An Economic Analysis of the Charlottesville Area's High-Technology Industry

Prepared for

Charlottesville Business Innovation Council

and the

City of Charlottesville
Office of Economic Development

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Executive Summary

The Charlottesville area of Virginia is highly regarded for its rich history, the beauty of its land, and the high quality of life enjoyed by its residents. The City has earned a reputation as being one of the most livable places in the country. In 2004, Charlottesville City received the distinction by Cities Ranked and Rated as the "Best Place to Live in America," and Charlottesville has consistently been listed among Money Magazines' "Best Places to Live" and "Best Places to Retire." Charlottesville is also known as the home of the University of Virginia, founded by Thomas Jefferson, and of Jefferson's mountain-top estate Monticello.

While these important features are the reason that many people know about the region, the Charlottesville area also plays an important role in the economy of the Commonwealth of Virginia. When examining the presence of the *High-Technology Industry* across Virginia, for example, the Charlottesville area ranks as one of the largest metro areas – both in terms of the number of high-technology employees and companies.

This report presents the findings of an economic analysis of the Charlottesville region's *High-Technology Industry*. The study was conducted by the Center for Public Policy at Virginia Commonwealth University, in Richmond, Virginia, on behalf of the Charlottesville Business Innovation Council (CBIC) [*formerly known as the Virginia Piedmont Technology Council + Charlottesville Venture Group, VPTC+CVG*] and the City of Charlottesville's Office of Economic Development. The key objective of the study was to understand more about the composition of the *High-Technology Industry* and its role in the region's economy.

This *Industry* is not comprised simply of one type of business or sector. Instead, it is made up of a variety of businesses, including companies that produce goods and services that are, in themselves, high-technology products (e.g., computer manufacturing); companies that produce goods and services used in the production of other items considered to be high-technology products (e.g., scientific consulting); and companies that primarily use high-technology methods when producing their goods or services (e.g., manufacturing of paint, coatings, and adhesives). To determine the types of businesses that would be included in a measure of the Charlottesville area's *High-Technology Industry*, the VCU Center for Public Policy used an industry-code definition developed by Mr. Daniel Hecker (an economist with the U.S Bureau of Labor Statistics). Hecker's

definition makes use of several industry codes, allowing for the collection of data on the number of employees, wages paid to these employees, and number of firms.

The University of Virginia (UVA) was recognized by the research team as a major component of the region's *High-Technology Industry. H*ecker's definition does not include universities and colleges, however, because the focus of these institutions is education and not the use of high-technology to produce goods and services. The City of Charlottesville's Office of Economic Development obtained employment and wage data from UVA for their employees working in *High-Technology* sectors. UVA divisions that are part of this *Industry* included their School of Engineering & Applied Science; Information Technology and Communication; the basic sciences section of the School of Medicine; and the science departments in the College of Arts & Sciences.

Combining the data from UVA with the *High-Technology* information for other businesses in the Charlottesville region, the estimated total employment was 11,691 (both full-time and part-time), total annual wages and salaries were estimated at $765 million, and average annual salary was estimated at $65,400 per person (not including benefits). When the Charlottesville region's *High-Technology Industry* is compared with that of the Commonwealth's other major regions, Charlottesville ranks highly. Of the eleven metropolitan regions in Virginia, the Charlottesville area ranked the fifth largest *High-Technology Industry* in terms of the number of employees. In terms of the number of high-technology firms, the region ranked fourth among Virginia's MSA regions.

These wage and employment data were used by the VCU Center for Public Policy to estimate the economic impacts of the *High-Technology Industry* on the Charlottesville region. To prepare these estimates, an IMPLANPro™ computer model was developed specifically for the Charlottesville metropolitan area. IMPLAN is a regional input-output computer modeling system that allows researchers to examine the relationships between the components of an economy, recognizing that market transactions made by one industry or firm (or group of industries or firms) will have an economic impact on other industries. The economic effects of the *Industry* were its direct impact on output and employment of the region, plus additional "multiplier effects" that it has on other local industries. The total economic impact of the *High-Technology Industry* on the Charlottesville area was estimated at $4.4 billion, including support for over 25,000 area jobs.

Introduction

This report presents findings from an economic analysis of the *High-Technology Industry* within the Charlottesville region of Virginia. The Charlottesville area is highly regarded for its rich history, the beauty of the land, and the high quality of life enjoyed by its residents. The region has also earned a reputation as being one of the most livable places in the country. In 2004, Charlottesville City received the distinction by Cities Ranked and Rated as the "Best Place to Live in America," and Charlottesville has consistently been listed among Money Magazines' "Best Places to Live" and "Best Places to Retire."[1] Charlottesville is also known as the home of the University of Virginia (founded by Thomas Jefferson) and for Jefferson's mountain-top estate Monticello.

These features and accolades, alone, make the Charlottesville area important to the Commonwealth of Virginia. As shown in this study, however, the region also plays an important role in Virginia's economy – one example of which is the presence of its *High-Technology Industry*. The key objective of the analysis for this report was to establish the *Industry*'s composition and to estimate the economic contributions that it has on the region.

Compared with other industry sectors, an important distinction needs to be made about the *High-Technology Industry*. It is not comprised simply of one type of business or sector; instead, the *Industry* is made up of a variety of businesses such as the following:

- companies producing goods and services that are, in themselves, high-technology products (e.g., computer manufacturing);
- companies producing goods and services used in the production of other items considered to be high-technology products (e.g., scientific consulting); and
- companies using primarily high-technology methods when producing their goods or services (e.g., manufacturing of paint, coatings, and adhesives).

[1] Sperling, Bert and Peter Sander. Cities Ranked and Rated: Your Guide to the Best Places to Live in the U.S. and Canada. 2004. Also, www.Charlottesville.org, the website of the City of Charlottesville, Virginia.

For this report, the region's *High-Technology Industry* is examined in the following ways:

- Number of employees;
- Annual wages and salaries paid;
- Value added to goods and services;
- Total economic impact to the Charlottesville region;
- Comparison of Charlottesville's *High-Technology Industry* with the size and composition of all industries in the region; and
- Comparison of the Charlottesville *High-Technology Industry* with the *Industry's* presence across Virginia.

Virginia Commonwealth University's (VCU) Center for Public Policy conducted this research on behalf of the Charlottesville Business Innovation Council (CBIC) [*formerly known as the Virginia Piedmont Technology Council + Charlottesville Venture Group (VPTC + CVG)*] and the City of Charlottesville's Office of Economic Development. When defining the types of businesses that comprise the Charlottesville region's *High-Technology Industry*, the VCU Center for Public Policy used an approach developed by Mr. Daniel Hecker – an economist with the U.S Bureau of Labor Statistics. Hecker's model established a set of industry codes that allowed data to be isolated specifically for businesses within the *High-Technology Industry.* The sections that follow discuss Hecker's definition, the geographic regions used for this analysis, the size and composition of the *Industry* in the Charlottesville region, and the *Industry's* economic impact to the region.

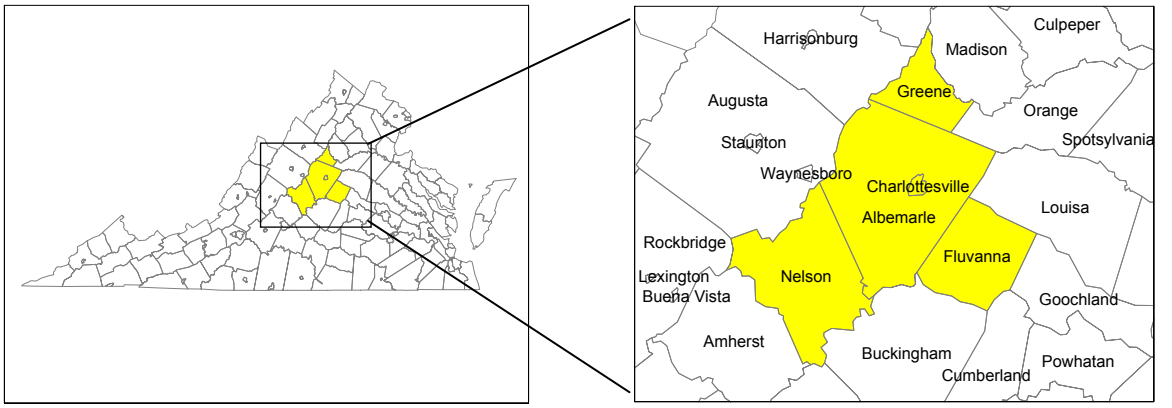
Analyzing the High-Technology Industry

As the initial step in analyzing the business sectors that comprise the Charlottesville area's *High-Technology Industry*, it was necessary to determine the geographic regions for which employment and wage information would be collected. These boundaries could have been identified in multiple ways: specific cities, counties, multi-county regions, or even the entire state. (A multi-county and city region was used for this analysis.) After establishing the geographic boundaries, a definition for the *Industry* was needed that would allow data to be collected for the area's firms and employees.

Geographic Regions for the Industry

This analysis focused on the economic effects generated for the Charlottesville, Virginia metropolitan statistical area (MSA). The Charlottesville region includes five jurisdictions: the independent City of Charlottesvile and the Counties of Albemarle, Fluvanna, Greene, and Nelson. Figure 1 highlights these localities and their location within the Commonwealth.

