patterns
n.e.c. - not elsewhere classified

Appendix D (cont.)

	Code	Employment	Quotient
* Electronic components, n.e.c.	3679	3765	1.50
* Misc. electrical equipment and supplies	369	1452	0.48
Transportation equipment	37	28657	0.78
Motor vehicles and equipment	371	2698	0.19
* Aircraft and parts	372	18989	1.34
* Aircraft	3721	3750**	0.51
* Aircraft engines and engine parts	3724	7500**	2.50
* Aircraft parts and equipment, n.e.c.	3728	4345	1.12
Ship and boat building and repairing	373	446	0.17
Railroad equipment	374	0	0.00
Motorcycles, bicycles, and parts	375	10**	0.06
* Guided missiles, space vehicles, parts	376	6064	1.43
* Guided missiles and space vehicles	3761	3750**	1.16
* Space propulsion units and parts	3764	10**	0.01
* Space vehicle equipment, n.e.c.	3769	1750**	5.98
Miscellaneous transportation equipment	379	285	0.48
* Instruments and related products 38	13292	0.70	
* Search and navigation equipment	381	8059	1.23
* Measuring and controlling devices	382	2900	0.54
* Laboratory apparatus and furniture	3821	10**	0.03
* Environmental controls	3822	60**	0.15
* Process control instruments	3823	1986	1.95
* Fluid meters and counting devices	3824	60**	0.35
* Instruments to measure electricity	3825	220	0.15
* Analytical instruments	3826	238	0.31
* Optical instruments and lenses	3827	175**	0.38
* Measuring and controlling devices, n.e.c.	3829	157	0.21
* Medical instruments and supplies	384	2172	0.46
* Surgical and medical instruments	3841	750**	0.42
* Surgical appliances and supplies	3842	1449	0.93
* Dental equipment and supplies	3843	10**	0.04
* X-ray apparatus and tubes	3844	0	0.00
* Electromedical equipment	3845	175**	0.20
* Ophthalmic goods	385	60**	0.14
* Photographic equipment and supplies	386	60**	0.03
* Watches, clocks, watchcases and parts	387	0	0.00
Miscellaneous manufacturing industries	39	3889	0.81
Jewelry, silverware, and plated ware	391	225	0.39
Musical instruments	393	322	2.13
Toys and sporting goods	394	2003	1.76
Pens, pencils, office, and art supplies	395	92	0.22
Costume jewelry and notions	396	48	0.16
Miscellaneous manufactures	399	1183	0.55
TRANSPORTATION AND PUBLIC UTILITIES	4	81603	0.80
Local and interurban passenger transit	41	3523	1.26
Trucking and warehousing	42	18916	0.89
Water transportation	44	149	0.05
Transportation by air	45	18081	1.37
Pipelines, except natural gas	46	129	0.25
Transportation services	47	8527	1.72
Communication	48	17782	0.60
Electric, gas, and sanitary services	49	12796	0.55
WHOLESALE TRADE	———	72286	0.67
Wholesale trade - durable goods	50	44224	0.73
Wholesale trade - nondurable goods	51	24763	0.66
RETAIL TRADE	———	309561	2.15
Building materials and garden supplies	52	9049	1.39
General merchandise stores	53	30176	2.21
Food stores	54	47773	2.18
Automotive dealers and service stations	55	33838	1.53
Apparel and accessory stores	56	15126	2.13
Furniture and homefurnishings stores	57	11735	1.50
Eating and drinking places	58	112448	3.75

* Signifies a High Technology Business
** Employment estimate, based on midpoint of range reported by County Business Patterns
n.e.c. - not elsewhere classified

Appendix D (cont.)

