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The NASA Glenn Research Center:

An Economic Impact Study Fiscal Year 2006

CENTER FOR ECONOMIC DEVELOPMENT

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EXECUTIVE SUMMARY

- The John H. Glenn Research Center at Lewis Field (Glenn) is one of 10 National Aeronautics and Space Administration (NASA) Centers. Glenn is situated on 350 acres adjacent to Cleveland Hopkins International Airport. Its physical plant includes more than 150 buildings that contain a unique collection of world-class test facilities. Glenn also includes the 6,400-acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. It specializes in large-scale tests that would be hazardous within the confines of the main campus.
- NASA Glenn is focusing on efforts related to developing the new hardware required for space exploration systems. Glenn has several vital roles and responsibilities within the Constellation Program, the centerpiece of NASA's exploration mission. Glenn leads NASA research and development in the area of aeropropulsion, powering flight through the atmosphere and beyond. Glenn is also supporting the Aviation Safety Program and the Aeronautics Test Program. It has been assigned lead responsibility for integrating Agency technology efforts in space communication and navigation as a precursor to assuming Agency management responsibility. NASA Glenn has also been selected to manage the In-Space Propulsion Program for the Science Mission Directorate and plays an active role in their technology portfolio for advanced power systems.
- This report has two major sections. The first section is an overview of Glenn including information related to employment and occupations, employee residence, payroll, expenditures, awards to academia and other institutions, revenues, and taxes paid by NASA Glenn employees. The second section provides estimates of the economic impact generated by NASA Glenn on an eight-county Northeast Ohio region and the state of Ohio during FY 2006. The report is an update of earlier studies (published in May 2000 and December 2005) in which Glenn's FY 1998 and FY 2004 economic impacts on Northeast Ohio and the state of Ohio were estimated.

ECONOMIC IMPACT GENERATED BY GLENN RESEARCH CENTER SPENDING

- Economic impact is an analytical approach used to estimate economic benefits generated by an entity on an affected region. It uses an input/output (I/O) model to estimate the effect of NASA Glenn spending on the studied economies. This model measures economic impact in terms of growth in output (sales), the number of new jobs created, and the increase in household earnings. The table below summarizes Glenn's economic impact on Northeast Ohio and the state of Ohio during FY 2006.

IMPACT	NORTHEAST OHIO	STATE OF OHIO
Output	$955.0 Million	$1.1 Billion
Employment	6,046 Jobs	7,360 Jobs
Household Earnings	$305.2 Million	$365.2 Million

- NASA Glenn activities in Northeast Ohio in FY 2006, stimulated by $720 million in revenues primarily from outside the region, generated an increased demand in output (sales) for products and services used in Northeast Ohio that were valued at $955 million. In addition, 6,046 jobs were created in the region, and households in Northeast Ohio saw their earnings increase by $305.2 million.
- Glenn activities in Ohio in FY 2006, stimulated by $720 million in revenues primarily from outside the state, generated an increased demand in output (sales) for products and services used across the state that were valued at $1.1 billion. In addition, 7,360 jobs were created in Ohio and households across the state saw their earnings increase by $365.2 million.
- Industries deriving the most benefit from direct NASA Glenn spending include scientific research and development services, other professional and technical services, colleges and universities, data processing, power generation, facilities support, and construction.
- Businesses deriving the most benefit from spending by Glenn personnel and other workers whose earnings are due, in part, to Glenn expenditures, follow typical consumer spending patterns. These include real estate companies, telecommunications, law firms, accounting firms, commercial banks, and restaurants.

GLENN RESEARCH CENTER: AN OVERVIEW

- Civil service employment at NASA Glenn declined slightly each year between 1998 and 2004 and then more substantially between 2004 and 2006. In FY 1998, Glenn reported 2,045 employees. By the end of FY 2004, the labor force had declined about five percent to 1,945 workers; by FY 2006 Glenn employed 1,678 civil service workers. These figures do not include employees who work for NASA Glenn's local prime contractors. The number of on- or near-site contractors was approximately 1,800 in 2005 and 1,450 in 2006.
- Total compensation for NASA Glenn's civil service employees was $187.1 million in FY 2006. Of this amount, payroll accounted for $151.4 million while employee benefits accounted for another $35.7 million. Glenn employees experienced a total payroll increase of $19.8 million (15%) between 1998 and 2006 (in nominal terms). During this same time period, civil service employment decreased from 2,045 to 1,678 workers. As a result, the average wage per Glenn employee increased from $64,350 in FY 1998 to $90,225 in FY 2006, a rise of 40.2 percent. Accounting for inflation, in real dollars, the average employee wage rose by 17.2 percent or about two percent per year. In 2006, Glenn employees paid more than $9 million in state and local taxes.
- Total Glenn expenditures, excluding monies allocated for payroll and benefits, were $436.4 million in FY 2006. Glenn spending in FY 2006 was approximately 15 percent lower than in FY 1998 and FY 2004 (in nominal dollars). The expenditure share for Northeast Ohio and the state of Ohio increased significantly between 1998 and 2004, but there was little change between 2004 and 2006. During FY 1998, Glenn distributed 32.9 percent of its total spending to Northeast Ohio vendors. This spending share increased to 45.4 percent in FY 2004; in FY 2006, the share was 45.6 percent ($198.9 million). Likewise, the spending share across the state of Ohio increased from 47.3 percent in FY 1998 to 64.2 percent in FY 2004; in FY 2006, the share was 60.9 percent ($266.0 million).
- In FY 2006, Glenn received $669.6 million in revenues from NASA. This amount represents 93 percent of its total income. Glenn revenues remained nearly stable (in nominal dollars) between FY 1998 and FY 2006. During the interim period, NASA Glenn saw its revenues decline in 1999 and 2000 and then began to increase, reaching a peak of $821.3 million in FY 2003.

A. INTRODUCTION

In this report, we describe the economic impact of the National Aeronautics and Space Administration's (NASA) Glenn Research Center (Glenn) on the eight-county Northeast Ohio region and the state of Ohio during FY 2006.[1] The report also provides some background information related to NASA Glenn's R&D activities and an overview of Glenn. The analysis was conducted by the Center for Economic Development at Cleveland State University's Maxine Goodman Levin College of Urban Affairs.

This report is an update to previous studies (published in May 2000 and December 2005), which estimated Glenn's FY 1998 and FY 2004 economic impact on Northeast Ohio and the state of Ohio.[2] Economic impact is an analytical approach used to estimate economic benefits generated by an entity on an affected region. It uses an input/output (I/O) model to estimate the effect of Glenn spending on the studied economies. This model measures economic impact in terms of growth in total output (sales), household earnings, and the number of new jobs created.

[1] For purposes of this study, Northeast Ohio is limited to the Akron and Cleveland metropolitan areas, which include Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit Counties.

[2] Austrian, Z. & Wolf, A. (2000). *The NASA Glenn Research Center: An Economic Impact Study*. Cleveland State University, Center for Economic Development.
Sadowski, B. (2005). *The NASA Glenn Research Center: An Economic Impact Study, Fiscal Year 2004*. Cleveland State University, Center for Economic Development.

B. NASA GLENN RESEARCH CENTER: BACKGROUND

NASA's mission is to pioneer the future in space exploration, scientific discovery, and aeronautics research. As one of NASA's 10 field centers, the John H. Glenn Research Center at Lewis Field (Glenn) affects many unique contributions that fulfill NASA's vision and enable its mission. Glenn's mission is to work as a diverse team in partnership with government, industry, and academia to increase national wealth, safety, and security, protect the environment, and explore the universe. NASA Glenn develops and transfers critical technologies that address national priorities through research, technology development, and systems development for safe and reliable aeronautics, aerospace, and space applications.

B.1 NASA GLENN TEST FACILITIES

NASA Glenn is located at Lewis Field, a 350-acre site adjacent to Cleveland Hopkins International Airport. Glenn's physical plant includes more than 150 buildings that contain a unique collection of world-class test facilities. Since the groundbreaking for the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics (forerunner to NASA) on January 23, 1941, more than $433 million has been invested in Glenn's physical plant. The estimated replacement cost is approximately $1.6 billion.

NASA Glenn also includes the 6,400-acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. It specializes in large-scale tests that would be hazardous within the confines of the main campus. Plum Brook contains the world's largest space environment simulation chamber (100 feet in diameter by 122 feet high). Its large size made it ideal for testing full-size Mars lander systems and International Space Station hardware. This facility will undergo a $60-million expansion to add spacecraft vibration and acoustic test capability and will then be used to conduct integrated, system-level testing of the new Orion Crew Exploration Vehicle, simulating conditions from launch through insertion into orbit. The total replacement cost of all Plum Brook facilities is approximately $651 million.

B.2 GLENN MISSION AREAS SUPPORTING NASA THEMES

As NASA moves forward to fulfill the *Vision for Space Exploration*,[3] Glenn is focusing on efforts related to developing the new hardware required for exploration systems. Glenn has several vital roles and responsibilities within the Constellation Program, the centerpiece of NASA's exploration mission. NASA Glenn is building the simulated upper stage for the first Ares launch vehicle test flight that will be launched in 2009. NASA Glenn also is designing several subsystems for the Ares upper stage including the thrust vector control, electrical power system, and development flight instrumentation. NASA Glenn is responsible for the management and oversight of the Service Module, which will provide propulsion, power, and communications for the Crew Module in orbit. NASA Glenn is also leading development of selected Orion subsystems such as electrical power. At NASA Glenn's Plum Brook Station, preparations are underway to conduct major Orion integrated, system-level environmental testing in the Space Power Facility.

Glenn leads NASA research and development in the area of aeropropulsion, powering flight through the atmosphere and beyond. Glenn is contributing its expertise in materials, structures, internal fluid mechanics, instrumentation and controls, interdisciplinary technologies, and aircraft icing research to support the goals of the Fundamental Aeronautics Program, which has a renewed focus on mastering the fundamentals of flight at subsonic, supersonic, and hypersonics speeds.