Figure 1. Maps of Virginia and the Charlottesville MSA



Defining the Industry

For this project, the CBIC and the City of Charlottesville's Office of Economic Development decided to work with an existing definition of the *High-Technology Industry.* This definition had been developed by Mr. Daniel Hecker, an economist at the U.S. Bureau of Labor Statistics, and was presented in his July 2005 article "*High-technology Employment: A NAICS-based Update*."[2] Hecker included in his measure of high-technology all industry sectors where technology oriented employment is at least twice (2.0 times) the average for all other sectors (4.9 percent) – that is, where technology oriented employment is at least 9.8 percent. The sectors were defined using national employment levels and combinations of specific industry classification codes from the North American Industry Classification System (NAICS).

The NAICS system, which was developed in 1997 through collaboration among the statistical agencies of the United States, Canada, and Mexico, provides the basis for

[2] Hecker, Daniel. "High-technology employment: a NAICS-based update." U.S. Bureau of Labor Statistics. Monthly Labor Review. July 2005. Pages 57–72.

classifying businesses by industry and collecting data on the economic activity in these industries. Under the NAICS system, establishments that use the same or similar processes to produce goods or services are grouped together and assigned a unique classification number – i.e., the NAICS code.[3] For example, grocery stores and supermarkets, which provide a service to consumers, are classified using the 6-digit NAICS code of 445110. Economic data about the level of employment, wages and salaries, and number of firms for the grocery store and supermarket sectors are compiled and made available using this NAICS code as a method for identifying the specific sector.[4] The fact that Federal and state agencies report a wide variety of data about industries using the NAICS classification system makes it an excellent means for collecting information on the firms that comprise the Charlottesville MSA's *High-Technology Industry*.

Table 1 shows the NAICS sectors that are included within Hecker's definition of *High-Technology* employment. His definition segmented the NAICS codes into three "Levels," each of which is listed below and presented separately in the table:

- "**Level 1**" included those occupations for which technology oriented employment was at least 5 times the average for all industries (average of 4.9 percent);
- "**Level 2**" firms had at least 3.0 to 4.9 times the average; and
- "**Level 3**" firms had at least 2.0 to 2.9 times the average.

[3] *Development of NAICS*. U.S. Census Bureau website. www.census.gov/epcd/www/naicsdev.htm

[4] Prior to the implementation of the NAICS system in 1997, the U.S. government used a similar system of codes called the Standard Industrial Classification (SIC) to report data on various industries. The SIC classification system was originally adopted in 1939 and last refined in 1987. As of 2002, government data are no longer reported using the SIC codes and only the NAICS system is used.

Table 1. Daniel Hecker's Definition of the *High Technology Industry*		
Hecker's Level *	**4-Digit NAICS Code**	**Definition of NAICS Code**
Level 1	3254	• Pharmaceutical & Medicine Mfg.
	3341	• Computer & Peripheral Equipment Mfg.
	3342	• Communications Equipment Mfg.
	3344	• Semiconductor & Other Electronic Component Mfg.
	3345	• Navigational, Measuring, Electromedical, & Control Instruments Mfg.
	3364	• Aerospace Product & Parts Mfg.
	5112	• Software Publishers
	5161	• Internet Publishing & Broadcasting
	5179	• Other Telecommunications
	5181	• Internet Service Providers & Web Search Portals
	5182	• Data Processing, Hosting, & Related Services
	5413	• Architectural, Engineering, & Related Services
	5415	• Computer Systems Design & Related Services
	5417	• Scientific Research & Development Services
Level 2	1131	• Timber Tract Operations
	1132	• Forest Nurseries & Gathering of Forest Products
	2111	• Oil & Gas Extraction
	2211	• Electric Power Generation, Transmission & Distribution
	3251	• Basic Chemical Mfg.
	3252	• Resin, Synthetic Rubber, and Artificial Synthetic Fibers & Filaments Mfg.
	3332	• Industrial Machinery Mfg.
	3333	• Commercial & Service Industry Machinery Mfg.
	3343	• Audio & Video Equipment Mfg.
	3346	• Manufacturing and Reproducing Magnetic & Optical Media
	4234	• Professional and Commercial Equipment & Supplies Merchant Wholesalers
	5416	• Management, Scientific, and Technical Consulting Services

Table 1 Continues

Table 1 Continues Here

Table 1. Daniel Hecker's Definition of the *High Technology Industry*

Hecker's Level *	4-Digit NAICS Code	Definition of NAICS Code
Level 3	3241	• Petroleum & Coal Products Mfg.
	3253	• Pesticide, Fertilizer, & Other Agricultural Chemical Mfg.
	3255	• Paint, Coating, & Adhesive Mfg.
	3259	• Other Chemical Product & Preparation Mfg.
	3336	• Engine, Turbine, & Power Transmission Equipment Mfg.
	3339	• Other General Purpose Machinery Mfg.
	3353	• Electrical Equipment Mfg.
	3369	• Other Transportation Equipment Mfg.
	4861	• Pipeline Transportation of Crude Oil
	4862	• Pipeline Transportation of Natural Gas
	4869	• Other Pipeline Transportation
	5171	• Wired Telecommunications Carriers
	5172	• Wireless Telecommunications Carriers (except Satellite)
	5173	• Telecommunications Resellers
	5174	• Satellite Telecommunications
	5211	• Monetary Authorities - Central Bank
	5232	• Securities & Commodity Exchanges
	5511	• Management of Companies & Enterprises
	5612	• Facilities Support Services
	8112	• Electronic and Precision Equipment Repair & Maintenance

Source: Daniel Hecker's definition of "High-technology employment." NAICS code descriptions are from the U.S. Census Bureau.

Appendix A provides a detailed list Charlottesville MSA companies that fall into each of the three Levels. Examples of those businesses are also provided below:

Level 1 **Occupations for which technology oriented employment was at least 5 times the average for all industries**

- Andrew S. Thomas, architect (*Landscape Architectural Services*, located in Charlottesville City);
- Black Cat Computer Service (*Computer Systems Design Services*, located in Charlottesville City);
- Cole Software LLC (*Software Publishers*, located in Nelson County);
- Expressions Networks LLC (*Data Processing, Hosting, and Related Services*, located in Charlottesville);
- Kuyk & Associates, Inc. (*Architectural Services*, located in Greene County);
- National Radio Astronomy Observatory (*Research and Development in the Social Sciences and Humanities*, located in Charlottesville City);
- Northrop Grumman Defense (*Computer Systems Design Services*, located in Albemarle County); and
- Vivus Software, Inc. (*Custom Computer Programming Services*, located in Fluvanna County).

Level 2 **Occupations for which technology oriented employment was at least 3.0 to 4.9 times the average for all industries**

- Arc Light Holdings, LLC (*Administrative Management and General Management Consulting Services*, located in Albemarle County);
- Innovative Lasers, Inc. (*Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers*, located in Charlottesville City);
- National Optronics (*All Other Industrial Machinery Manufacturing*, located in Charlottesville City);
- NBS Food Equipment (*Other Commercial Equipment Merchant Wholesalers*, located in Charlottesville City);
- Status Solutions LLC (*Computer and Computer Peripheral Equipment and Software Merchant Wholesalers, located in Albemarle County);*
- Ultimate Performance Systems Process (*Physical Distribution, and Logistics Consulting Services*, located in Albemarle County); and
- Western Telecommunication *(Other Management Consulting Services*, located in Charlottesville City).

National Optronics located in Charlottesville

Continued

Level 3 **Occupations for which technology oriented employment was at least 2.0 to 2.9 times the average for all industries**

- Alltel Communications, Inc. (*Cellular and Other Wireless Telecommunications*, located in Charlottesville City and Albemarle County);
- California Sidecar Escape (*Motorcycle, Bicycle, and Parts Manufacturing*, located in Nelson County);
- First Avenue Networks, Inc. (*Telecommunications Resellers*, located in Charlottesville City); and
- National Ground Intelligence Center (*Corporate, Subsidiary, and Regional Managing Offices*, located in Albemarle County).

Measuring the Industry

The 4-digit NAICS codes used in Hecker's definition of the *High-Technology Industry* are the level of detail available to the public through the U.S. Bureau of Labor Statistics and each state's employment agency. However, more detailed data exist and these were obtained by the VCU Center for Public Policy for this research. Underlying the 4-digit NAICS codes are sets of 5-digit codes (with additional detail) and 6-digit codes (with even more detail). Information from the 6-digit NAICS codes was used to gather detailed data about number of firms, number of employees, and average wages paid to employees in this *Industry*. (See Table B1 in Appendix B for a list of the 6-digit NAICS codes that underlie Hecker's definition of the *High-Technology Industry*.)

Within the Charlottesville MSA, the following types of data were obtained to analyze the *High-Technology Industry*:

(1) employment and wage data for firms using the NAICS codes of Hecker's industry definition; and

(2) high-technology employment and wage data from the University of Virginia.

These two categories are explained in more detail on the following page.

(1) Data using the NAICS codes of Hecker's Definition

The data source for the 6-digit NAICS information was the quarterly "Census of Employment and Wages" (CEW). CEW data are collected and reported by the labor commission of each state; Virginia data comes from the Virginia Employment Commission. These data provide an actual count of the number of employees and the wages paid for virtually every non-agricultural firm in the United States.[5]

Annual CEW data for 2006 were used for each of the Charlottesville region's industry codes included in Hecker's definition.