	Code	Employment	Quotient
Miscellaneous retail	59	37480	1.86
FINANCE, INSURANCE, AND REAL ESTATE	6	90950	0.69
Depository institutions	60	26082	0.74
Nondepository institutions	61	8794	0.95
Security and commodity brokers	62	3105	0.14
Insurance carriers	63	15756	0.52
Insurance agents, brokers, and service	64	9540	0.85
Real estate	65	23817	1.52
Holding and other investment offices	67	3025	0.46
SERVICES	7	428904	1.12
Hotels and other lodging places	70	34856	3.12
Personal services	72	20206	2.40
Business services	73	79706	1.31
Advertising	731	1551	0.37
Credit reporting and collection	732	3228	2.51
Mailing, reproduction, stenographic	733	3263	1.07
Services to buildings	734	11551	2.21
Misc. equipment rental and leasing	735	3394	1.26
Personnel supply services	736	28215	2.15
Computer and data processing services	737	7834	0.41
* Computer programming services	7371	2232	0.39
* Prepackaged software	7372	719	0.26
* Computer integrated systems design	7373	1557	0.65
Data processing and preparation	7374	1377	0.34
Information retrieval services	7375	113	0.23
Computer facilities management	7376	18	0.04
Computer rental and leasing	7377	108	0.40
Computer maintenance and repair	7378	701	0.60
* Computer related services, n.e.c.	7379	892	0.62
Miscellaneous business services	738	18981	1.74
Auto repair, services, and parking	75	16883	1.93
Miscellaneous repair services	76	5925	1.18
Motion pictures	78	3947	0.74
Amusement and recreation services	79	18377	1.96
Health services	80	124056	0.86
Legal services	81	13124	0.65
Educational services	82	14726	0.73
Social services	83	28120	1.95
Museums, botanical, zoological gardens	84	894	1.31
Membership organizations	86	20810	1.40
Engineering and management services	87	39756	0.79
Engineering and architectural services	871	9800	0.52
Accounting, auditing, and bookkeeping	872	11343	1.29
Research and testing services	873	5200	0.65
* Commercial physical research	8731	1481	0.35
Commercial nonphysical research	8732	1876	1.32
* Noncommercial research organizations	8733	1049	0.82
* Testing laboratories	8734	776	0.70
Management and public relations	874	13324	0.91
Services, n.e.c.	89	1051	0.73
Administrative and auxiliary	899	6467	0.74
Unclassified Establishments	99	822	2.46

* Signifies a High Technology Business
** Employment estimate, based on midpoint of range reported by County Business Patterns
n.e.c. - not elsewhere classified

APPENDIX E - SURVEY METHODOLOGY

One of the first tasks in the survey process was to determine the approximate number of high technology industry firms and to collect existing directories of such firms. A random sample was then drawn from these directories and examined in order to remove duplicate listings in the survey sample list. The directories used for the purpose of selecting a sample included the 1994 Arizona Industrial Directory, the 1994 Arizona High Technology Industry Directory, the Arizona Software Association Directory, the Center for Software Excellence Directory, the Optics, Biotechnology and Environmental Technology Cluster Directories and the Arizona Electronics Association Directory.

Because there is no clear consensus on the definition of high technology industry, our original sample was drawn using a very broad definition of high technology. Thus, we sampled from a much larger pool of firms than is indicated by the number of questionnaires distributed to high technology firms. Future publications will compare characteristics of high technology firms with other manufacturing firms and explore alternative ways of defining high technology industry.

A survey questionnaire was designed with input from numerous industry and academic reviewers (Appendix F). The questionnaire was designed for distribution by mail. A reminder postcard was sent to all firms that had not returned their surveys within one month of distribution. A second survey was then sent several months after the postcard. Finally, a research assistant called a subset of firms that had still not responded and in some cases mailed or faxed an additional copy of the survey to firms that indicated they were willing to complete the questionnaire. A total of 613 questionnaires were distributed to firms that fit our definition of high technology industry. This number includes only those firms that were still in business in Arizona at the time of the survey and who did not indicate to us that they were involved strictly in distribution and sales in Arizona (there were 18 firms involved exclusively in distribution and sales that returned their questionnaires). Ninety-six surveys were completed fully or partially and returned. Our total response rate was 15.7 percent. However, the responding firms in total, including the largest firms, provide approximately 55 percent of total jobs in high technology industry.