Glenn is also supporting the Aviation Safety Program and the Aeronautics Test Program, a key part of the Agency-level Shared Capabilities Asset Program, which is dedicated to preserving NASA's aeronautics facilities as critical assets to the Agency and the nation. The Glenn Icing Research Tunnel, the 9x15 foot subsonic tunnel, the Propulsion Systems Lab, and the 10x10 foot supersonic tunnel are all considered critical assets under this program, as are the Space Power Facility and the B-2 Rocket Propulsion Test Facility at Plum Brook.

Glenn has been assigned lead responsibility for integrating Agency technology efforts in space communication and navigation as a precursor to assuming Agency management responsibility. Specific technology topics include Software Defined Radio, Spacecraft Antenna Technology, Spectrum Efficient Technology, Radio Frequency amplifiers, and select technology demonstration flights on the International Space Station. NASA Glenn will also be the lead for

[3] *A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration* is a directive for the U.S.'s space exploration program as announced by President Bush on January 14, 2004. The fundamental goal is to advance U.S. scientific, security, and economic interests through a robust space exploration program.

integrating NASA's space communication technology efforts within the Agency's Small Business Innovation Research Program.

Finally, NASA Glenn has been selected to manage the In-Space Propulsion Program for the Science Mission Directorate and plays an active role in their technology portfolio for advanced power systems. This selection typifies Glenn's willingness to use the Center's talented workforce to contribute to NASA-wide needs.

C. NASA GLENN RESEARCH CENTER: AN OVERVIEW

In this section, we present a brief overview of the NASA Glenn Research Center (Glenn) for fiscal year (FY) 2006. Topics discussed include employment and occupations, place of residence, payroll, expenditures, awards to academia and other institutions, revenues, and taxes paid by Glenn employees. Where data is available, we present a comparison between FY 2006 and earlier years.

C.1 EMPLOYMENT AND OCCUPATIONS

The NASA Glenn labor force has two components: civil service employees and local contractors. This dual approach is common to federal labs because contract employees provide the necessary labor force flexibility. The number of contract employees can easily be adjusted according to the needs of the research lab, while hiring of civil servants is more complex and permanent.

Civil service employment at NASA Glenn declined slightly each year between 1998 and 2004 and then more substantially between 2004 and 2006. In FY 1998, Glenn reported 2,045 employees. By the end of FY 2004, the labor force had declined about five percent to 1,945 workers; by FY 2006 Glenn employed 1,678 civil service workers.[4] These figures do not include employees who work for NASA Glenn's local prime contractors.[5] The number of on- or near-site contractors was approximately 1,450 in 2006 and 1,800 in 2005.

Glenn's civil servant labor force is highly skilled and highly educated. In FY 2006, almost 50 percent of NASA employees possessed a graduate degree. More specifically, 15 percent of NASA Glenn's civil servants held a doctoral degree, 34 percent had a master's degree, and an additional 24 percent had a bachelor's degree. Consequently, any major Glenn staff reduction might contribute to a "brain drain" from Northeast Ohio.

Civil service employees at Glenn are categorized into five occupational groups: administrative professional, clerical, scientists and engineers, technicians, and trades. Table 1 shows the changing occupational mix at Glenn between FY 1998 and FY 2006.

[4] In FY 2005, Glenn lost an estimated 150 civil servants and 340 contractors according to *Crain's Cleveland Business*: Pettypiece, S. (2005, September 26-October2). Whitlow tagged to tackle challenges at NASA Glenn. *Crain's Cleveland Business*, p.6. These losses are due to NASA refocusing its mission to send humans to the moon and Mars.

[5] For a detailed listing of Glenn's local contractors, go to http://www.grc.nasa.gov/WWW/Procure/ContractorList/On-siteServiceContractorListing.htm

Table 1. Glenn Civil Service Employment Distribution by Occupational Category

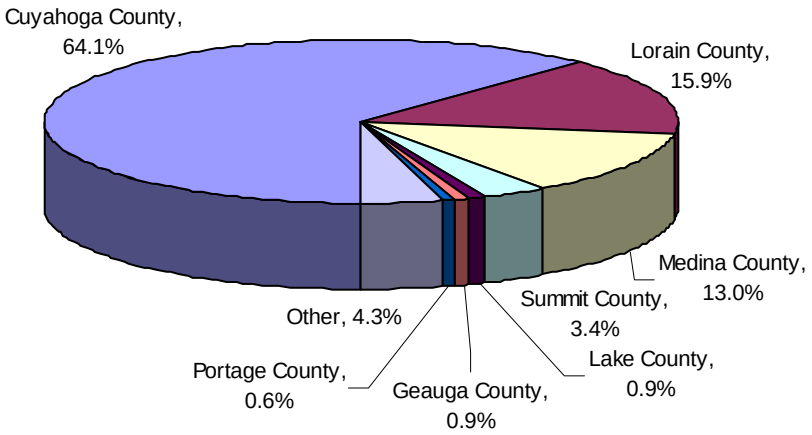
Fiscal Year	Total Employment	Administrative Professional	Clerical	Scientists & Engineers	Technicians	Trades
1998	2,045	14.5%	6.2%	56.1%	12.9%	10.3%
1999	2,021	15.1%	6.3%	55.9%	12.8%	9.9%
2000	1,982	15.5%	6.0%	56.5%	13.5%	8.6%
2001	1,967	15.6%	6.1%	55.8%	21.9%	0.6%
2002	1,955	19.4%	6.2%	55.9%	18.1%	0.4%
2003	1,948	20.0%	6.1%	56.5%	17.4%	0.1%
2004	1,945	20.2%	6.0%	57.2%	16.6%	0.1%
2005	1,769	20.6%	5.5%	58.3%	15.4%	0.1%
2006	1,678	20.9%	5.2%	59.5%	14.4%	0.0%

Scientists and engineers are the largest occupational category at NASA Glenn, accounting for an average of 56.9 percent of civil service employment between 1998 and 2006. The share of scientists and engineers relative to total employment has increased gradually from 1998 through 2006. However, due to Glenn's declining labor force, there were 149 fewer scientists and engineers in 2006 than in 1998. Administrative professionals reported an increased employment share of more than six percentage points between 1998 and 2006 (resulting in about additional 50 workers). There was little variation in the number of clerical workers between 1998 and 2004, but they felt the impact of job cuts between 2004 and 2006 (the number of clerical workers declined from 117 in 2004 to 87 in 2006). Technicians saw their share increase slightly between 1998 and 2006, but the number of workers in this category declined from 264 to 242 (there was substantial variation within the period of time). Persons working in the trades saw their employment share decrease from 10 percent in 1998 to zero in 2006.

C.2 Place of Residence for Glenn Employees

The vast majority of NASA Glenn's civil servants (97%) live in Northeast Ohio. The majority live in Cuyahoga County (64.1%) but a significant number also live in Lorain (15.9%) and Medina Counties (13.0%). The Akron metropolitan area is the place of residence for four percent of the Glenn workforce (Figure 1).

Figure 1. Glenn Civil Service Employees by County of Residence, 2006



As expected, the majority of Glenn employees, regardless of occupation, live in Cuyahoga County. Likewise, Lorain and Medina Counties have the second and third highest residential share, respectively, for each occupational category (Table 2). Results were similar in FY 2004.

Table 2. Glenn Civil Service Employees by Occupation and Place of Residence

Residence	Administrative Professional	Clerical	Scientists & Engineers	Technician & Trades	Total
Northeast Ohio	97.1%	96.9%	96.2%	99.5%	96.8%
Cuyahoga County	62.8%	65.1%	66.9%	53.0%	64.1%
Lorain County	17.8%	25.4%	13.4%	21.4%	15.9%
Medina County	12.6%	4.8%	12.7%	17.7%	13.0%
Summit County	4.9%	0.0%	3.5%	1.9%	3.4%
Lake County	0.8%	1.6%	0.8%	1.4%	0.9%
Geauga County	0.0%	1.6%	1.1%	1.4%	0.9%
Portage County	0.0%	0.0%	0.6%	1.4%	0.6%
Stark County	0.3%	0.0%	0.5%	0.9%	0.5%
Other NE Ohio	0.8%	1.6%	0.4%	0.9%	0.6%
Other Ohio	2.4%	3.2%	1.9%	0.5%	1.8%
Out of State	0.5%	0.0%	2.0%	0.0%	1.3%

C.3 PAYROLL

Total compensation for NASA Glenn's civil service employees was $187.1 million in FY 2006. Of this amount, payroll accounted for $151.4 million while employee benefits accounted for another $35.7 million. Glenn employees experienced a total payroll increase of $19.8 million (15%) between 1998 and 2006 (in nominal terms). During this same time period, civil service employment decreased from 2,045 to 1,678 workers. As a result, the average wage per Glenn employee increased from $64,350 in FY 1998 to $90,225 in FY 2006, a rise of 40.2 percent. Accounting for inflation, in real dollars, the average employee wage rose by 17.2 percent or about two percent per year.