(2) Data from the University of Virginia

In the Charlottesville area, the University of Virginia plays a large role in high-technology development and analysis. However, its NAICS code (NAICS code 611310, "Colleges, Universities, and Professional Schools") is not included in Hecker's definition for the *Industry*. Because of this, 2006 annual data for the University of Virginia were obtained directly from UVA's Office of Research and Graduate Studies.[6]

The *High-Technology* divisions of the University were as follows: School of Engineering & Applied Science; Information Technology and Communication (ITC); the School of Medicine (basic sciences only, not clinical); and science departments in the College of Arts & Sciences (i.e., astronomy, biology, chemistry, environmental sciences, mathematics, physics, psychology, statistics).

Table 2 presents the estimated annual employment and wages for the *High-Technology Industry* in the Charlottesville MSA. This includes firms that match Hecker's NAICS code definition and the University of Virginia. For 2006, it was estimated that the *Industry* employed a total of 11,691 people (both full and part-time employees) and paid annual

[5] Bureau of Labor Statistics. Report titled *People are Asking*. BLS website (www.bls.gov/cew/peoplebox.htm#1). CEW data covers roughly 97 percent of all non-farm employment in the United States. Covered employment data includes all jobs that are covered by unemployment insurance (i.e., the "Virginia Unemployment Compensation Act").

[6] To preserve the confidentiality of company information, data from individual firms (including the University of Virginia) are not presented separately.

wages of $765 million.[7] These wages represent an average annual salary of $65,400, not including any value of benefits.[8]

Table 2. Data for the *High-Technology Industry* in the Charlottesville MSA*
(Dollar Values in 2006 Dollars)

	Employment Level (Jobs)*	Total Annual Wages & Salaries (Millions of $)	Average Annual Wages & Salaries per Employee
Totals	***11,691***	***$765.0 million***	***$65,400***

* Employment and wage data for UVA do not include hourly employees. The UVA Office Research and Graduate Studies reported that hourly employees accounted for less than 5 percent of the salary budget for the University's *High-Technology Industry* employees.

Sources: Virginia Employment Commission, University of Virginia Office of Research and Graduate Studies, and VCU Center for Public Policy estimates.

Table 4 presents a comparison between the *High-Technology Industry* in the Charlottesville MSA's and the other ten MSA regions of Virginia. (Appendix D presents a definition of the localities included in each MSA region.) It is clear from these data that the *Industry's* presence in the Charlottesville MSA is relatively large. This MSA had the fifth largest *High-Technology Industry* employment / jobs in the Commonwealth (among twelve MSA regions). When considering the number of *High-Technology* firms in each region, the Charlottesville MSA ranked fourth largest (followed closely by the Roanoke MSA, with 606 firms). It is important to note when examining this table that data for the Charlottesville MSA is the only area that includes employment at a college or university as part of the *High-Technology Industry*. Even if the UVA data are removed, however, the relative rankings remain the same when comparing the Charlottesville region to Virginia's other metro areas.

[7] Table C1, in Appendix C, compares the size and composition of the *High-Technology Industry* for the Charlottesville MSA with other industry sectors in the MSA.

[8] The VCU Center for Public Policy estimated the value of benefits for employees in the *High-Technology Industry* prior to developing the economic impact. These estimates were developed using data from the U.S. Bureau of Economic Analysis' (BEA) "National Income and Product Accounts."

Table 4. CEW Data for the *High-Technology Industry*, within Virginia's MSA Regions
(Dollar Values in 2006 Dollars)

Metropolitan Statistical Area (MSA) Name	Employment Level (Jobs)	Number of Firms	Total Annual Wages & Salaries (Millions of $)	Average Wages & Salaries per Employee*
Blacksburg-Christiansburg-Radford, VA	6,914	292	$356.8 m	$51,600
Charlottesville, VA*	***11,691***	***636***	***$765.0 m***	***$65,400***
Danville, VA	1,171	107	$52.8 m	$45,100
Harrisonburg, VA	3,100	153	$188.1 m	$60,700
Kingsport-Bristol-Bristol, TN-VA *(Virginia Portion)*	3,246	123	$146.6 m	$45,200
Lynchburg, VA	6,823	403	$330.0 m	$48,400
Richmond, VA	68,310	3,121	$5,225.9 m	$76,500
Roanoke, VA	12,819	606	$700.6 m	$54,700
Virginia Beach-Norfolk-Newport News, VA-NC *(Virginia Portion)*	64,967	3,199	$3,872.6 m	$59,600
Washington-Arlington-Alexandria, DC-VA-MD-WV *(Virginia Portion)*	283,627	13,857	$27,662.4 m	$97,500
Winchester, VA-WV *(Virginia Portion)*	2,488	165	$146.3 m	$58,800

* Due to rounding of the total wage figures, the "Average Wages and Salaries per Employee" values presented in this table may not equal to the "Total Annual Wages & Salaries" divided by the Employment Level.

** Totals for the Charlottesville metro area include data from the University of Virginia (UVA). When comparing the Charlottesville region with Virginia's other metro areas, the relative rankings remain the same whether or not the UVA data are included. Among Virginia's metro areas, the Charlottesville region has the 5th largest number of high-technology employees, the 4th largest number of high-technology firms, and ranks 3rd for the average wages paid to high-technology employees.

Sources: Virginia Employment Commission, University of Virginia's Office of Research and Graduate Studies, and VCU Center for Public Policy estimates.

Table 5 contrasts the results for the Charlottesville MSA's *High-Technology Industry* with data for all industries in the MSA. In 2006, the *High-Technology Industry* represented twelve percent of the Charlottesville MSA's employees, eleven percent of firms, and twenty-one percent of the annual wages and salaries paid to employees. The average wage per employee for *High-Technology Industry* workers was 167 percent greater than the average wage per employee for all industries in the region ($64,500 per year versus $39,100 per year).

Table 5. Data for the *High-Technology Industry* in the Charlottesville MSA (Dollar Values in 2006 Dollars)				
Locality Name	**Employment Level (Jobs)**	**Number of Firms**	**Total Annual Wages & Salaries** (Millions of $)	**Average Wages & Salaries per Employee***
High-Technology Industry	***11,691***	***636***	***$765.0 m***	***$65,400***
All Industries	95,162	5,992	$3,716.3 m	$39,100
High-Technology Industry as a percentage of All Industries	12%	11%	21%	167%

* Due to rounding of the total wage figure, the "Average Wages and Salaries per Employee" value presented in this table is not equal to the "Total Annual Wages & Salaries" divided by the Employment Level

Sources: Virginia Employment Commission, University of Virginia data Office of Research and Graduate Studies, and VCU Center for Public Policy estimates.

For comparison, Table 6 shows the statewide data for the *High-Technology Industry* and all industries. In Virginia, the *High-Technology Industry* represented fourteen percent employees, twelve percent of firms, and twenty-six percent of the total wages and salaries paid each year to employees. The average wage per employee for *High-Technology Industry* workers, statewide, was 190 percent greater than the average wage per employee for all industries in the Commonwealth ($83,500 per year versus $44,000 per year).

Table 6. Data for the *High-Technology Industry* in Virginia (Dollar Values in 2006 Dollars)				
Locality Name	**Employment Level (Jobs)**	**Number of Firms**	**Total Annual Wages & Salaries** (Millions of $)	**Average Wages & Salaries per Employee***
High-Technology Industry	496,908	26,436	$41,474.6	$83,500
All Industries	3,636,596	214,996	$160,170.2	$44,000
High-Technology Industry as a percentage of All Industries	14%	12%	26%	190%

* Due to rounding of the total wage figure, the "Average Wages and Salaries per Employee" value presented in this table is not equal to the "Total Annual Wages & Salaries" divided by the Employment Level

Sources: Virginia Employment Commission and VCU Center for Public Policy estimates.

When comparing the *High-Technology Industry* in the Charlottesville MSA with the Industry elsewhere in Virginia, we see that the Charlottesville region represents about two percent of the state's high-technology employment, two percent of its firms, and about two percent of total wages paid. In addition, annual wages paid to *High-Technology Industry* workers in the Charlottesville region were about seventy-eight percent of the statewide average wages paid to *Industry* employees ($65,400 in Charlottesville MSA versus $83,500 statewide).

Economic Impacts of the High-Technology Industry

After obtaining employment and wage data for the component industries of the *High-Technology Industry*, the VCU Center for Public Policy developed an economic impact model for the geographic study area (i.e., the Charlottesville MSA) and applied the data in order to estimate the *Industry*'s economic impact. The IMPLANPro™ computer model was used in preparing these estimates.[9] IMPLAN is a regional input-output modeling system that allows a user to examine the relationships between the components of an economy, recognizing that market transactions made by one industry or firm (or group of industries or firms) will have an economic impact on other industries.