From the outset it was decided that a complete enumeration of the largest 20 high technology firms in the state should be conducted (i.e., basically all firms with approximately 1,000 employees or more). This list of 20 was drawn from the 1994 High Technology Directory and on advice from the Arizona Department of Commerce. Out of these 20 firms, two did not actually fall in the SIC codes that we used to define high technology industry. One firm was involved only in distribution and sales so it was not included. Of the remaining 17 firms, 14 responded, giving us a response rate of 82 percent for large firms.

Most of the figures provided in the following section have been calculated by weighting them by total employment in each responding firm. The grand totals have also been weighted by the share of total 1994 high technology employment in a particular sector such as electronic components and computers. The exception to this is any figures that are presented according to the number of firms. These have not been weighted by employment and are presented as results for the survey firms.

Appendix F. Arizona Industry Survey.

I. ORGANIZATION

a. Standard Industrial Classification (SIC) Code(s): _____ (if known) or category number from the accompanying Product Classification list: ____________________

b. Year established __________ **c.** City and State or Country of Establishment ______________________________

d. Year established in Arizona ___________

e. Please check the category that best describes your firm *in Arizona*:
- q single location
- q headquarters only
- q Arizona headquarters with at least one other facility in Arizona
- q headquarters outside of Arizona with at least one other facility in Arizona

Please indicate state or country of headquarters: ______________________________

f. In total, how many facilities (excluding headquarters) are located:
- ___________ in Arizona
- ___________ in the rest of the U.S.
- ___________ in locations outside of U.S.

Please indicate state(s) or country(ies): ______________________________

g. Please describe where decisions are made about:

hiring workers:	q at headquarters	q at individual facilities	q both
purchasing inputs:	q at headquarters	q at individual facilities	q both

h. How large is your CURRENT workforce in Arizona (as of 2nd Quarter, 1994)?

Total number of employees_____________ Number of full-time equivalent (FTE) employees ______________

i. How large was your PAST workforce in Arizona (as of 2nd Quarter, 1989)? (Put 0 if your firm was established after 1989.)

Total number of employees_______ Number of full-time equivalent (FTE) employees

j. At this location, what percentage of your employment is in:

______ administration	______ user support services and/or MIS services
______ research	______ distribution
______ product development	______ sales
______ manufacturing	100%

k. If 100% of your employment in Arizona is involved in sales and/or distribution, where is the manufacturing of your product occurring?

City and State/Country: ______________________________

IF 100% OF YOUR EMPLOYMENT IS IN SALES AND/OR DISTRIBUTION, YOU MAY STOP HERE. EVEN IF YOU STOP HERE, PLEASE RETURN THE SURVEY.

l. Does your firm consider itself to be part of the high technology industry? q yes q no. If yes, please explain ______________________

____

m. Does your firm consider itself part of any of the following industries or clusters of industries? (*Check all that apply*.)

q Aerospace/Aeronautics	q Biotechnology/Bio-industry
q Communication Technology	q Computer Software
q Environmental Technology	q Optics
q Computers, Semiconductors &Electronics	q Other: ____________

n. Does your firm have any special business relationships with other firms? (*Check all that apply.*)

	Firm(s) in Arizona	Firm(s) not in Arizona
Exclusive subcontractor to	q	q
You are the exclusive buyer of key inputs from	q	q
Some of your inputs/components are only available from one seller	q	q
Product bundling with	q	q
Joint research and development ventures with	q	q
Share development or engineering resources with	q	q
License your technology to	q	q
Buy technology licenses from	q	q
Belong to an organization that coordinates research and development projects	q	q
Other (*please describe*) ____________		

Please answer the following for each facility in Arizona. (*Attach a separate sheet of paper for additional facilities.*)

		Facility #1	Facility #2	Facility #3
o.	ZIP code	________	________	________
p.	School District	________	________	________
q.	Years at Current Site	________	________	________
r.	Has this facility ever been located elsewhere? YES or NO	________	________	________
s.	If YES, give ZIP code of previous location	________	________	________
t.	Is this facility ISO 9000 certified at any ISO level? YES or NO	________	________	________
u.	Is this facility not ISO 9000 certified but meet ISO standards? YES or NO	________	________	________

II. RESEARCH AND DEVELOPMENT

a. What are the sources of the technologies that you use in your firm's product or services? (*Check all that apply*.)