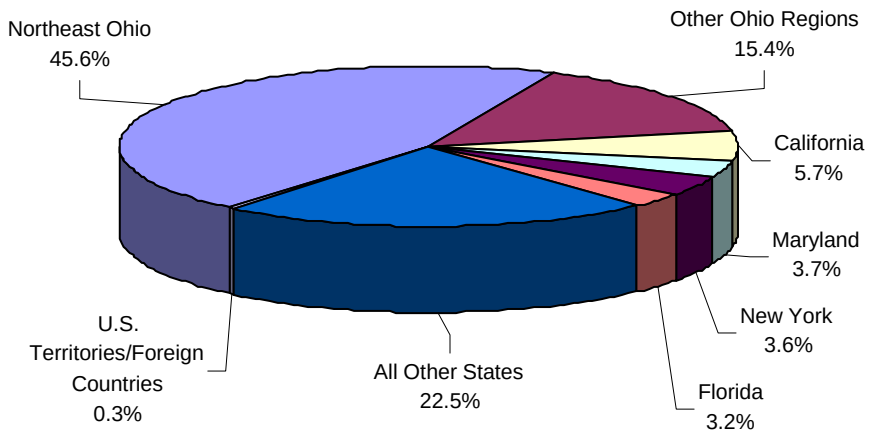
C.4 GLENN EXPENDITURES, FY 2006

NASA Glenn expenditures extend far beyond the state of Ohio. In fact, vendors in 48 states (including Ohio) and several foreign countries were beneficiaries of Glenn spending. Expenditures generally fall within one of the following classifications: equipment, supplies and materials, grants, R&D contracts, and advisory services. Total Glenn expenditures, excluding monies allocated for payroll and benefits, were $436.4 million in FY 2006. Glenn spending in FY 2006 was approximately 15 percent lower than in FY 1998 and FY 2004.[6] The expenditure share for Northeast Ohio and the state of Ohio vendors increased significantly between 1998 and 2004, but there was little change between 2004 and 2006. During FY 1998, Glenn distributed 32.9 percent of its total spending to Northeast Ohio vendors. This spending share increased to 45.4 percent in FY 2004; in FY 2006, the share was 45.6 percent ($198.9 million). Likewise, the spending share across the state of Ohio increased from 47.3 percent in FY 1998 to 64.2 percent in FY 2004; in FY 2006, the share was 60.9 percent ($266.0 million). The share of expenditures accounted for by Northeast Ohio and Ohio have a strong influence on economic impact in both the region and the state since the greater the amount of money Glenn spends locally, the greater the impact on local economies.

Four states other than Ohio received more than $10 million in expenditures from NASA Glenn during FY 2006, including California, Maryland, New York, and Florida. Figure 2 shows Glenn spending in select states. Table A.1 in Appendix A lists NASA Glenn spending by state for FY 2006.

[6] NASA expenditures totaled $514 million in 1998 and $511.9 million in 2004; spending comparisons are in nominal dollars, that is, 1998 and 2004 dollars have not been inflated to 2006 levels.

Figure 2. NASA Glenn Spending in Select States, FY 2006



Total Expenditures: $436.4 million

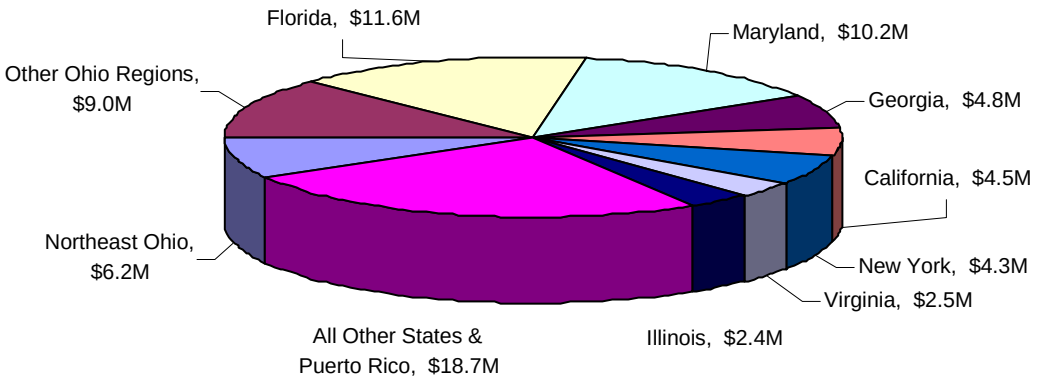
C.5 Glenn Awards to Academia and Other Institutions

In support of its own mission, NASA Glenn provides funding for research and other educational activities to colleges, universities, and other nonprofit institutions around the country. This funding is primarily in the form of R&D contracts and grants. In FY 2006, total funding allocated to academia and other nonprofits across the U.S. and Puerto Rico was $96.4 million, slightly less than in FY 2004 (a 5% decrease in nominal dollars).[7] Colleges and universities received $74.2 million, or 77 percent of the $96.4 million.

Of all 50 states, Ohio received the largest share of funding awarded to colleges and universities—$15.2 million (20.5% of the total). Academic institutions in Northeast Ohio received $6.2 million (41%) of this amount. Colleges and universities in 13 other states and Puerto Rico received more than $1 million from NASA Glenn during FY 2006. Figure 3 shows the distribution of monies awarded to educational institutions in select states. Table A.2, Appendix A, provides a complete listing of NASA Glenn awards to colleges and universities by state.

[7] The $96.4 million is included in Glenn's total spending of $436.4 million in FY 2006.

Figure 3. NASA Glenn Awards to Colleges and Universities, FY 2006



Total Academic Awards: $74.2M

Table 3 shows Glenn awards to colleges and universities in the state of Ohio for FY 1998, FY 2004, and FY 2006 (if applicable). Four universities received more than $2 million each in FY 2006: the University of Toledo ($4.7 million), The Ohio State University ($3.5 million), Case Western Reserve University ($3.1 million), and Cleveland State University ($2.2 million). The University of Akron received grants totaling approximately $800,000. Combined, these five universities received 95 percent of the monies allocated by NASA Glenn to academic institutions across the state of Ohio.

Table 3. Glenn Educational Grants in Ohio by Academic Institution, FY 1998, FY 2004, FY2006

OHIO COLLEGES & UNIVERSITIES	FY 1998	FY 2004	FY 2006	2006 SHARE
University of Toledo	$1,165,382	$3,217,582	$4,718,151	31.1%
Ohio State University	$918,165	$4,238,483	$3,536,141	23.3%
Case Western Reserve University	$3,211,270	$3,384,290	$3,095,665	20.4%
Cleveland State University	$2,089,788	$3,693,230	$2,246,489	14.8%
University of Akron	$1,227,429	$1,403,576	$797,122	5.3%
Bowling Green State University	n/a	$384,728	$285,612	1.9%
University of Dayton	n/a	$2,798	$151,847	1.0%
Ohio University	n/a	$225	$114,875	0.8%
Wright State University	n/a	$53,599	$78,029	0.5%
University of Cincinnati	$201,022	$224,511	$74,045	0.5%
Cuyahoga Community College	$765,290	$32,305	$36,382	0.2%
Baldwin Wallace College	n/a	$77,835	$19,687	0.1%
Kent State University	$198,294	$138,687	$12,177	0.1%
Myers University	n/a	$19,431	$6,401	0.04%
Lorain County Community College	n/a	$2,517	$1,174	0.01%
Malone College	n/a	n/a	$640	0.004%
Capital University	n/a	n/a	($80)	
Central State University	$148,442	$419,282	n/a	
John Carroll University	n/a	$35,385	n/a	
Oberlin College	n/a	$22,888	n/a	
Xavier University	n/a	$4,221	n/a	
Notre Dame College of Ohio	n/a	$1,215	n/a	
Youngstown State University	n/a	$749	n/a	
Ohio Northern University	n/a	$210	n/a	
TOTAL		**$17,357,746**	**$15,174,357**	

Other organizations in Ohio that received major grants from NASA Glenn in FY 2006 included the Ohio Aerospace Institute ($12.6 million), Battelle Memorial Institute ($2.6 million), the Cleveland Clinic Foundation ($496,000), Northeast Ohio Technology Coalition ($493,000), and Glennan Microsystems Initiative ($440,000).

C.6 GLENN REVENUES

Monies authorized by NASA accounted for more than 96 percent of Glenn's revenues for fiscal years 1998 through 2005. In FY 2006 other sources provided a slightly larger share of Glenn's revenues than in previous years and NASA authorized monies accounted for 93 percent of total revenues. Glenn revenues remained nearly stable (in nominal dollars) between FY 1998 and FY 2006 (they increased 1.2%). During the interim period, NASA Glenn revenues declined between 1999 and 2000 and then began to increase, reaching a peak of $821.3 million in FY 2003. Table 4 provides a detailed breakdown of Glenn revenues from FY 1998 through FY 2006. For example, in FY 2006, Glenn received $669.6 million in revenues from NASA. This amount represents 93 percent of its total income. An additional $50.2 million in revenues was received from the Department of Defense, other federal agencies, and other domestic, non-federal entities. NASA Glenn's total revenues during FY 2006 were $720 million.

Table 4. NASA Glenn Revenues, FY 1998 – FY 2006 (in millions $)

Revenue Source	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06
NASA Direct Authority	661.9	602.3	590.6	647.4	668.1	794.1	767.3	704.5	669.6
Reimbursable Commitments	37.0	25.2	18.9	16.1	26.4	27.2	27.7	25.3	50.2
Total FY Authority	698.9	627.5	609.5	663.5	694.5	821.3	795.0	729.8	719.8
Revenue from NASA	94.7%	96.0%	96.9%	97.6%	96.2%	96.7%	96.5%	96.5%	93.0%

For the full time period shown in Table 4, Glenn's revenue from sources other than NASA (reimbursable commitments) amounted to $254 million. The reimbursable commitments can be categorized as follows: domestic, non-federal entities (38%); Department of Defense (32%); other federal agencies, excluding Department of Defense (28%); and foreign agreements (2%).

C.7 TAXES PAID BY GLENN EMPLOYEES

Taxes paid by NASA Glenn employees to state and local governments are important to Ohio's economy. The amounts are determined by the number of civil service employees, their physical location on the Glenn campus, and their earnings. Most Glenn employees' workplaces are located in the city of Brook Park as a result of a land swap with the city of Cleveland in 2001.[8] Other facilities fall within the boundaries of the cities of Cleveland and Fairview Park.

The data shown in Table 5 represent taxes withheld from employee paychecks and sent directly to state and local governments. It does not include taxes paid directly by employees to local governments based on residence. From 2001 to 2006, state and local taxes increased by 12.7 percent (in nominal terms). During this period of time, the state of Ohio received $37.9 million in taxes from Glenn employees and local municipalities received $17.4 million. The slight decline in payroll tax revenue between 2004 and 2006 is due to a reduction in Glenn civil service employment during this period.