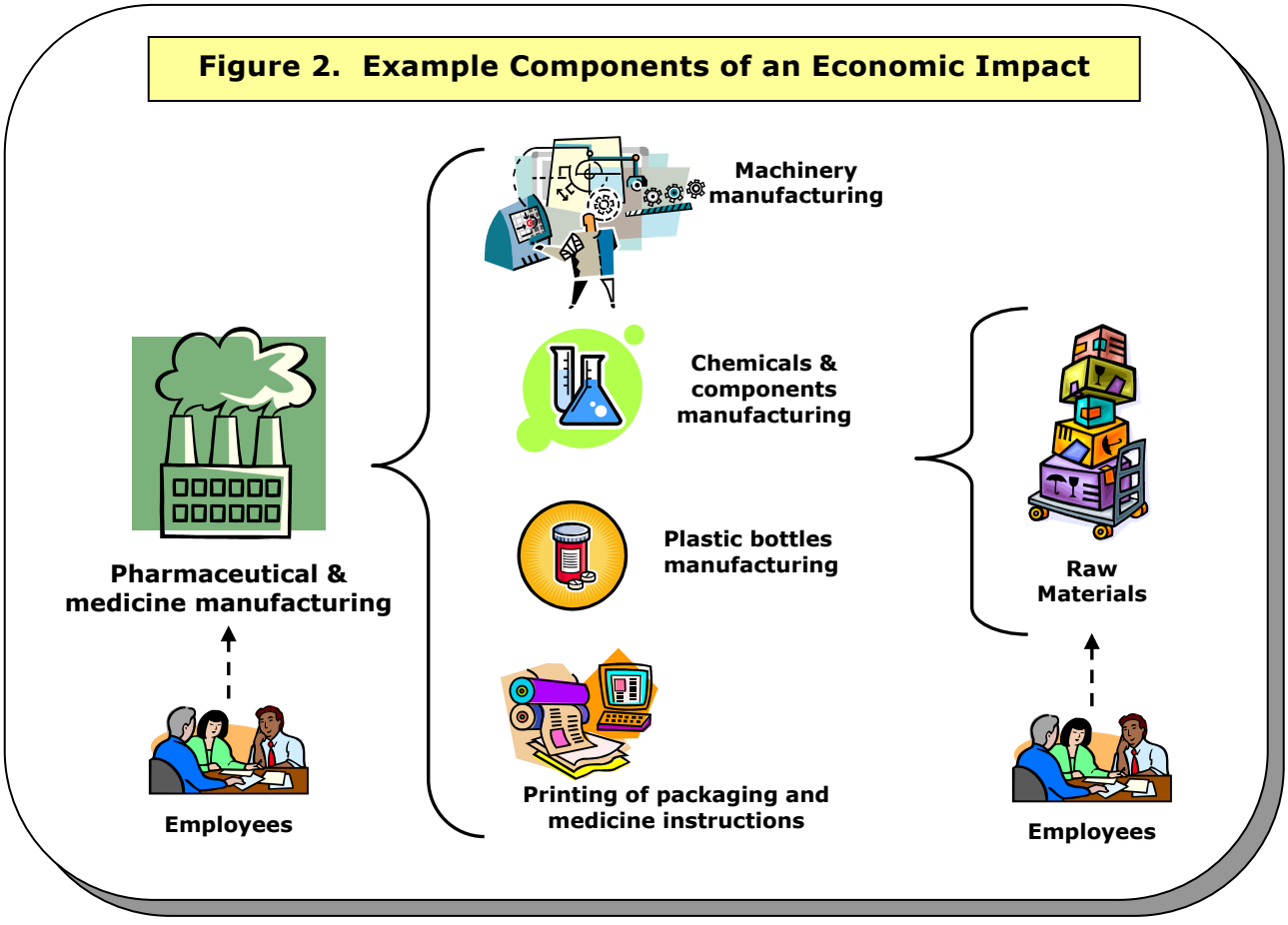
The total economic impact from market transactions is comprised of three phases: direct, indirect, and induced economic effects. The "direct effects" are expenditures made by *High-Technology* firms for their operations. When supplier firms (providing goods and services to *High-Technology* companies) receive orders, they must purchase additional inventory or new products for inputs. These subsequent purchases are referred to as the "indirect effects" and contribute to the area's overall economic impact, both in terms of jobs and additional output for the region. The final component of economic impact results from the "induced effects" associated with changes in household expenditures. As companies increase their outputs because of business activity linked to the presence of the *High-Technology Industry*, they will hire new employees or pay existing employees to work longer hours. When

[9] IMPLAN (Impact Analysis for Planning) was developed in 1979 by the United States Department of Agriculture, Forest Service in cooperation with the Federal Emergency Management Agency and the United States Department of the Interior, Bureau of Land Management. The IMPLAN program originally required a mainframe computer system, but has progressed into a program that runs on a standard microcomputer. The IMPLANPro software was created in 1996 and is maintained and updated by the Minnesota IMPLAN Group, Inc.

household incomes increase, employees will spend more money in the area, generating an even greater economic benefit for the region.

Figure 2 gives an example of the components of an economic impact. In order for a "pharmaceutical and medicine manufacturing" firm to produce its output, it must buy inputs from a variety of sources. Some of these inputs will be items such as machinery, chemicals and component materials, plastic bottles, and printing services. The initial purchases from the supplier firms represent the direct economic effect. As a result of this manufacturer's purchase – and the purchases of many other customers – suppliers must purchase additional raw materials for the production of their goods and services. This economic activity adds value to the stages of production for the pharmaceutical goods and generates indirect economic effects. At the each stage of the direct and indirect effects, employees of the various firms receive payment for their services. The new spending of these employees generates induced economic impact within the economy.

Figure 2. Example Components of an Economic Impact



Using employment and wage data as inputs to the IMPLAN model, the overall economic effects of the *High-Technology Industry* were estimated. The total effects include the *Industry*'s direct impact on output and employment of the region, plus additional "multiplier effects" that this *Industry* has on other local industries. For this report, the multiplier effects – that is, the combination of the indirect and induced impacts – are called "Additional impact." Also, the economic impact estimates presented in this report are in 2006 dollars.

Data generated through the IMPLAN analysis includes estimates of the direct, indirect, and induced impacts for each of the following elements:

- **Employment** – the number of total jobs, including both full-time and part-time employees;
- **Economic impact** - the economic impact generated in the region;
- **Value Added** – in addition to personal income, this includes income from rents, dividends, profits, royalties, interest, and indirect business taxes paid by companies; and [10]
- **Labor Income** – this includes wages and salaries paid, including benefits for employees of firms. It also includes payments received as income by freelance employees.

The "Valued Added" component from IMPLAN can be interpreted as the industry's contribution to a state's Gross Domestic Product (GDP), i.e., the value of all final goods and services produced within the borders of a state.[11]

As shown in Table 7, there were an estimated 11,691 jobs ("direct employment") within the Charlottesville MSA's *High-Technology Industry* during 2006. This included employment outside of the University of Virginia and within the University. The

[10] Olson, Doug and Scott Lindall. "IMPLAN Professional Software, Analysis, and Data Guide." Minnesota IMPLAN Group, Inc. 1996.

[11] Friedenberg, Howard and Richard Beemiller. "Comprehensive Revision of Gross State Product by Industry, 1977 – 94." ***Survey of Current Business***. June 1997. From the Bureau of Economic Analysis website: *www.bea.doc.gov/bea/ar/0697rea.pdf.* In this publication, the Gross State Product is defined as "the sum of the costs incurred (such as compensation of employees, net interest, and indirect business taxes) and the profits earned in production."

economic activity associated with this level of employment supported 13,483 additional jobs in other sectors of the economy and generated a total economic impact to Virginia of $4.4 billion and supported an estimated $182 million of state and local tax revenues.[12] The economic activity included a total Value Added for the region of $2.2 billion. Value added is equal to the *Industry*'s estimated contribution to Gross Domestic Product; because of this, spending by component firms contributed about 0.59 percent of the Commonwealth's total Gross Domestic Product in 2006.[13] Also, the *Industry*'s operations expenditures in 2006 were responsible for $1.5 billion of Labor Income (wages and benefits) paid to employees.

Table 7. Total Economic Impact of the *High-Technology Industry* in the Charlottesville MSA
(Dollar Values in Millions of 2006 Dollars)

Type of Impact	Direct Impact	Additional Impact	Total Impact
Employment	11,691	13,483	25,174
Economic Impact	$2,891 m	$1,529 m	$4,421 m
Value Added	$1,274 m	$931 m	$2,206 m
Labor Income (wages plus an estimate of benefits received)	$967 m	$501 m	$1,468 m
State and Local Tax Revenues			$182 m

Sources: VCU Center for Public Policy estimates developed using IMPLANPro. Annual CEW data obtained from the Virginia Employment Commission. Inflation adjustments made using the "Consumer Price Index for All Urban Consumers" (CPI-U) from the U.S. Bureau of Labor Statistics.

Conclusion

This report presents the findings from a study of the *High-Technology Industry* within the Charlottesville MSA. While it is not the largest industry sector in the region, the *High-Technology Industry* clearly contributes much – in terms of overall impact, jobs,

[12] The method used to estimate state and local tax revenues is a revision of the approach used by John Knapp, Ph.D., and Catherine Barcher in the report "Monticello's Economic Impact on the Charlottesville-Albemarle Area." Weldon Cooper Center for Public Service. University of Virginia. December 2001.