Research done:	In Arizona	Outside Arizona
Within the firm	q	q
By other private firms	q	q
By Universities or research facilities	q	q
Elsewhere (*describe*) ____________		

b. How many of your employees are working in research and development?___________________

c. What percent of your *research* funds come from the following sources?

- _________ internal sources
- _________ private for-profit entities
- _________ private nonprofit entities.
- _________ the U.S. Department of Defense
- _________ public entities other than the U.S. Department of Defense

100%

d. Approximately how much has your firm invested in Research and Development **as a percentage of your total sales** over the past **five** fiscal years? (*Check the category that best describes your R & D expenditure*.)

q less than 1%	q 1-3%	q 4-5%	q 6-8%
q 9-12%	q 13-25%	q greater than 25%	

III. EXPENDITURES

a. Please indicate what percent of the original cost of capital equipment (all manufacturing equipment, computer equipment, specialized structures or rooms, such as clean rooms or laboratories) in Arizona has been purchased within:

- _____________ %the last one year
- _____________ %the last five years
- _____________ %the last 10 years

b. Please indicate the FULL CASH VALUE (NOT assessed value) of your firm's Arizona: (*This is the larger of the values listed on your tax bill.*)

- _____________ personal property (i.e., taxable equipment)
- _____________ improvements to the land (e.g., buildings at the production facility)
- _____________ land (*Do not include landholdings not associated with the production facility.*)

Please provide the following expenditure information for all Arizona facilities for your last full fiscal year. If you don't have data for all Arizona facilities, please provide information for your facility and provide names & phone numbers of contact people at other facilities. If you don't know expenditures by these categories, please provide for the groupings you use.

Personnel Expenses

c. Wages and Salaries $ ____________

d. Benefits $ ____________

Taxes

e. Arizona Corporate Taxes $ ____________

f. Property Taxes paid in AZ $ ____________

g. Sales Taxes paid in AZ $ ____________

h. All other taxes paid in AZ $ ____________

Building Expenses

i. Mortgage/leasing expenses $ ____________

j. Building maintenance/repair (excluding salaries) $ ____________

k. Building remodeling and/or construction $ ____________

Utility Expenses

l. Water/Sewer $ ____________

m. Gas $ ____________

n. Electric $ ____________

o. Telephone and/or Communications $ ____________

TOTAL FOR THESE CATEGORIES **$ ____________**

To assess the impact of your industry on the Arizona economy, we need to know about the materials and supplies you purchase and where you purchase them.

Please provide the following expenditure information for your firm's **total Arizona operations**, by location of **supplier** for your last full fiscal year. Please indicate type of your predominant supplier using **R** for retail and/or wholesale distributor, and **M** for other manufacturer or service provider.

	R/M	Supplier Location: In Arizona	Outside of Arizona
EQUIPMENT EXPENSES			
p. Purchases/leases	______	$ ______	$ ______
q. Maintenance/repair (excluding salaries)	______	$ ______	$ ______
r. Materials and Supplies			
(Select 5 materials or supply categories from the attached Product Classification List that represent your largest dollar volume of purchases.)			
1. ____________	______	$ ______	$ ______
2. ____________	______	$ ______	$ ______
3. ____________	______	$ ______	$ ______
4. ____________	______	$ ______	$ ______
5. ____________	______	$ ______	$ ______
s. ALL OTHER EXPENDITURES		$ ______	$ ______
t. TOTAL EXPENDITURES FOR THESE CATEGORIES (Equipment, Materials & Supplies and Other)		**$ ______**	**$ ______**