Table 5. Income Taxes Paid by Glenn Employees

	2001	2002	2003	2004	2005	2006
City of Brook Park	n/a	$2,546,501	$2,625,066	$2,968,106	$2,625,474	$2,600,094
City of Cleveland	$2,261,792	$93,441	$2,266	$1,486	$2,311	$2,433
City of Fairview Park	$271,014	$231,963	$236,884	$166,488	$336,740	$386,722
State of Ohio	$5,623,913	$6,204,138	$6,421,506	$6,811,979	$6,613,854	$6,205,963
Total	**$8,156,719**	**$9,076,043**	**$9,285,722**	**$9,948,059**	**$9,578,379**	**$9,195,211**

[8] In March 2001, Cleveland and Brook Park completed a land swap deal. Under the agreement, 135 acres — including the IX Center and other development parcels in Brook Park — moved into Cleveland's boundaries to be used for airport expansion. In return, Brook Park received portions of NASA Glenn property that were in Cleveland and are worth more than $2 million in annual tax revenue.

D. ECONOMIC IMPACT OF NASA GLENN SPENDING PATTERNS

This section discusses the economic impact of the NASA Glenn Research Center (Glenn) on Northeast Ohio and the state of Ohio in FY 2006.[9] Impact is measured in terms of output (sales), employment, and household earnings. For each of these categories, total economic impact is estimated as the sum of four components: change in final demand, direct impact, indirect impact, and induced impact. Glenn's total impact on the two studied economies (Northeast Ohio and the state of Ohio) is estimated separately.

D.1 METHODOLOGY

If we imagine that the Glenn Research Center came into existence in one day, we can assume that the investment it would bring to the Northeast Ohio or Ohio economy from outside the respective region would stimulate activity by creating a demand for goods and services. A value can be placed on this stimulus—known as the change in final demand—and it must be included in any estimate of Glenn's economic impact.[10] The effects of a change in final demand can then be traced throughout the Northeast Ohio or state economy using an input-output model that captures the buy-sell linkages among all industry sectors and the household sector.

In order for Glenn to engage in research and development, other goods and services are needed as intermediate inputs. This leads to the other components of economic impact—direct, indirect, and induced. Direct impact refers to the initial value of goods and services, including labor, purchased by Glenn within Northeast Ohio or the state of Ohio. These purchases are sometimes referred to as the first-round effect. Indirect impact measures the value of labor, capital, and other inputs of production needed to produce the goods and services required by Glenn (second-round and additional-round effects). Induced impact measures the change in spending by local households due to increased earnings by employees in local industries who produce goods and services for Glenn and its suppliers.

As stated earlier, economic impact analysis takes into account inter-industry relationships within an economy—that is, the buy-sell relationships among industries. These relationships largely determine how an economy responds to changes in economic activity. Input-output (I-O) models estimate inter-industry relationships in a county, region, state, or country by measuring the industrial distribution of inputs purchased and outputs sold by each

[9] For the purposes of this analysis, Northeast Ohio is limited to the Akron and Cleveland metropolitan areas and includes Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit Counties.

[10] Change in final demand is defined as the purchase of goods and services for final consumption—in this case by Glenn Research Center.

industry and the household sector. Thus, by using I-O models, it is possible to estimate how the impact of one dollar or one job ripples through the local economy, creating additional expenditures and jobs. The economic multiplier measures the ripple effect that an initial expenditure has on the local economy.[11] This study utilizes regional I-O multipliers from IMPLAN Professional.[12]

Two factors are taken into account when estimating economic impact: 1) purchases from companies located outside Northeast Ohio or the state of Ohio and 2) share of revenues received from local sources.

For this analysis, economic impact is generated only by Glenn purchases from companies located within Northeast Ohio or the state of Ohio. Therefore, when estimating the impact on Northeast Ohio, goods and services purchased from businesses and other entities located outside the eight-county region were excluded from the model. Likewise, when estimating the impact on the state of Ohio, goods and services purchased from businesses and other entities located outside the state were excluded from the model.

Before entering local (Northeast Ohio or the state of Ohio) expenditures into the IMPLAN model, the amounts must be discounted by the percentage of revenues that are received from local sources. If expenditures were not discounted by the percentage of revenues coming from local sources, sometimes referred to as “neutral monies,” then the economic impact values would simply reflect the redistribution of local funds. The objective of impact analysis is to estimate the effect of monies coming from outside the studied economy rather than the redistribution of monies already existing in that economy. Revenues coming from outside the local economy are sometimes referred to as “good money.” Since almost all Glenn revenues are derived from federal sources (97%),[13] discounting of expenditures due to local revenues was not necessary.

Figure 4 illustrates the process by which NASA Glenn impacts the local economy through its spending in the Akron and Cleveland metro areas. Through its attraction of federal dollars, Glenn creates new demand for goods and services (final demand change). Some of this demand is generated for goods and services provided by vendors outside the Akron-

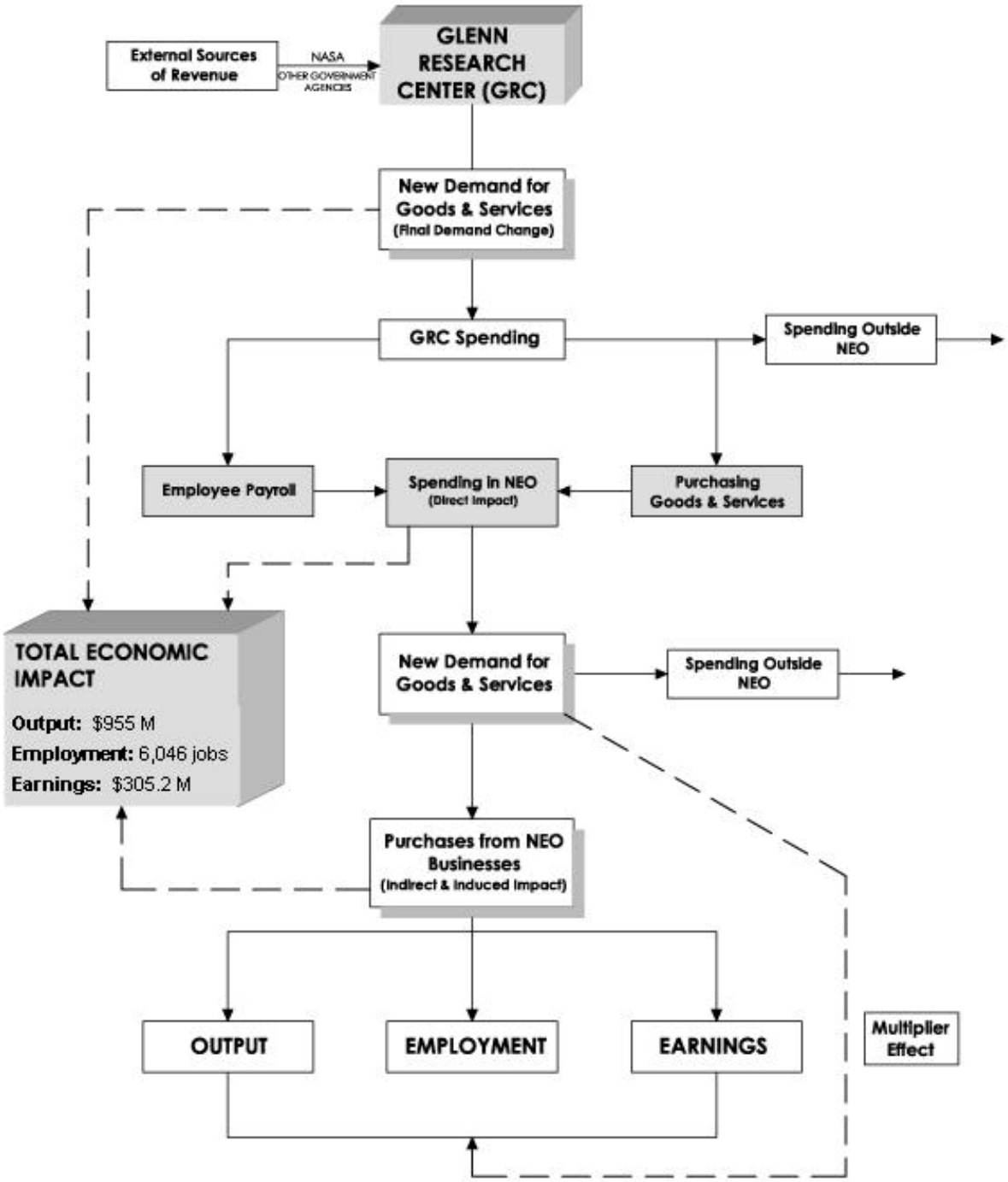
[11] For example, suppose that company XYZ reports sales of $1 million. From the revenues, the company pays its suppliers and workers, covers production costs, and takes a profit. Once the suppliers and employees receive their payments, they will spend a portion of their money in the local economy purchasing goods and services, while another portion of the monies will be spent outside the local economy (leakage). By evaluating the chain of local purchases that result from the initial infusion of $1 million, it is possible to estimate a regional economic multiplier.

[12] IMPLAN was originally developed by two federal agencies, the Department of Agriculture and the Department of the Interior, to assist in land and resource management planning. The model was later commercialized by the Minnesota IMPLAN Group, Inc.

[13] This includes revenue from NASA and other federal agencies.

Cleveland metro areas, resulting in dollars leaking from the local economy. However, many goods and services are purchased locally. Local spending by Glenn for goods, services, and labor is the direct impact. As these dollars move through the economy, they result in additional demand for goods and services, creating indirect and induced impact. The total economic impact of Glenn is equal to the sum of the change in final demand, direct, indirect, and induced impacts.

Figure 4. Glenn Research Center—Economic Impact on Northeast Ohio, FY 2006



D.2 ECONOMIC IMPACT ON NORTHEAST OHIO

In this section, we discuss the economic impact that NASA Glenn spending generated for the Northeast Ohio economy in FY 2006. More specifically, we present a detailed analysis of the change in output (sales), employment, and household earnings due to Glenn activities.

D.2.1 Output Impact on Northeast Ohio

This analysis uses multipliers to estimate the ripple effect that an initial expenditure has on a local economy.[14] These multipliers measure the effect of Glenn Research Center spending on output (sales) in Northeast Ohio. They provide a quantitative measure of the total change in output produced by Northeast Ohio industries for each additional final demand dollar expended by Glenn.