[13] Bureau of Economic Analysis. Gross Domestic Product data for Virginia, in 2006, was $369.3 billion. June 7, 2007 revisions.

and tax revenues – to the region. When compared with the ten other metropolitan areas of Virginia, Charlottesville ranks as the fifth largest in terms of *High-Technology* employment and the fourth largest in the number of *High-Technology* firms. For the analysis presented in this report, the VCU Center for Public Policy used a NAICS-code industry definition (developed by economist Daniel Hecker) to determine which industries and businesses in the Charlottesville area were to be considered part of the *High-Technology Industry*. Employment and wages from applicable divisions of the University of Virginia were also included in the analysis to take into account that University's role in the region's *High-Technology Industry*.

The Charlottesville MSA was estimated to have 11,691 employees working at area *High-Technology* establishments (including divisions of UVA) in 2006. The average wage paid to these employees was $65,400 and the "direct" economic effect of the *Industry* was about $2.9 billion. Combining these direct economic effects with the resulting multiplier effects, the *Industry* is estimated to have contributed a total economic impact of $4.4 billion to the Charlottesville MSA. This level of impact supported over 25,000 area jobs and generated $182 million of tax revenue for Virginia and the Charlottesville region's local governments.

APPENDIX A

Charlottesville's *High Technology Industry* Companies, within Daniel Hecker's Three Levels

Appendix A: Charlottesville's *High Technology Industry* Companies, within Daniel Hecker's Three Levels

"Level 1" Companies: Occupations for which technology oriented employment was at least 5 times the average for all industries

- 2rw & Di LLC
- 2rw Consultants Inc
- A D I Engineering Inc
- A J Associates Inc
- Abrasive Resources Inc
- Advanced Programming Tech
- Afton Scientific Corp
- Albiston Associates
- Alion Science & Technology
- American Cancer Society
- American Heart Association
- American Society on Aging
- Andrew S Thomas Architect
- Apex Learning Inc
- Applied Data Systems Inc
- Aqua Air Laboratories Inc
- Arc Light Technologies Inc
- Archimedes Inc
- Artisoft Inc
- Atwood Architects Inc
- Autologue Computer System
- Avionics Specialties Inc
- Avir, LLC
- Backlund Enterprises Inc
- Barron Associates Inc
- Battelle Memorial Institute
- Bell & Howell Information
- Bent Tree Design PLC Inc
- Biocatalyst International
- Bioengineering Consultant
- Biotage Inc
- Bitstream Inc
- Black Cat Computer Service
- Blue Ridge Numerics Inc
- Blue Ridge Software Systems
- Blue Ridge Websoft LLC
- Bluewall LLC
- Bob Anderson Architect PC
- Breezing Internet Comm.
- Brian P Smith Civil Engineer
- Broadband Network Service
- Brownell Metal Studio Inc
- BRW Architects
- Bushman Dreyfus Architect
- Cadforce Inc
- CAE Technical Services
- Candace M P Smith Architect
- Cardio Concepts Inc
- Carlisle Home Inspection
- Category 4 Design
- Cellular Materials Intern
- Chambers & Associates
- Charles J Stick Inc
- Charlottesville Medical
- Charlottesville Tomorrow
- Chiltern International Inc
- Christian J. Lehmbeck, Inc
- City of Charlottesville
- Cloud Brain LLC
- Cognigen Corp
- Cole Software LLC
- Commonwealth Clinical Sys.
- Commonwealth Computer Res
- Commonwealth of Virginia - Virginia Information Technology
- Commonwealth of Virginia
- Communications Industry R
- Community Planning & Design
- Compu Tune Up Inc
- Computer Assurance LLC
- Computer Sciences Corp
- Computing Technologies
- Contravac Inc
- Convista Consulting LLC
- Cottler Technologies LLC
- County of Albemarle
- Crotts & Saunders Engineers
- Crozet Systems Consulting
- Cs3 Solutions LLC
- Curtiss Wright Controls
- Custom Software Solutions
- Daggett & Grigg Architect

- Dalgliesh Eichman Gilpin
- Daniel S Suggs Engineering
- Darim Online
- Dasa Plc Etal
- Data Spectrum Inc
- David C Blankenbaker Inc
- Dbf Associates Architects
- Department of Defense
- Design Build Office Inc
- Diffusion Pharmaceuticals
- Directed Vapor Technologies
- Dirt Studio LLC
- Diversified Information
- Diversified Intelligence
- Domain Consultants Group
- Dominion Dev Resources LLC
- Draper Aden Associates In
- Dt7 Software LLC
- Dynamics Research Corp
- Dyncorp Tech Services LLC
- East Coast Architectural
- Easy It Inc
- Ecs Mid Atlantic LLC
- Eedo Knowledgeware Corp.
- Ehatcher Solutions Inc
- Eiden Systems Corp
- Electronic Cabling & Asse
- Electronic Data Systems
- Elisabeth Sloan, Architect
- Elsinore Technologies Inc
- Empirical Technologies Inc
- Entami Corp
- Epharmalearning Inc
- Equestrian Services, LLC
- Erica Inc
- Esignal Incorporated
- Expressions Networks LLC
- Fbm 2 Corp.
- Fdm Group Inc
- Financial Markets Center
- Firstnet of Virginia Inc
- Formwork Design Office
- Fpw Architects
- Frank D Cox Jr
- Froehling & Robertson Inc
- Frontline Test Equipment
- GE Fanuc Automation Mfg Inc
- GE Fanuc Automation Nort
- GE Infrastructure Sensing
- Gencia Corp
- General Dynamics Informat
- General Dynamics Network
- General Electric Co
- Gerald P. O'Brien EDP
- Gevity Hr Lp
- Global Cell Solutions, LLC
- Gloeckner Engineering
- Gooch Engineering & Testing
- Green Bar Software, Inc.
- Gregg Bleam Landscape
- Growing Technologies LLC
- Halmac Studios Inc.
- Hamady Architects LLC Eta
- Hamilton Technologies Inc
- Health Data Services Inc
- Helix Computer Systems
- Heyward Boyd Architects
- HKL Research Inc
- Home Pro of Central Virginia
- Honda R & D Americas Inc
- Hypogen, Inc.
- I Design
- Icollective Inc
- Idx Labs, LLC
- Inc Research Inc
- Indoor Biotechnologies Inc
- Infiniti Systems Group Inc
- Innovation Incorporated
- Inspection Services Inc
- Institute For Scientific
- Intalgent Technologies LLC
- Interact Systems Inc
- Interpretive Software Inc
- Iron Crown Enterprises
- Isotemp Research Inc
- J D Architectural Studio
- J R & H Architects, PLLC
- Jemstone Computer Service
- Jobe Analytics & Consulting
- Johnson Craven & Gibson
- Jurisearch Com LLC
- K J Consulting Inc
- K L Walker Consulting Inc
- Keeney & Company Architects

- Kirk Hughes & Associates
- Koch & Webber Architects
- Kollar Market Analytics
- Krisans Backoffice Inc
- Kuyk & Associates Inc
- Kvaser Inc
- Land Planning & Design
- Landscape Creations & LLC
- Lanscan Software Inc
- Limehouse Architects LLC
- Lockheed Martin Corporation
- Lombardi Software Inc
- Lums Land Surveys Inc
- M J Systems Inc
- M Jack Rinehart Jr
- Macrosoft Systems Inc
- Madison Spencer Architect
- Magma Design Automation
- Mallen Research
- Marconi Technology
- Mark J. Heinicke
- Mark Tamblyn Computer
- Marketminer Inc
- Mass Management LLC Inc
- McCade Design
- Mcguffey Hill LLC
- McKee Carson
- McLeod Consulting Group Inc
- Mcnc
- Medical Automation System
- Medical Predictive Science
- Metasoft Systems Inc
- Mikro Systems Inc
- Millennium Software Consulting
- Miller Management Support
- Missionsoft Inc
- Mitchell Matthews & Assoc
- Modmed Therapeutics Inc
- Moler & Associates
- Motion Technology Inc
- Mozilla Corporation
- MVP Technologies Inc
- Naeva Geophysics Inc
- National Radio Astronomy Observatory
- Native Design Inc
- NDE Technologies Inc
- Nelson Byrd Woltz LLC
- Neoventus Design Group LLC
- Netwave, LLC
- New Era Converting Machine
- Northrop Grumman Corp
- Northrop Grumman Defense
- Northrup Grumman
- NWG Solutions LLC
- O Connell & Associates Inc
- Oak Leaf Enterprise Solutions
- Oak Tree Systems Inc
- Old Albemarle Surveying
- Old Dominion Map Co
- Openq Inc.
- Osteen Phillips Architect
- Outcomes Incorporated
- Parker Innovations Inc
- Patton Harris Rust & Assoc
- Perrin Quarles Associates
- Peter L Sheeran AIA
- Pharmaceutical Research
- Pinnacle Engineering Plc
- Pinnacle Pharmaceuticals
- Precision IT Group
- Privaris Inc
- Protasis Corp
- Quat Rx Pharmaceuticals
- R T Eveland & Associates
- Raymond E Gaines
- Reactivity Inc
- Renaissance Planning Group
- Resource Consultants Inc
- Richard Barrett & Associates
- Rieley & Associates Pc
- Right Internet Inc
- Riovia Communications Group
- Robert Boucheron Architect
- Robert E Troxell Architect
- Robrose Net Inc
- Rodyn Vibration Analysis
- Roger W Ray & Assoc Inc
- Roudabush Gale & Assoc Inc
- Rpath Inc
- Safety Software Inc
- Safeware Engineering Corp
- Saunders Surveys Inc
- Sbi Enteris Incorporated
- Schnabel Engineering Inc