u. Approximately what percent of the total cost of your products or services is for transportation or shipping? ____________

v. Please provide expenditures for remodeling/construction projects in Arizona, if any, for the past 5 years.
Fiscal year ending:
1994 $ ________ 1991 $ ________
1993 $ ________ 1990 $ ________
1992 $ ________

w. Please provide expenditures for equipment purchases for use in Arizona, if any, for the past 5 years.
Fiscal year ending:
1994 $ ________ 1991 $ ________
1993 $ ________ 1990 $ ________
1992 $ ________

x. Do you buy inputs from any of the following firms in Arizona? q No q Yes (*if yes, check all that apply*)

q Alcatel Information System
q Bull Worldwide Info. Systems
q Digital Equipment
q Intel Corp.
q McDonnell Douglas Helicopter Division
q Honeywell
q Hughes Missile Co.
q Allied Signal
q Burr-Brown
q IBM (Adstar)
q AT&T Network Cable Systems
q Microage, Inc.
q Motorola, Inc.
q TRW Vehicle Safety Systems

y. Are any of the above firms among your five largest suppliers in terms of the dollar value of your purchases? q No q Yes

IV. MARKETING - *Please answer the following questions for goods and services produced in Arizona by your firm.*

a. Please describe your five major product lines or services and indicate the percentage of total sales that come from these products. (Some firms may have fewer than five.) *See the accompanying Product Classification List for examples of categories*.

Product or Service	% of Total Sales	Product or Service	% of Total Sales
1. ____________	______	4. ____________	______
2. ____________	______	5. ____________	______
3. ____________	______		

b. Approximately what percent of your sales are in:
________ Arizona
________ Rest of the U.S.
________ Canada
________ Mexico
________ Japan
________ Other Asian Countries
________ European Community
________ Other Countries
100%

c. Approximately what percent of your sales are:
________ used as inputs or components in other firms' products
________ sold as final products to persons or firms or governments
100%

d. Approximately what percent of your sales of inputs/components are:
________ formal subcontracts from buying firms
________ informal purchasing agreements
________ other (*please describe*) ____________
100%

e. Approximately what percent of your sales of inputs/ components are to:
________ small firms (less than 100 employees)
________ medium firms (101-1,000 employees)
________ large firms (over 1,000 employees)
100%

f. Approximately what percent of your sales of final products are:
________ sold to the U.S. Military or U.S. Department of Defense
________ sold to non-military federal agencies
________ sold to other entities
100%

g. Approximately what percent of your sales are:
________ custom made for the buying firm
________ standardized products
100%

h. Approximately what percent of your sales are to your:
________ single largest customer
________ five largest customers
100%

i. Approximately what is the average life span of your major product/products before making any major modifications (for example, in software development a new version of commercial software or an entirely new package; for custom built products, a major modification in the core or basic product). Average life span: ________

j. Do you sell to any of the following firms in Arizona? q Yes q No (*if yes, check all that you sell to*)

q Alcatel Information System
q Bull Worldwide Info. Systems
q Digital Equipment
q Intel Corp.
q McDonnell Douglas Helicopter Division
q Honeywell
q Hughes Missile Co.
q Allied Signal
q Burr-Brown
q IBM (Adstar)
q AT&T Network Cable Systems
q Microage, Inc.
q Motorola, Inc.
q TRW Vehicle Safety Systems

k. Are any of the above firms among your five largest customers in terms of your dollar volume of sales? q Yes q No

V. WORKFORCE/PERSONNEL ISSUES

Please provide the following information. If an individual employee has more than one responsibility (for example, if a plant manager is also an engineer), place that individual in the category for which he/she has the greatest responsibility.