NASA Glenn expenditures were divided into spending for goods and services purchased from companies and other entities, such as universities, located in Northeast Ohio (local) and spending for goods and services from businesses and other entities located elsewhere. Local spending is then categorized by industry, based upon an IMPLAN industry classification system that is analogous to the North American Industry Classification System (NAICS). Table A.3 in the appendix provides a detailed Glenn expenditure list by specific industry.

Table 6 presents the total output impact and its components. Local Glenn expenditures represent direct output impact. Indirect impact is estimated by summing the contributions of individual industries that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact is estimated by measuring the spending of workers who are employed as a result of the demand for products and services created by Glenn. Total output impact is the sum of change in final demand, direct impact, indirect impact, and induced impact. Table 6 reports output impacts by industry sector. It shows how Glenn spending across Northeast Ohio affects all sectors of the economy.[15]

[14] IMPLAN type SAM multipliers are used in this study. SAM multipliers are based on information in a social account matrix that considers social security and income tax leakage, institution savings, commuting, and inter-institutional transfers.

[15] Households (Glenn employees' disposable income) are not shown as an industry sector in Table 6, although they are included as an industry in Table A.3. The reason for this is that IMPLAN automatically distributes these monies directly to the industries from which households typically make purchases. The industry sector that is the largest beneficiary of household spending is foreign and domestic trade ($42.0 million). This sector represents products that are purchased by households locally but are produced outside Northeast Ohio, either domestically or internationally.

Table 6. Output Impact Based on Glenn Spending in Northeast Ohio, FY 2006

NASA Glenn Expenditures in Northeast Ohio: $322,040,455

Industry	Direct	Indirect	Induced	Total
Utilities	$16,848,387	$1,745,588	$1,900,846	$20,494,819
Construction	$26,328,531	$2,135,131	$692,799	$29,156,460
Manufacturing	$5,502,489	$10,395,215	$8,254,481	$24,152,171
Transportation & Warehousing	$1,670,204	$4,604,612	$2,965,209	$9,240,021
Retail Trade	$11,511,147	$4,204,537	$13,001,479	$28,717,162
Information	$28,211,030	$7,442,513	$3,042,207	$38,695,749
Finance & Insurance	$5,768,564	$7,018,169	$9,264,394	$22,051,125
Real Estate, Rental, Leasing	$2,189,988	$12,030,538	$6,554,889	$20,775,414
Professional, Scientific, Technical Services	$107,289,691	$14,970,216	$4,160,836	$126,420,750
Administrative & Support Services	$19,906,266	$10,596,208	$2,286,829	$32,789,302
Educational Services	$8,358,158	$496,216	$1,893,980	$10,748,353
Health Care & Social Assistance	$18,228,948	$176,667	$17,843,502	$36,249,118
Arts, Entertainment, Recreation	$1,711,630	$507,522	$1,818,942	$4,038,095
Accommodation & Food Services	$5,777,504	$1,971,915	$6,548,389	$14,297,806
Other Services	$5,263,870	$3,212,666	$5,920,429	$14,396,965
Government Enterprises	$3,859,088	$955,979	$1,246,073	$6,061,140
Owner-occupied Dwellings	$15,848,292	$0	$15,016,868	$30,865,159
Foreign & Domestic Trade	$42,001,698	$0	$0	$42,001,698
Other [a]	$739,496	$4,456,580	$2,221,028	$7,417,105
Total	$327,014,969	$86,920,256	$104,633,171	$518,568,400

Change in Final Demand [b]	$436,428,532
Direct Impact	$327,014,969
Indirect Impact	$86,920,256
Induced Impact	$104,633,171
Total Output Impact	**$954,996,928**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.

[b] For output impact, the change in final demand equals spending by Glenn within and outside Northeast Ohio excluding payroll and healthcare benefits.

The total output impact across Northeast Ohio as a result of Glenn Research Center activities was $955 million. Glenn's expenditures of $322 million in Northeast Ohio resulted in a change in output (sales) of $518.6 million across all industry sectors (Table 6). For example, Glenn spending affected a $24 million increase in sales (direct, indirect and induced impacts) by all manufacturing-related industries.

Forty-six percent ($436.4 million) of the total output impact is accounted for by the change in final demand that occurs because Glenn activities bring resources into Northeast Ohio from outside the region. Approximately $327 million (34%) of the total output impact is a result of direct spending by Glenn for goods and services purchased within Northeast Ohio. The remaining output impact of $191.6 million (20%) is attributable to the indirect and induced components as Glenn spending ripples through the economy.

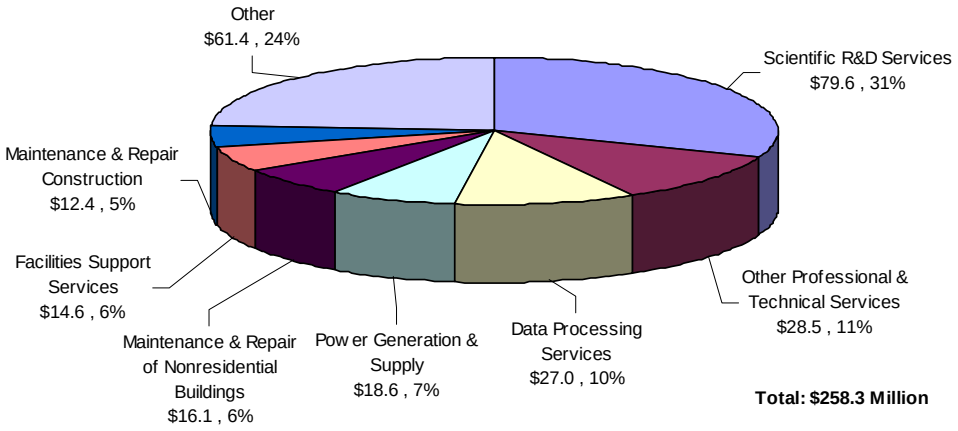
A detailed analysis of the IMPLAN model results indicates that the $518.6 million change in output (sales) generated by the direct, indirect, and induced impacts can be divided into three broad categories—Glenn-driven sectors, consumer-driven sectors, and other sectors. Glenn-driven sectors are those industry groups whose increased sales, employment, and earnings are attributed primarily but not exclusively to Glenn spending. They include utilities, construction, information, professional and scientific services, administrative and support services, and education. The total increase in output for these sectors in FY 2006 was $258.3 million.

Consumer-driven sectors are those industry groups whose increased sales, employment, and earnings are attributed primarily to spending by Glenn employees and other workers who produce goods and services for Glenn and their suppliers. They include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.[16] The total increase in output for these sectors in FY 2006 was $171.4 million.

Other sectors are those industry groups that are driven by both Glenn and consumer spending or whose impact is insignificant. They include manufacturing, government enterprises, agriculture, mining, wholesale trade, and transportation and warehousing. The output distribution for select industries within the Glenn-driven sectors is shown in Figure 5. The output distribution for select industries within the consumer-driven sectors is shown in Figure 6.

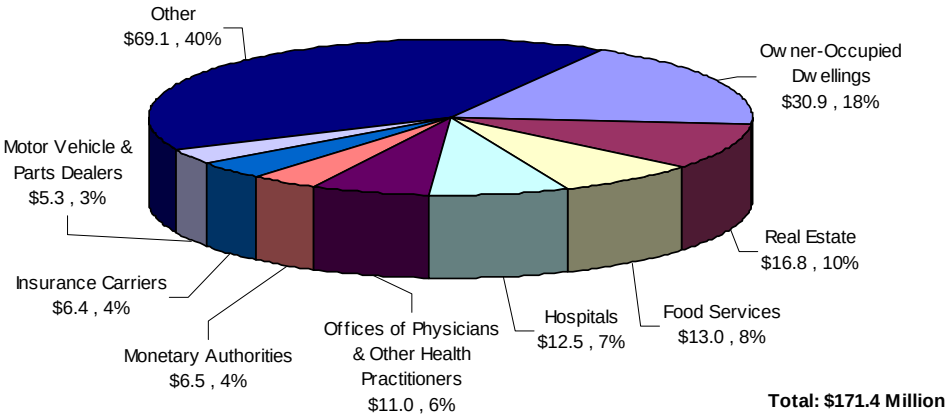
[16]Owner-occupied dwellings is a special industry sector developed by the Bureau of Economic Analysis. It estimates what owner/occupants would pay in rent if they rented rather than owned their homes. This sector creates an industry out of owning a home. Its sole product (or output) is ownership, purchased entirely by personal consumption expenditures. Owner-occupied dwellings capture the expenses of home ownership such as repair and maintenance construction, various closing costs, and other expenditures related to the upkeep of the space in the same way expenses are captured for rental properties.

Figure 5. Increase in Sales for Select Industries in Glenn-Driven Sectors, Northeast Ohio



The power generation industry (utilities sector) saw an increase in sales of $18.6 million in FY 2006 due to Glenn's spending patterns (Figure 5). This amount is the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by Glenn spending for electric utilities. $18.6 million represents a seven percent share of the $258.3 million increase in output for all industries within the Glenn-driven sectors. Other industries shown in Figure 5 can be interpreted in a similar manner.

Figure 6. Increase in Sales for Select Industries in Consumer-Driven Sectors, Northeast Ohio



The food services industry saw an increase in sales of $13 million in FY 2006 (Figure 6). This amount is the summation of the direct, indirect, and induced impacts generated primarily by Glenn employees and other workers for food and drink. $13 million represents an eight percent share of the $171.4 million increase in output for all industries within the consumer-driven sectors.

D.2.2 Employment Impact on Northeast Ohio

Glenn Research Center's activities in Northeast Ohio affect job creation beyond Glenn's hiring of its own employees (change in final demand). Glenn spending creates employment in industries from which it purchases goods and services (direct impact) and employment in industries that provide inputs into those goods and services (indirect impact). In addition, monies spent by Glenn employees and employees of those companies with which Glenn does business create jobs in a variety of other industries (induced impact). Total employment impact equals the sum of Glenn Research Center full-time equivalent employment, direct impact, indirect impact, and induced impact. Table 7 shows the number of jobs created by industry sector.