- Science Applicats Intl Co
- Scientific Software Solutions
- Sensor Concepts & Applica
- Setagon Inc
- Shank & Gray Architects
- SHPS Health Management
- Siderean Software Inc
- Silverchair Learning Systems
- Sime Development LLC Inc
- Siteworks
- Skyline Information Sys Inc
- Sldc Ltd
- Solucient LLC
- Solution Beacon Consulting
- Southeastern Life Science
- Spatlialogic
- Speedtest Incorporated
- Sportswar LLC
- Staengl Engineering LLC
- State Farm Fire & Casualty
- Stephens Consulting Group
- Steven L Key Inc
- Stoneking Von Storch Arch
- Studio 109 PLC
- Tandel Systems Inc
- Technology Tamers Inc
- Ted Jones Architect, P.C.
- Terra Concepts Pc
- Terra Engineering & Land.
- The Engineering Groupe Inc
- The Forecast Institute Inc
- The Green Thumb
- The Kodiak Group Inc
- The Mitre Corporation
- The Synetech Group Inc
- Thomas B Lincoln Land Surveyor
- Thomas Jefferson Foundation
- Topik Solutions Inc
- Trace Holographic Art & Design
- Train and Partners Architects
- Trimation Inc
- Trio Solutions LLC
- Trueline Surveying Inc
- Turn Key Industrial Engineers
- Unbound Medicine Inc
- Underwriters Lab Inc
- Universal Test Equipment
- Upstate Biotechnology Inc
- Upstate Group LLC
- Van Yahres Associates Lan
- Video Gaming Technologies
- Vidion Systems Inc - Osmosys
- Virginia Diodes Inc
- Virginia Lions Hearing Foundation - University of Virginia
- Virginia Mapping Inc
- Virginia Technologies Inc
- Visi Trak Worldwide LLC
- Vivus Software Inc
- Vmdo Architects Pc
- W G Clark Architect
- William A Edgerton Architect
- William Mcdonough and Prt
- William Morris Foster - Certified Land Surveyor
- Willowtree Interactive
- Wipro Limited
- Wolf Ackerman Design Inc
- Worrell Water Technologies
- Www Electronics Inc

"Level 2" Companies: Occupations for which technology oriented employment was at least 3.0 to 4.9 times the average for all industries

- Affinity Golf Management
- Afton Developments, Inc.
- Agape Construction Services
- Akin & Company
- Allison Partners LLC
- American Fibers And Yarns
- Angela Brement Consulting
- Angle Technology LLC
- Antec Inc
- Anthony Advisors Inc
- Appalachian Power Company
- Arc Light Holdings LLC
- Athena Innovative Solutio
- Bay Medical Products Inc
- Bayne Henyon & Associates
- Beights Development Corp
- Biomedical Insights Inc
- Blue Heron Capital Partners
- Blue Ridge Design & Consulting
- Blue Ridge Search Inc.
- Boss Instruments Ltd
- Boyd Caton & Grant Transp.
- Brg Machinery Consulting
- Bric Services Inc
- Cardinal Point Inc
- Central Va Electric Coop
- Ceramic Innovations Inc
- Charlottesville Office Inc
- Charlottesville Rehabilitation
- Chemical Information Serv.
- Clarke Health Care Produc
- Clear Path Communications
- Coast Solutions Inc
- Colony Marketing LLC
- Commonwealth Center for H
- Compusec Inc
- Construction Consulting
- Countryhouse Hotels LLC
- Courtney H Lyder Ltd
- Covol Services
- Crowder Consulting Corp
- D M Stevens & Associates
- David John Marotta, Inc.
- Dharma Group LLC
- Didex LLC Inc
- Diversified Business Cons
- Docassist Inc
- Dominion Digital Inc
- Dominion Resources
- Dorothy Batten
- E P System Inc
- E2 Inc
- Earth Vector Systems LLC
- Easter Consulting LLC
- Edgar O. Olsen
- Edgevale Associates Inc
- Education Graphic Solutions
- Educational Material Assoc.
- Ekholmen Com Inc
- Elder Research Ind
- Elysium LLC Etal
- Em Paks
- Emax Oil Company
- Environmental Standards Inc
- Esop Services Inc
- Federal Property Company
- Fisher Consulting Service
- Flying Buttress Associate
- Frischer Consulting Inc.
- Fund Management Services
- Future Perfect Worldwide
- Gatewick Enterprises Inc.
- Globequest Ltd
- Gravitys Edge Computers
- Greenlight Energy Inc
- Guesthouse International
- Health Futures Inc
- Hewlett Packard Company
- Ideal Healthcare Consulting
- Ikon Office Solutions Inc
- Innovative Lasers Inc
- Inpractice Group LLC
- Intergra Project Management
- Intuitive Intelligence Ap
- Invisible Path Publishing
- Ivy Group Ltd
- Jeffrey A Sitler Envirome
- Kalyx Systems Inc

- Kci Usa Inc
- Kenahora Wine Co Inc
- Lakeview Farm
- Lanfair Management Inc
- Leader Professional Services
- Leo Burnett Usa Inc
- Leveraged Energy Purchasing
- Lighthouse Instruments LLC
- Loki Data Products Inc
- M Cam Inc
- Madjic Consulting, Inc.
- Maier Consulting Inc
- Management Recruiters Int
- Mangham Associates Inc
- Marketing Arts Associates
- Matrix45 LLC
- Mcdonough Braungart Design
- McMenimen & Associates Inc
- Medaccord Incorporated
- Medical Device Consultant
- Merit Management Resource
- Mid Atlantic Medical
- Mid Atlantic Resources Inc
- Mid Atlantic Solutions Inc
- Mjl Associates Inc
- MK Direct Marketing & Communications
- Music Allies Inc
- Mwc Services Inc
- N T Brinkman Inc
- National Optronics
- NBS Food Equipment
- Net Forecast Inc
- Netcracker Technology Corp.
- New Hope Environmental Svcs.
- New Venture Directions Inc
- Old Mill Power Company
- Orbis Clinical LLC
- Osen Hunter Group LLC
- Perrin & Associates
- Petra Publishing Corp
- Piedmont Sales & Supply
- Pitney Bowes Management - University of Virginia
- Planet Enterprises, Inc.
- Prcess Manufacturing LLC
- Promotion Management Corp
- R K M And Associates Inc
- Rand Technologies
- RCF Associates Incorporated
- Real Tax Inc
- Redding Consultants Inc
- Rediscovery Software Inc
- Respiratory Research Inc
- Retail Services Consulting
- Rimm Kaufman Group LLC
- Rivanna Archaeological
- Ross Simmons & Associates
- Rutherford Manangement
- Rvmj Enterprises Inc
- Rwi Inc
- Science Strategies, LLC
- Seidl Enterprises LLC
- Shareholder Strategies Inc
- Simon Enterprises LLC
- Simpson Weather Associate
- Sita Corporation
- SNL Inc
- Somers Studios Inc
- South Central Land Mgt, Inc
- Southeastern Consultants
- Spaulding Lumber Company
- Springhaven Consulting
- Status Solutions LLC
- Strategic Targeting, Inc.
- Sun Model Corp Inc
- Tec Inc
- Teg Virginia LLC Inc
- Tenaska Operation Inc
- The Baldwin Group International
- The Cahill Weber Group Inc
- The Center for Sustainable
- The James River Consulting
- The Macklin Group, Inc.
- The Monticello Group
- The Wellington Group Inc
- Thomas Instrument Co Inc
- Thomas Studio Products Ltd
- Thrane Construction Management
- Tjl Environmental Health
- TLK Incorporated
- Toxicology Regulatory Services
- Transition Consulting Inc
- Triad Project Management
- Ultimate Lifestyle Academy

- Ultimate Performance Systems
- Unidiversity
- Va Electric & Power Co Inc
- Valley Office Machines
- Varian Medical Systems Inc
- Vega Group Limited
- Vips Incorporated
- Wayne C Micheletti Inc
- Western Telecommunication
- Whitley Inc
- Worksmart Systems Inc
- Wycliffe Capital Management

"Level 3" Companies: Occupations for which technology oriented employment was at least 2.0 to 2.9 times the average for all industries