OCCUPATION	NUMBER OF EMPLOYEES	LAST FISCAL YEAR PAYROLL, EXCLUDING BENEFITS
a. Executive and Managerial	________	________
b. Professional, e.g., accountants, lawyers	________	________
c. Engineers, Scientists & Mathematicians	________	________
d. Computer Programmers, Specialists, Analysts	________	________
e. Sales Representatives	________	________
f. Skilled Workers (e.g., mechanics, craftsmen, machinists)	________	________
g. Production Workers (assemblers, fabricators, operators)	________	________
h. Unskilled Workers (e.g., material handlers, laborers)	________	________
i. Clerical Workers	________	________
j. Other (*If many workers, please specify.*)	________	________

Please indicate the number of employees, by level of education and area of study.

LEVEL OF EDUCATION	TOTAL NUMBER OF EMPLOYEES	NUMBER WITH SCIENCE, ENGINEERING AND MATH DEGREES	NUMBER WITH BUSINESS DEGREES
k. High School or Less	______	________	________
l. 2 Year Technical Degree	______	________	________
m. 4 or 5 Year College Degree	______	________	________
n. Master's or Law Degree	______	________	________
o. Ph.D., M.D. or similar	______	________	________

p. Please rank the following types of employee training used in your firm according to the amount spent on each type. (1 indicates highest training expenditure, 2 next highest...). *Rank only those actually used by your firm.*

____ training employees with in-house training and/or on-the-job training
____ bringing in consultants to train employees
____ sending employees to seminars, meetings, and workshops
____ providing incentives/support for employees to get additional coursework/degrees
____ other. *Describe*: ________________________________

q. How much did you spend in the last fiscal year on employee training? $ __________ in-house $ __________ all other

VI.FINANCE

On a scale of 1 to 5 (1=poor and 5=excellent), how would you rate the availability of financing for your firm?
________ for start-up ________ for expansion. *Explain.* ________________________________
____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE!

Survey # __________

PRODUCT CLASSIFICATION LIST

Category #

(1) Agriculture-crops
(2) Agriculture-livestock
(3) Agriculture-services (includes landscaping)
(4) Forest and fisheries
(5) Raw mining products (includes oil and gas)
(6) Food and related products
(7) Textile mill products
(8) Apparel and finished fabric products
(9) Lumber and wood products (except furniture)
(10) Furniture and fixtures
(11) Paperboard containers and boxes
(12) Other paper products
(13) Printing, publishing and related products
(14) Drugs and biological products
(15) Chemicals and related products (includes drugs, plastic resins, manmade fibers, soaps and detergents, paints and varnishes, etc.)
(16) Silicon and silicon products
(17) Petroleum and related products (i.e., asphalt, lubricants, etc.)
(18) Rubber and miscellaneous plastic products
(19) Leather and leather products
(20) Stone, clay, glass and concrete products
(21) Primary metal products (excludes castings, precious metals, sheet plate bar extrusion, wire)
(22) Fabricated metals-sheet metal products
(23) Fabricated metals-machined metals
(24) Fabricated metals-ball and roller bearings
(25) Fabricated metal products-forgings
(26) Fabricated metals-metal stampings
(27) Fabricated metals- others (metal cans, tools, pipes, plumbing and heating equipment, valves)
(28) Ordnance and accessories, except vehicles and missiles (excludes ammunition, bombs, small arms, artillery components)
(29) Industrial and commercial machinery (excludes conveyors, cranes, industrial trucks, trailers and stackers, metalworking machinery, power driven tools)
(30) Computers and office machines (computers, storage devises, terminals, peripherals, calculating machines, registers, office machines)
(31) Electrical equipment and components except computer equipment (transmission and distribution equipment, switchgear and switchboard apparatus, motors, generators, relays and controls, communications equipment, household appliances, electrical wiring and lighting equipment)
(32) Electronic components- printed circuit boards
(33) Electronic components- semiconductors and related devices (including silicon wafers, integrated circuits, solar cells, etc.)
(34) Electronic components- other (capacitors, resistors, coils, transformers, connectors, magnetic cores, antennas)
(35) Transportation equipment- motor vehicles & parts, truck trailers, motor homes
(36) Transportation equipment- aircraft and aircraft parts (except instruments)
(37) Transportation equipment- guided missiles, space vehicles and parts (except instruments)
(38) Transportation equipment- other (boats, railroad equipment, motorcycles, bicycles, travel trailers, campers, golf carts, tanks)
(39) Measuring and analyzing instruments (counting devices, industrial instruments, instruments for measuring and testing electricity, meters, laboratory instruments, optical instruments and lenses, medical instruments, x-ray equipment, photography equipment and supplies, watches, clocks and clockwork operated devices and parts)
(40) Controlling instruments (search, detection navigation, guidance, aeronautical, and nautical systems, instruments and equipment, automatic controls)
(41) Miscellaneous manufactured goods
(42) Railroad transportation
(43) Motor & air freight transportation and warehousing (includes package and mail delivery)
(44) Air transportation (passenger transportation include travel agents & tour operator services)
(45) Miscellaneous transportation (water transportation, transit and interurban highway passenger transportation, pipelines)
(46) Transportation services- arrangement of transportation of freight and cargo (shipping agents, freight consolidators, customhouse brokers, forwarding, etc.)
(47) Transportation services- miscellaneous (rental of railroad cars, packing and crating, inspection and weighing services)