Table 7. Employment Impact Based on Glenn Spending in Northeast Ohio, FY 2006

NASA Glenn Expenditures in Northeast Ohio: $322,040,455

Industry	Direct	Indirect	Induced	Total
Utilities	32	3	4	39
Construction	284	21	6	312
Manufacturing	15	36	22	76
Transportation & Warehousing	13	48	27	87
Retail Trade	168	62	188	419
Information	163	29	12	203
Finance & Insurance	25	41	46	112
Real Estate, Rental, Leasing	18	85	50	153
Professional, Scientific, Technical Services	769	123	38	930
Administrative & Support Services	436	242	42	720
Educational Services	144	8	39	192
Health Care & Social Assistance	226	1	223	451
Arts, Entertainment, Recreation	32	10	35	77
Accommodation & Food Services	121	41	137	299
Other Services	98	41	106	244
Government Enterprises	10	4	6	20
Other [a]	5	24	14	43
Total	2,560	821	997	4,378

Change in Final Demand [b]	1,668 jobs
Direct Impact	2,560 jobs
Indirect Impact	821 jobs
Induced Impact	997 jobs
Total Employment Impact	**6,046** jobs

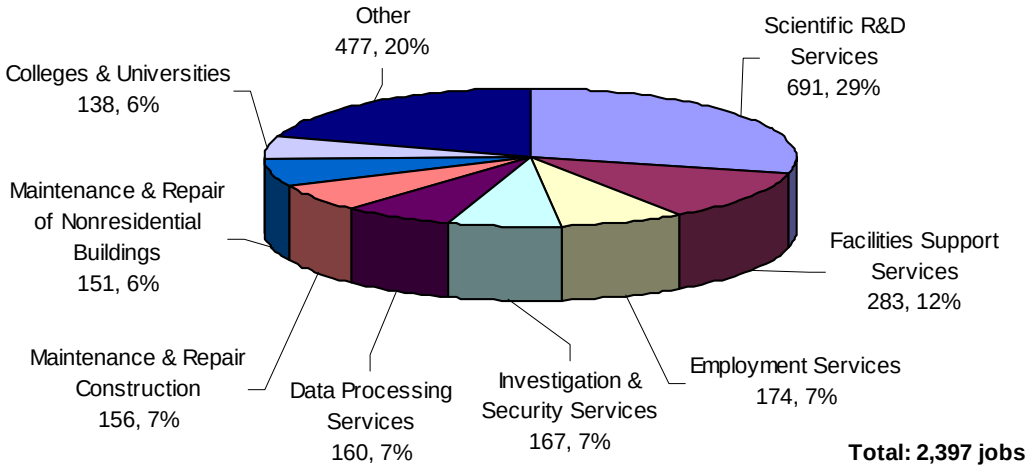
[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.

[b] For employment impact, the change in final demand is equal to the number of full-time equivalent employees working for Glenn.

The total employment impact by Glenn Research Center on the Northeast Ohio economy is 6,046 jobs. 1,668 of these jobs (28%) are directly associated with NASA Glenn. As a result of Glenn's direct spending for goods and services purchased in the region, 2,560 jobs (42%) were created. The remaining employment impact, 1,818 jobs, is in the form of indirect and induced impacts as Glenn spending ripples through the economy.

Of the 4,378 jobs created in Northeast Ohio due to the direct, indirect, and induced impacts, 2,397 (55%) are found in the Glenn-driven sectors, 1,755 (40%) are in the consumer-driven sectors, and 226 (5%) fall under other sectors.[17] The job distribution for select industries within the Glenn-driven sectors is shown in Figure 7. The job distribution for select industries within the consumer-driven sectors is shown in Figure 8.

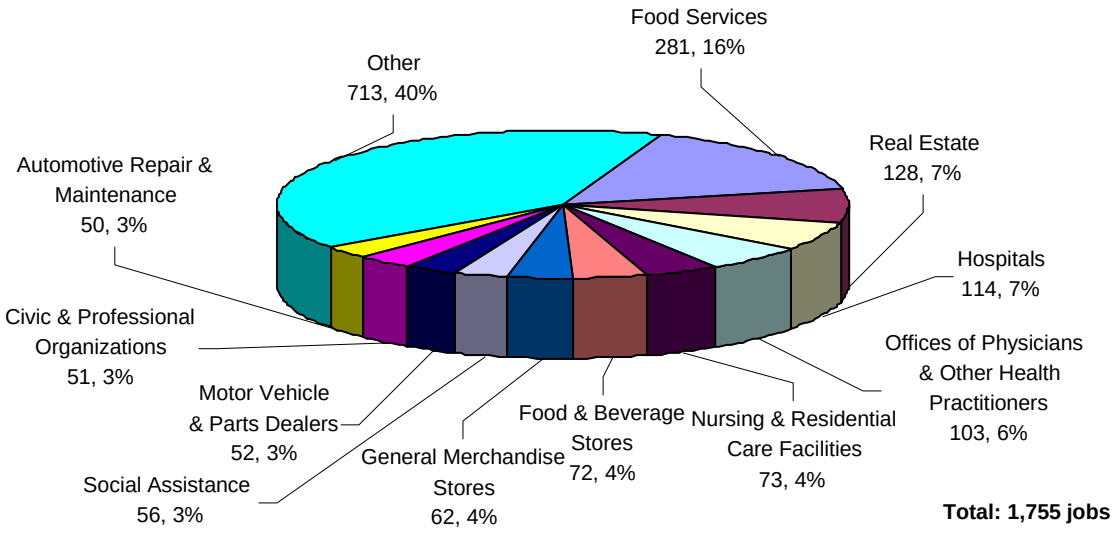
Figure 7. Increase in Jobs for Select Industries in Glenn-Driven Sectors, Northeast Ohio



Companies engaged in scientific R&D (professional, scientific, and technical services sector) saw an increase of 691 jobs in FY 2006 due to NASA Glenn activities (Figure 7). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily but not exclusively by Glenn spending for local R&D contractors. The 691 jobs represent a 29 percent share of the 2,397 jobs that were created in all industries within the Glenn-driven sectors.

[17] Glenn-driven sectors include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven sectors include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.

Figure 8. Increase in Jobs for Select Industries in Consumer-Driven Sectors, Northeast Ohio



Food and beverage stores (retail trade sector) saw an increase of 72 jobs in FY 2006 because of Glenn spending (Figure 8). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily by Glenn employees and other workers for food and drink products. The 72 jobs represent a four percent share of the 1,755 jobs that were created in all industries within the consumer-driven sectors.

D.2.3 Earnings Impact on Northeast Ohio

Earnings impact is the estimated total change in earnings paid to local households due to spending by Glenn Research Center for goods and services from businesses and other entities in Northeast Ohio. Monies paid to employees of companies and other entities who supply goods and services to Glenn represent direct earnings impact. Indirect impact is estimated by summing the monies paid to persons who work for companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact represents monies paid to workers in all industries who are employed as a result of purchases by households whose income is affected by the demand for products and services created by Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total earnings impact. Table 8 shows earnings impact by industry sector.

Table 8. Earnings Impact Based on Glenn Spending in Northeast Ohio, FY 2006

NASA Glenn Expenditures in Northeast Ohio: $322,040,455

Industry	Direct	Indirect	Induced	Total
Utilities	3,314,742	331,795	356,859	4,003,396
Construction	13,087,502	939,934	288,873	14,316,308
Manufacturing	937,428	2,269,232	1,413,705	4,620,382
Transportation & Warehousing	602,044	2,294,741	1,234,139	4,130,926
Retail Trade	4,644,032	1,578,100	5,181,820	11,403,952
Information	8,148,892	1,711,046	673,841	10,533,779
Finance & Insurance	1,635,498	2,604,560	2,982,636	7,222,693
Real Estate, Rental, Leasing	485,330	2,262,295	1,254,571	4,002,195
Professional, Scientific, Technical Services	53,375,374	7,042,041	2,012,858	62,430,272
Administrative & Support Services	11,362,084	5,953,185	1,113,339	18,428,607
Educational Services	4,661,582	262,108	1,038,949	5,962,640
Health Care & Social Assistance	9,410,747	62,199	9,449,471	18,922,416
Arts, Entertainment, Recreation	694,284	262,564	763,526	1,720,374
Accommodation & Food Services	1,819,643	630,028	2,062,859	4,512,532
Other Services	2,186,217	1,307,558	2,492,218	5,985,995
Government Enterprises	603,598	299,112	408,674	1,311,384
Other [a]	217,265	1,558,585	834,684	2,610,532
Total	117,186,259	31,369,091	33,563,019	182,118,369

Change in Final Demand [b]	$123,112,953
Direct Impact	$117,186,259
Indirect Impact	$31,369,091
Induced Impact	$33,563,019
Total Earnings Impact	**$305,231,322**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.

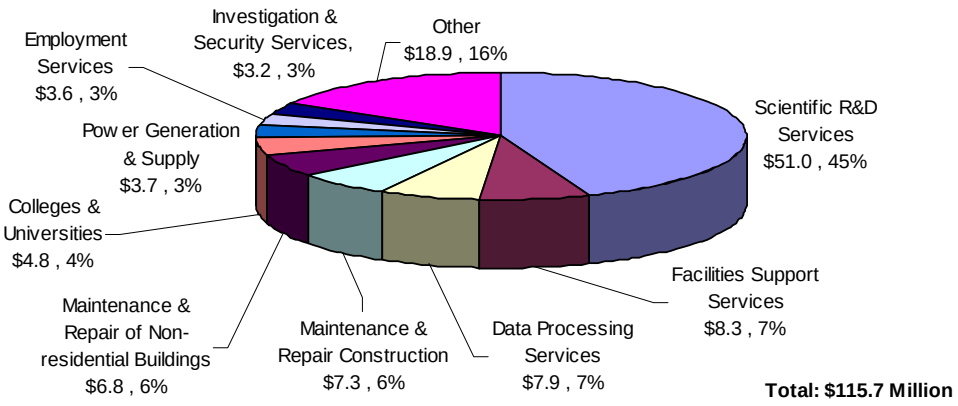
[b] For earnings impact, change in final demand is equal to the disposable income (75 percent of gross income) plus healthcare benefits paid to Glenn employees.