- Acc Operations Inc
- Ace Computer Service
- Afs Intercultural Program
- Alan Ritchey Inc
- Alltel Communications Inc
- American Environics LLC
- American Precision Indust
- Amvest Corporation
- Amvest Mineral Services Inc
- Anderson & Strudwick Inc
- AT & T Corp
- Atlantic Computing LLC
- Atomized Products Group Inc
- Austin Powder Co
- Bellwether Holdings Ltd
- Blue Ridge Mountain Sports
- Bulgarian American Enterprises
- California Sidecar Escape
- Central Telecom Inc
- Central Telephone Co of Va
- Colonial Pipeline Company
- Columbia Gas Transmission
- Comcast Cablevision
- Commonwealth Pizza of Charlottesville
- Creative Hotel Associates
- Delaware Valley Comm Co
- Dovetail Resources LLC
- Eagle Corp
- Embarq Management Company
- Er Communications LLC
- Filtroil Inc
- First Avenue Networks Inc
- Global Fleet Sales Inc
- Great Eastern Resort Corp
- Hampshire Designers Inc
- Hampton & Harrison LLC Inc
- Jefferson Area Board Aging
- Julann Productions of Virginia
- L & S Communications Group
- L P N H Holdings Limited
- Lees TV & VCR Service
- Luck Stone Corporation
- Lucky Seven Food Stores
- Management Service Corpor
- MCI Communications Inc
- MCI Network Services Inc.
- Mobile Communication & El
- Moores Electrical & Mecha
- National Association to P
- National Ground Intelligence Center
- Nextel Partners Operating
- Palais Royal Inc
- Radioshack Corporation
- Rei Drilling Inc
- Senabank Na
- Southern Concrete Product
- Sprint Mid Atlantic Telecom.
- Sprint United Management
- Srm Corp of Virginia
- State Farm Mutual Automob
- Telephone Data Systems
- The Arc of The Piedmont
- The Clean Machine Inc
- The Nature Conservancy Inc
- Transcontinental Gas
- Truslows Garage Wrecker
- Unisys Corp
- University of Virginia Community Credit Union
- V Comm Corp
- Venturedyne Ltd
- Verizon Virginia Inc
- Viceroy Inc
- Virginia Asphalt Services
- Virginia Lube Inc
- Virginia Oil Company
- Watson Furniture Group In
- Worksource Enterprises

APPENDIX B

Definitions of the 6-Digit NAICS Codes Used for the *High-Technology Sector*

Appendix B: Definitions of the 6-Digit NAICS Codes Used for the *High-Technology Industry*

Table B1 provides a list of the 6-digit NAICS codes that underlie the 4-digit NAICS code definition for the *High-Technology Industry* that was developed by Mr. Daniel Hecker.

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*

Hecker's Level	4-Digit NAICS Codes	6-Digit NAICS Codes	Definition of NAICS Code
Level 1	*Occupations for which technology oriented employment was at least 5 times the average for all industries*		
	3254	325411	• Medicinal and Botanical Mfg.
		325412	• Pharmaceutical Preparation Mfg.
		325413	• In-Vitro Diagnostic Substance Mfg.
		325414	• Biological Product (except Diagnostic) Mfg.
	3341	334111	• Electronic Computer Mfg.
		334112	• Computer Storage Device Mfg.
		334113	• Computer Terminal Mfg.
		334119	• Other Computer Peripheral Equipment Mfg.
	3342	334210	• Telephone Apparatus Mfg.
		334220	• Radio and Television Broadcasting and Wireless Communications Equipment Mfg.
		334290	• Other Communications Equipment Mfg.
	3344	334411	• Electron Tube Mfg.
		334412	• Bare Printed Circuit Board Mfg.
		334413	• Semiconductor and Related Device Mfg.
		334414	• Electronic Capacitor Mfg.
		334415	• Electronic Resistor Mfg.
		334416	• Electronic Coil, Transformer, and Other Inductor Mfg.
		334417	• Electronic Connector Mfg.
		334418	• Printed Circuit Assembly (Electronic Assembly) Mfg.
		334419	• Other Electronic Component Mfg.

Table B1 Continues

Table B1 Continues Here

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*

Hecker's Level	4-Digit NAICS Codes	6-Digit NAICS Codes	Definition of NAICS Code
	3345	334510	• Electromedical and Electrotherapeutic Apparatus Mfg.
		334511	• Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Mfg.
		334512	• Automatic Environmental Control Mfg. for Residential, Commercial, and Appliance Use
		334513	• Instruments and Related Products Mfg. for Measuring, Displaying, and Controlling Industrial Process Variables
		334514	• Totalizing Fluid Meter and Counting Device Mfg.
		334515	• Instrument Mfg. for Measuring and Testing Electricity and Electrical Signals
		334516	• Analytical Laboratory Instrument Mfg.
		334517	• Irradiation Apparatus Mfg.
		334518	• Watch, Clock, and Part Mfg.
		334519	• Other Measuring and Controlling Device Mfg.
	3364	336411	• Aircraft Mfg.
		336412	• Aircraft Engine and Engine Parts Mfg.
		336413	• Other Aircraft Parts and Auxiliary Equipment Mfg.
		336414	• Guided Missile and Space Vehicle Mfg.
		336415	• Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Mfg.
		336419	• Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Mfg.
	5112	511210	• Software Publishers
	5161	516110	• Internet Publishing and Broadcasting
	5179	517910	• Other Telecommunications
	5181	518111	• Internet Service Providers
		518112	• Web Search Portals
	5182	518210	• Data Processing, Hosting, and Related Services
	5413	541310	• Architectural Services

Table B1 Continues

Table B1 Continues Here

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*

Hecker's Level	4-Digit NAICS Codes	6-Digit NAICS Codes	Definition of NAICS Code
		541320	• Landscape Architectural Services
		541330	• Engineering Services
		541340	• Drafting Services
		541350	• Building Inspection Services
		541360	• Geophysical Surveying and Mapping Services
		541370	• Surveying and Mapping (except Geophysical) Services
		541380	• Testing Laboratories
	5415	541511	• Custom Computer Programming Services
		541512	• Computer Systems Design Services
		541513	• Computer Facilities Management Services
		541519	• Other Computer Related Services
	5417	541710	• Research and Development in the Physical, Engineering, and Life Sciences
		541720	• Research and Development in the Social Sciences and Humanities
Level 2	*Occupations for which technology oriented employment was at least 3.0 to 4.9 times the average for all industries*		
	1131	113110	• Timber Tract Operations
	1132	113210	• Forest Nurseries and Gathering of Forest Products
	2111	211111	• Crude Petroleum and Natural Gas Extraction
		211112	• Natural Gas Liquid Extraction
	2211	221111	• Hydroelectric Power Generation
		221112	• Fossil Fuel Electric Power Generation
		221113	• Nuclear Electric Power Generation
		221119	• Other Electric Power Generation
		221121	• Electric Bulk Power Transmission and Control
		221122	• Electric Power Distribution
	3251	325110	• Nuclear Electric Power Generation
		325120	• Industrial Gas Mfg.

Table B1 Continues

Table B1 Continues Here

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*

Hecker's Level	4-Digit NAICS Codes	6-Digit NAICS Codes	Definition of NAICS Code
		325131	• Inorganic Dye and Pigment Mfg.
		325132	• Synthetic Organic Dye and Pigment Mfg.
		325181	• Alkalies and Chlorine Mfg.
		325182	• Carbon Black Mfg.
		325188	• All Other Basic Inorganic Chemical Mfg.
		325191	• Gum and Wood Chemical Mfg.
		325192	• Cyclic Crude and Intermediate Mfg.
		325193	• Ethyl Alcohol Mfg.
		325199	• All Other Basic Organic Chemical Mfg.
	3252	325211	• Plastics Material and Resin Mfg.
		325212	• Synthetic Rubber Mfg.
		325221	• Cellulosic Organic Fiber Mfg.
		325222	• Noncellulosic Organic Fiber Mfg.
	3332	333210	• Sawmill and Woodworking Machinery Mfg.
		333220	• Plastics and Rubber Industry Machinery Mfg.
		333291	• Paper Industry Machinery Mfg.
		333292	• Textile Machinery Mfg.
		333293	• Printing Machinery and Equipment Mfg.
		333294	• Food Product Machinery Mfg.
		333295	• Semiconductor Machinery Mfg.
		333298	• All Other Industrial Machinery Mfg.
	3333	333311	• Automatic Vending Machine Mfg.
		333312	• Commercial Laundry, Drycleaning, and Pressing Machine Mfg.
		333313	• Office Machinery Mfg.
		333314	• Optical Instrument and Lens Mfg.
		333315	• Photographic and Photocopying Equipment Mfg.
		333319	• Other Commercial and Service Industry Machinery Mfg.

Table B1 Continues

Table B1 Continues Here

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*

Hecker's Level	4-Digit NAICS Codes	6-Digit NAICS Codes	Definition of NAICS Code
	3343	334310	• Audio and Video Equipment Mfg.
	3346	334611	• Software Reproducing
		334612	• Prerecorded Compact Disc (except Software), Tape, and Record Reproducing
		334613	• Magnetic and Optical Recording Media Mfg.
	4234	423410	• Photographic Equipment and Supplies Merchant Wholesalers
		423420	• Office Equipment Merchant Wholesalers
		423430	• Computer and Computer Peripheral Equipment and Software Merchant Wholesalers
		423440	• Other Commercial Equipment Merchant Wholesalers
		423450	• Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
		423460	• Ophthalmic Goods Merchant Wholesalers
		423490	• Other Professional Equipment and Supplies Merchant Wholesalers
	5416	541611	• Administrative Management and General Management Consulting Services
		541612	• Human Resources and Executive Search Consulting Services
		541613	• Marketing Consulting Services
		541614	• Process, Physical Distribution, and Logistics Consulting Services
		541618	• Other Management Consulting Services
		541620	• Environmental Consulting Services
		541690	• Other Scientific and Technical Consulting Services
Level 3	*Occupations for which technology oriented employment was at least 2.0 to 2.9 times the average for all industries*		
	3241	324110	• Petroleum Refineries
		324121	• Asphalt Paving Mixture and Block Mfg.
		324122	• Asphalt Shingle and Coating Materials Mfg.
		324191	• Petroleum Lubricating Oil and Grease Mfg.