(48) Automobile/vehicle rentals/leases
(49) Insurance (excluding employee benefit insurance such as health, life, disability insurances)
(50) Security and commodity brokerage and related services
(51) Banking and financial services (includes security and commodity brokerage, banking)
(52) Real estate, title companies and developers
(53) Holding and other investment services (royalty and patent purchases, licensing and leasing, trusts, holding services, investment services)
(54) Hotels and lodging places
(55) Eating, drinking, and amusement and recreation services (restaurants, catering, bars, golf courses, sports and recreation clubs)
(56) Personal services (laundry and cleaning services, photographic studios)
(57) Business services- advertising (including direct mail & photocopying)
(58) Business services- Building services
(59) Business services- miscellaneous equipment rental and leasing
(60) Business services- personnel supply services (temporary employees)
(61) Business services- prepackaged software
(62) Business services- computer programming, systems design, computer consultants
(63) Business services- computer services (information retrieval and processing, facilities management, computer rental & leasing, computer maintenance and repair)
(64) Business services- miscellaneous (security, photo finishing, telemarketing service)
(65) Automotive repair and parking
(66) Other repair services (electrical, refrigeration and air conditioning, electronic)
(67) Video and motion picture production
(68) Legal services
(69) Educational services
(70) Social services (child day care services, counseling services, substance rehabilitation services)
(71) Membership organizations (business, civic or social, political organizations, etc.)
(72) Engineering services
(73) Architectural and surveying services
(74) Accounting, auditing and bookkeeping services
(75) Research, development and testing services- private research and laboratory services in physical and biological sciences
(76) Research, development and testing services- marketing, business and economic and related research.
(77) Management and public relations services
(78) Other, please specify

GLOSSARY OF TERMS

Custom Made - Any product or service made to the specifications of the buying firm.

Facility - A building or group of buildings located in close proximity.

Final Product - A final product (good or service) that can be used by the end user (a consumer, business, or government agency) without further modification.

Full Cash Value - The value of property set by the assessor which is supposed to be related to market value. This figure is reported on the assessor's statement and is larger than the assessed value. The assessed value equals full cash value times an assessment:sales ratio.

Full-time Equivalent - A full-time equivalent is 40 hours per week, 280 days per year. For example, two half-time employees would be one FTE.

Input/component - A material, service, or product that is incorporated into a final product. For example, flour is an input to bread, but the mixer is not. A circuit board is a component of a computer.

ISO 9000 - Refers to the quality standards set by the International Standards Organization in Switzerland that are often required for a company to bid on large public and private contracts in Europe and elsewhere. Certification is done on a facility by facility basis. Some firms choose to meet the ISO 9000 standards but not go to the expense of being certified.

Product Bundling - Several products made by different firms are sold together as a package. For example, a computer equipped with several different kinds of software packages.

Standardized - A product that is mass produced to the same specifications for multiple buyers.