Total household earnings in Northeast Ohio increased by $305.2 million as a result of Glenn's spending for goods and services. $123.1 million (40%) of this amount is the disposable income plus healthcare benefits paid directly to NASA Glenn employees—change in final demand. $117.2 million (38%) represents monies paid to employees of companies in Northeast Ohio that supply goods and services to Glenn—direct impact. The remaining earnings impact, (indirect and induced components) estimated at $64.8 million (21%), occurs as the effects of Glenn spending ripples through the Northeast Ohio economy.

Of the $182.1 million increase in household earnings generated across Northeast Ohio due to the direct, indirect, and induced impacts, $115.7 million (64%) was reported in Glenn-driven sectors; $53.8 (30%) was generated in consumer-driven sectors; and $12.7million (7%)

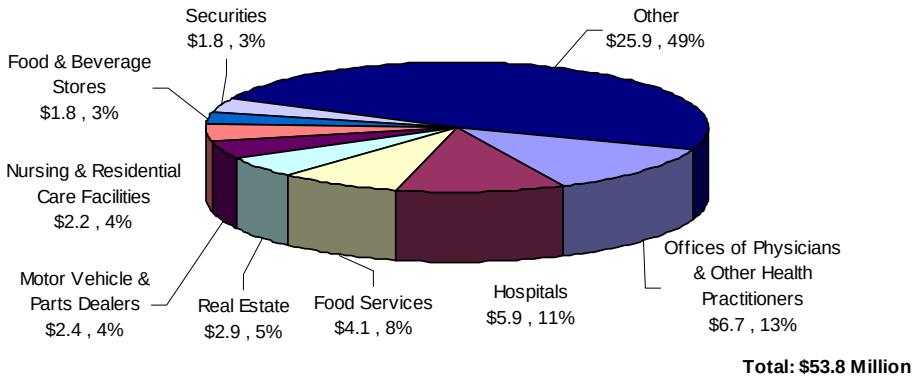
was reported in other sectors.[18] The household earnings distribution for select industries within the Glenn-driven sectors is shown in Figure 9. The household earnings distribution for select industries within the consumer-driven sectors is shown in Figure 10.

Figure 9. Increase in Earnings for Select Industries in Glenn-Driven Sectors, Northeast Ohio



Persons engaged in data processing services (information sector) saw their household earnings increase by $7.9 million in FY 2006 (Figure 9). These earnings are the summation of the direct, indirect, and induced impacts generated primarily, but not exclusively, by Glenn spending for data services. The $7.9 million represents a seven percent share of the $115.7 million earnings increase that was reported by all industries within the Glenn-driven sectors.

Figure 10. Increase in Earnings for Select Industries in Consumer-Driven Sectors, Northeast Ohio



[18]See section D.2.1 Output Impact on Northeast Ohio for detailed definitions of Glenn-driven, consumer-driven, and other sectors.

Persons working in food services saw their household earnings increase by $4.1 million in FY 2006 (Figure 10). These earnings are the summation of the direct, indirect, and induced impacts generated by consumer spending at restaurants and bars. The $4.1 million represents an eight percent share of the $53.8 million earnings increase that occurred in all industries within the consumer-driven sectors.

D.2.4 Northeast Ohio Impact Summary

Economic activity generated by Glenn Research Center produced the following impacts on Northeast Ohio (2006 dollars):

- Total Output Impact: $955 million
- Total Employment Impact: 6,046 jobs
- Total Earnings Impact: $305.2 million

The economic impact presented here reflects NASA Glenn expenditures in Northeast Ohio in FY 2006. During that time period, 72 percent of Glenn expenditures were allocated to Glenn payroll, scientific research and development services, other professional and technical services, and colleges and universities.

Other industries deriving significant benefits from direct Glenn spending include data processing, power generation, facilities support, and construction. Businesses deriving the most benefit from spending by Glenn personnel and other workers whose earnings are due in part to Glenn expenditures follow typical consumer spending patterns. These include real estate companies, telecommunications, legal services, accounting services, commercial banks, and restaurants.

D.3 ECONOMIC IMPACT ON THE STATE OF OHIO

In this section, we discuss the economic impact that NASA Glenn spending had on the Ohio economy during FY 2006. More specifically, we present a detailed analysis of the change in output (sales), employment, and household earnings due to Glenn activities.

This section follows the structure of Section D.2, Economic Impact on Northeast Ohio. Readers who are less interested in the detailed discussion should proceed to section D.3.4, Ohio Impact Summary.

D.3.1 Output Impact on the State of Ohio

This analysis uses multipliers to estimate the ripple effect that an initial expenditure has on a studied economy. These multipliers measure the effect of Glenn Research Center (Glenn) spending on output (sales) across the state of Ohio. The multipliers that are applied to spending in Ohio are generally larger than those applied to expenditures in Northeast Ohio. The reason being that a larger geographic area assures less leakage from the economy. Stated another way, as the geographic area being analyzed increases in size, the amount of goods and services purchased from outside that area decreases.

NASA Glenn expenditures were divided into spending on goods and services purchased from companies and other entities located in the state of Ohio (local) and spending for goods and services from businesses located elsewhere. Local spending is then categorized by industry based upon the IMPLAN industry classification system. Table A.4 in Appendix A lists detailed Glenn expenditures by specific industry.

Table 9 presents the total output impact and its components. Local Glenn expenditures represent direct output impact. Indirect impact is estimated by summing the contributions of individual industries that provide inputs to the producers of the goods and services ultimately consumed by NASA Glenn. Induced impact is estimated by measuring the spending of workers who are employed as a result of the demand for products and services created by Glenn. Total output impact is the sum of change in final demand, direct impact, indirect impact, and induced impact. Table 9 reports output impacts by industry sector. It shows how Glenn spending across Ohio affects all sectors of the economy.[19]

[19] Disposable income spent by Glenn employees is automatically distributed by IMPLAN to those industries from which households typically make purchases. The result being that "households" is not identified as a unique industry sector in Table 10. The industry sector that is the largest beneficiary of household spending is foreign and domestic trade ($38.8 million). This sector represents products that are purchased by households locally but are produced outside Ohio, either domestically or internationally.

Table 9. Output Impact Based on Glenn Spending in the State of Ohio, FY 2006

NASA Glenn Expenditures in Ohio: $389,100,133

Industry	Direct	Indirect	Induced	Total
Utilities	$17,045,946	$2,600,502	$3,032,448	$22,678,895
Construction	$38,190,692	$2,650,847	$998,335	$41,839,874
Manufacturing	$7,712,323	$17,025,313	$15,780,248	$40,517,888
Transportation & Warehousing	$1,583,482	$6,189,227	$4,294,605	$12,067,316
Retail Trade	$12,319,820	$5,699,073	$19,037,654	$37,056,549
Information	$28,417,185	$9,603,568	$4,617,764	$42,638,514
Finance & Insurance	$5,722,221	$8,309,938	$12,690,554	$26,722,710
Real Estate, Rental, Leasing	$2,226,963	$15,492,464	$9,089,269	$26,808,696
Professional, Scientific, Technical Services	$154,284,201	$19,771,144	$5,970,153	$180,025,500
Administrative & Support Services	$19,906,215	$13,240,347	$3,203,887	$36,350,450
Educational Services	$17,104,985	$475,282	$2,095,983	$19,676,251
Health Care & Social Assistance	$18,330,361	$182,679	$24,546,251	$43,059,291
Arts, Entertainment, Recreation	$1,620,216	$650,900	$2,368,433	$4,639,551
Accommodation & Food Services	$5,756,331	$2,361,672	$8,952,845	$17,070,847
Other Services	$5,469,324	$4,099,527	$8,360,708	$17,929,556
Government Enterprises	$4,598,092	$1,276,847	$1,822,219	$7,697,156
Owner-occupied Dwellings	$15,848,265	$0	$20,332,657	$36,180,923
Foreign & Domestic Trade	$38,835,661	$0	$0	$38,835,661
Other [a]	$1,930,345	$11,031,326	$7,409,495	$20,371,169
Total	$395,783,830	$115,011,431	$151,149,709	$661,944,969

Change in Final Demand [b]	$436,428,532
Direct Impact	$395,783,830
Indirect Impact	$115,011,431
Induced Impact	$151,149,709
Total Output Impact	**$1,098,373,501**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.

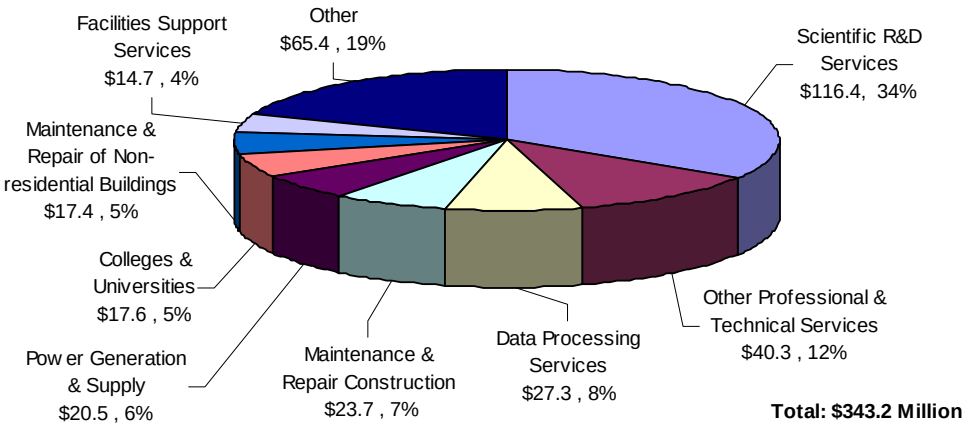
[b] For output impact, the change in final demand equals spending by Glenn within and outside Ohio excluding payroll and healthcare benefits.

The total output impact across the state of Ohio as a result of Glenn Research Center activities was $1.1 billion. Glenn's expenditures of $389.1 million resulted in an increase in output (sales) of $661.9 million across all industry sectors (Table 9). For example, Glenn spending affected a $40.5 million increase in sales (direct, indirect, and induced impacts) by the manufacturing sector and $180 million in professional, scientific, and technical services.