Table B1 Continues

Table B1 Continues Here

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*

Hecker's Level	4-Digit NAICS Codes	6-Digit NAICS Codes	Definition of NAICS Code
		324199	• All Other Petroleum and Coal Products Mfg.
	3253	325311	• Nitrogenous Fertilizer Mfg.
		325312	• Phosphatic Fertilizer Mfg.
		325314	• Fertilizer (Mixing Only) Mfg.
		325320	• Pesticide and Other Agricultural Chemical Mfg.
	3255	325510	• Paint and Coating Mfg.
		325520	• Adhesive Mfg.
	3259	325910	• Printing Ink Mfg.
		325920	• Explosives Mfg.
		325991	• Custom Compounding of Purchased Resins
		325992	• Photographic Film, Paper, Plate, and Chemical Mfg.
		325998	• All Other Miscellaneous Chemical Product and Preparation Mfg.
	3336	333611	• Turbine and Turbine Generator Set Units Mfg.
		333612	• Speed Changer, Industrial High-Speed Drive, and Gear Mfg.
		333613	• Mechanical Power Transmission Equipment Mfg.
		333618	• Other Engine Equipment Mfg.
	3339	333911	• Pump and Pumping Equipment Mfg.
		333912	• Air and Gas Compressor Mfg.
		333913	• Measuring and Dispensing Pump Mfg.
		333921	• Elevator and Moving Stairway Mfg.
		333922	• Conveyor and Conveying Equipment Mfg.
		333923	• Overhead Traveling Crane, Hoist, and Monorail System Mfg.
		333924	• Industrial Truck, Tractor, Trailer, and Stacker Machinery Mfg.
		333991	• Power-Driven Handtool Mfg.
		333992	• Welding and Soldering Equipment Mfg.
		333993	• Packaging Machinery Mfg.

Table B1 Continues

Table B1 Continues Here

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*

Hecker's Level	4-Digit NAICS Codes	6-Digit NAICS Codes	Definition of NAICS Code
		333994	• Industrial Process Furnace and Oven Mfg.
		333995	• Fluid Power Cylinder and Actuator Mfg.
		333996	• Fluid Power Pump and Motor Mfg.
		333997	• Scale and Balance (except Laboratory) Mfg.
		333999	• All Other Miscellaneous General Purpose Machinery Mfg.
	3353	335311	• Power, Distribution, and Specialty Transformer Mfg.
		335312	• Motor and Generator Mfg.
		335313	• Switchgear and Switchboard Apparatus Mfg.
		335314	• Relay and Industrial Control Mfg.
	3369	336991	• Motorcycle, Bicycle, and Parts Mfg.
		336992	• Military Armored Vehicle, Tank, and Tank Component Mfg.
		336999	• All Other Transportation Equipment Mfg.
	4861	486110	• Pipeline Transportation of Crude Oil
	4862	486210	• Pipeline Transportation of Natural Gas
	4869	486910	• Pipeline Transportation of Refined Petroleum Products
		486990	• All Other Pipeline Transportation
	5171	517110	• Wired Telecommunications Carriers
	5172	517211	• Paging
		517212	• Cellular and Other Wireless Telecommunications
	5173	517310	• Telecommunications Resellers
	5174	517410	• Satellite Telecommunications
	5211	521110	• Monetary Authorities - Central Bank
	5232	523210	• Securities and Commodity Exchanges
	5511	551111	• Offices of Bank Holding Companies
		551112	• Offices of Other Holding Companies
		551114	• Corporate, Subsidiary, and Regional Managing Offices

Table B1 Continues

Table B1 Continues Here

Table B1. 6-Digit NAICS Codes that Correspond to Hecker's 4-Digit NAICS Code Definition of the *High Technology Industry*			
Hecker's Level	**4-Digit NAICS Codes**	**6-Digit NAICS Codes**	**Definition of NAICS Code**
	5612	561210	• Facilities Support Services
	8112	811211	• Consumer Electronics Repair and Maintenance
		811212	• Computer and Office Machine Repair and Maintenance
		811213	• Communication Equipment Repair and Maintenance
		811219	• Other Electronic and Precision Equipment Repair and Maintenance

APPENDIX C

The Charlottesville MSA's *High-Technology Industry* compared with other Industry Sectors in the MSA

Table C1. The Charlottesville MSA's *High-Technology Industry* compared with other Industry Sectors in the MSA*

(Dollar Values in 2006 Dollars)

NAICS Sector Code	NAICS Sector Name	Employment Level (Jobs)	Total Annual Wages & Salaries (Millions of $)	Average Annual Wages & Salaries per Employee
11	Agriculture, Forestry, Fishing and Hunting	822	$18.6 m	$22,600
21	Mining, Quarrying, and Oil and Gas Extraction	121	$5.7 m	$46,900
22	Utilities	445	$52.4 m	$117,700
23	Construction	6,834	$249.1 m	$36,500
31 – 33	Manufacturing	4,409	$209.1 m	$47,400
42	Wholesale Trade	1,544	$72.3 m	$46,800
44 – 45	Retail Trade	10,956	$267.8 m	$24,400
48 – 49	Transportation and Warehousing	1,877	$71.6 m	$38,200
51	Information	2,364	$129.4 m	$54,800
52	Finance and Insurance	2,219	$146.4 m	$66,000
53	Real Estate and Rental and Leasing	1,536	$54.3 m	$35,400
54	Professional, Scientific, and Technical Svcs.	6,002	$330.8 m	$55,100
55	Management of Companies and Enterprises	1,821	$105.3 m	$57,800
56	Administrative and Support and Waste Management and Remediation Services	3,184	$79.3 m	$24,900
61	Educational Services	17,809	$794.6 m	$44,600
62	Health Care and Social Assistance	15,001	$661.5 m	$44,100
71	Arts, Entertainment, and Recreation	1,755	$43.5 m	$24,800
72	Accommodation and Food Services	9,236	$140.7 m	$15,200
81	Other Services (except Public Admin.)	3,598	$114.5 m	$31,800
92	Public Administration	3,628	$169.2 m	$46,600
	Total 2-digit NAICS codes	***95,161***	***$3,716.1 m***	***$39,100***
	High-Technology Industry	***11,691***	***$765.0 m***	***$65,400***

* The *High-Technology Industry* is not exclusive of the other industry sectors. That is, it includes NAICS codes that are also included in the other key industry sectors shown here.

APPENDIX D

Localities Comprising Virginia's Metropolitan Statistical Area (MSA) Regions

Appendix D. Localities Comprising Virginia's Metropolitan Statistical Area (MSA) Regions

Localities from the June 2003 Definitions, along with Locality Code Numbers

Blacksburg-Christiansburg-Radford, VA *

- Giles County * 51071
- Montgomery County * 51121
- Pulaski County * 51155
- Radford City * 51750

Charlottesville, VA

- Albemarle County 51003
- Fluvanna County 51065
- Greene County 51079
- Nelson County * 51125
- Charlottesville City 51540

Danville, VA

- Pittsylvania County 51143
- Danville City 51590

Harrisonburg, VA *

- Rockingham County * 51165
- Harrisonburg City * 51660

Kingsport-Bristol-Bristol, TN-VA *

Virginia Portion

- Scott County 51169
- Washington County 51191
- Bristol City 51520

Lynchburg, VA

- Amherst County 51009
- Appomattox County * 51011
- Bedford County 51019
- Campbell County 51031
- Bedford City 51515
- Lynchburg City 51680

Richmond, VA

- Amelia County * 51007
- Caroline County * 51033
- Charles City County 51036
- Chesterfield County 51041
- Cumberland County * 51049
- Dinwiddie County 51053
- Goochland County 51075
- Hanover County 51085
- Henrico County 51087
- King and Queen County * 51097
- King William County * 51101
- Louisa County * 51109
- New Kent County 51127
- Powhatan County 51145
- Prince George County 51149
- Sussex County * 51183
- Colonial Heights City 51570
- Hopewell City 51670
- Petersburg City 51730
- Richmond City 51760

Roanoke, VA

- Botetourt County 51023
- Craig County * 51045
- Franklin County * 51067
- Roanoke County 51161
- Roanoke City 51770
- Salem City 51775

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***** New for June 2003 MSA Definitions

Virginia Beach-Norfolk-Newport News, VA-NC
Virginia Portion

"Hampton Roads Area"

- Gloucester County 51073
- Isle of Wight County 51093
- James City County 51095
- Mathews County 51115
- Surry County * 51181
- York County 51199
- Chesapeake City 51550
- Hampton City 51650
- Newport News City 51700
- Norfolk City 51710
- Poquoson City 51735
- Portsmouth City 51740
- Suffolk City 51800
- Virginia Beach City 51810
- Williamsburg City 51830

Washington-Arlington-Alexandria, DC-VA-MD-WV
Virginia Portion

"Northern Virginia Area"

- Arlington County 51013
- Clarke County 51043
- Fairfax County 51059
- Fauquier County 51061
- Loudoun County 51107
- Prince William County 51153
- Spotsylvania County 51177
- Stafford County 51179
- Warren County 51187
- Alexandria City 51510
- Fairfax City 51600
- Falls Church City 51610
- Fredericksburg City 51630
- Manassas City 51683
- Manassas Park City 51685

Winchester, VA-WV *
Virginia Portion

- Frederick County * 51069
- Winchester City * 51840

***** New for June 2003 MSA Definitions