Forty percent ($436.4 million) of the total output impact is accounted for by the change in final demand that occurs because Glenn activities bring resources into Ohio from outside the state. Approximately $395.8 million (36%) of the total output impact is a result of direct spending by Glenn for goods and services purchased within the state of Ohio. The remaining output impact of $266.2 million (24%) is attributable to the indirect and induced components as Glenn spending ripples through the economy.

An analysis of the IMPLAN model results shows that the $661.9 million increase in sales generated by the direct, indirect, and induced impacts can be divided into the same broad categories that were identified for Northeast Ohio—Glenn-driven sectors, consumer-driven sectors, and other sectors.[20] The output distribution for select industries within the Glenn-driven sectors is shown in Figure 11. The output distribution for select industries within the consumer-driven sectors is shown in Figure 12.

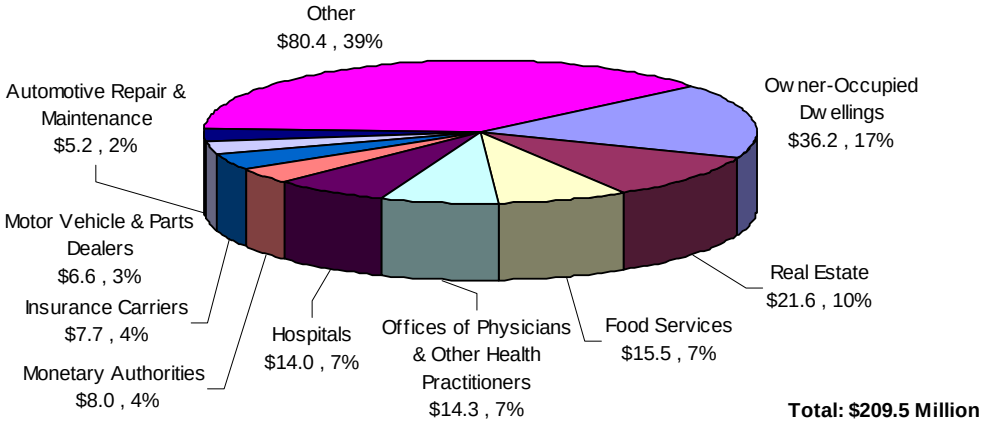
Figure 11. Increase in Sales for Select Industries in Glenn-Driven Sectors, Ohio



[20] Glenn-driven sectors include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven sectors include retail, finance and insurance, real estate, health care, entertainment and food, other services, and owner-occupied buildings.

Colleges and universities (education sector) across the state of Ohio saw an increase in revenues of $17.6 million in FY 2006 (Figure 11). This amount is the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by Glenn spending for research by colleges and universities. $17.6 million represents a five percent share of the $343.2 million increase in output value for all industries within the Glenn-driven sectors.

Figure 12. Increase in Sales for Select Industries in Consumer-Driven Sectors, Ohio



Insurance carriers (finance and insurance sector) experienced a sales increase of $7.7 million in FY 2006 (Figure 12). This amount is the summation of the direct, indirect, and induced impact components generated primarily by Glenn employees and other workers for insurance products. $7.7 million represents a four percent share of the $209.5 million increase in output for all industries within the consumer-driven sectors.

D.3.2 Employment Impact on the State of Ohio

Glenn Research Center's activities affect job creation beyond Glenn's hiring of its own employees (change in final demand). Glenn spending creates employment across the state of Ohio in industries from which it purchases goods and services (direct impact) and employment in industries that provide inputs into those goods and services (indirect impact). In addition, monies spent by Glenn employees and employees of those companies with which NASA Glenn does business create jobs in a variety of other industries (induced impact). Total employment impact equals the sum of Glenn Research Center full-time equivalent employment and the

direct, indirect, and induced components. Table 10 shows the number of jobs created by industry sector.

Table 10. Employment Impact Based on Glenn Spending in the State of Ohio, FY 2006

NASA Glenn Expenditures in Ohio: $389,100,133

Industry	Direct	Indirect	Induced	Total
Utilities	31	5	6	41
Construction	445	26	10	480
Manufacturing	21	56	40	120
Transportation & Warehousing	13	62	39	114
Retail Trade	188	84	284	557
Information	162	39	18	219
Finance & Insurance	26	51	67	144
Real Estate, Rental, Leasing	18	108	69	194
Professional, Scientific, Technical Services	1,072	159	54	1,285
Administrative & Support Services	415	313	62	790
Educational Services	294	9	45	347
Health Care & Social Assistance	230	2	310	541
Arts, Entertainment, Recreation	32	16	49	97
Accommodation & Food Services	121	49	189	359
Other Services	102	55	152	309
Government Enterprises	13	7	10	30
Other [a]	6	31	27	64
Total	3,190	1,072	1,430	5,692

Change in Final Demand [b]	1,668
Direct Impact	3,190
Indirect Impact	1,072
Induced Impact	1,430
Total Employment Impact	**7,360**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.

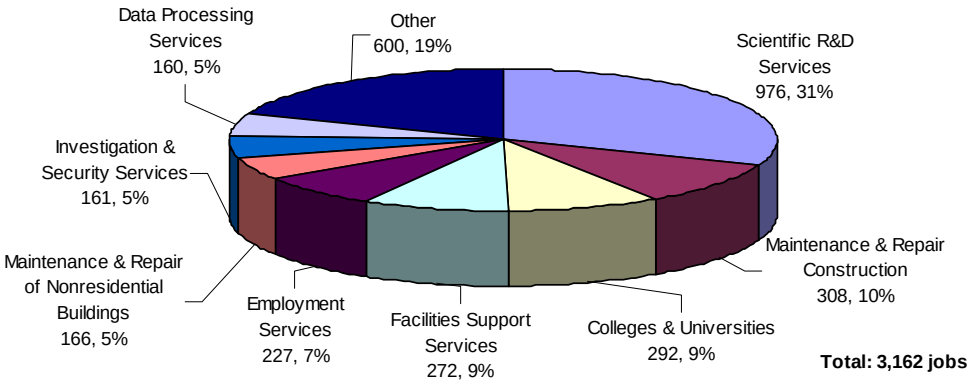
[c]For employment impact, the change in final demand is equal to the number of full-time equivalent employees working for Glenn.

Employment increased by 7,360 jobs across the state of Ohio due to the presence of NASA Glenn. Of these, 1,668 jobs (23%) are directly associated with Glenn. As a result of Glenn's direct spending for goods and services purchased in Ohio, 3,190 jobs (43%) were created. The remaining employment impact—2,502 jobs (34%)—is in the form of indirect and induced impacts as NASA Glenn spending ripples through the economy.

Of the 5,692 jobs created in Ohio due to the direct, indirect, and induced components, 3,162 (56%) are found in the Glenn-driven sectors, 2,200 (39%) are in the consumer-driven

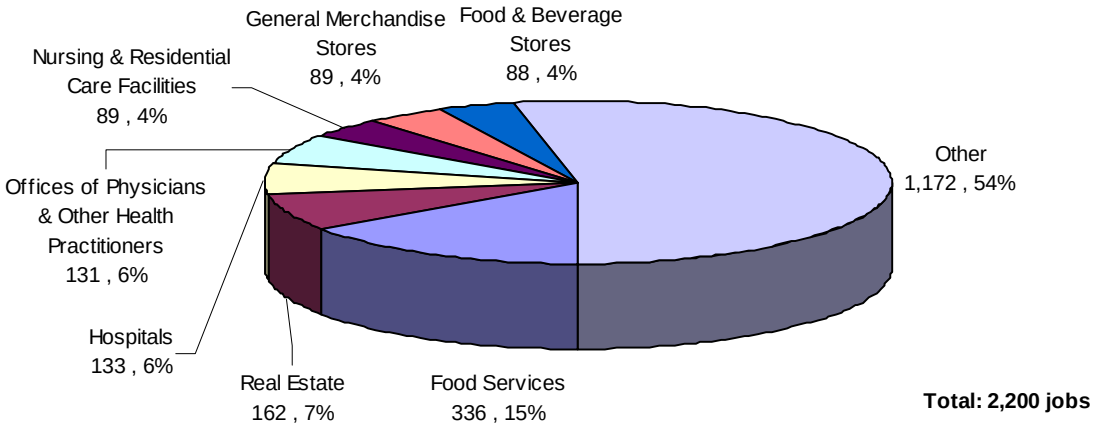
sectors, and 330 (6%) fall under other sectors.[21] The job distribution for select industries within the Glenn-driven sectors is shown in Figure 13. The job distribution for select industries within the consumer-driven sectors is shown in Figure 14.

Figure 13. Increase in Jobs for Select Industries in Glenn-Driven Sectors, Ohio



Due to spending by Glenn Research Center in the state of Ohio, 160 jobs were added in the data processing industry (information sector) during FY 2006 (Figure 13). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily but not exclusively by Glenn's need for data services. The 160 jobs represent a five percent share of the 3,162 jobs that were created in all industries within the Glenn-driven sectors.

Figure 14. Increase in Jobs for Select Industries in Consumer-Driven Sectors, Ohio



[21] Glenn-driven sectors include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven sectors include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.

The food services industry experienced an increase of 336 jobs in FY 2006 (Figure 14). These jobs are the summation of the direct, indirect, and induced components generated primarily by NASA Glenn employees and other workers who patronize restaurants and bars. The 336 jobs represent a 15 percent share of the 2,200 jobs that were created in all industries within the consumer-driven sectors.

D.3.3 Earnings Impact on the State of Ohio

Earnings impact is the estimated change in earnings received by households in the state of Ohio due to spending by Glenn Research Center for goods and services from businesses and other entities across the state. Monies paid to employees of companies and other entities who supply goods and services to Glenn represent direct earnings impact. Indirect impact is estimated by summing the monies paid to persons who work for companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact represents monies paid to workers in all industries who are employed as a result of the demand for products and services created by NASA Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total earnings impact. Table 11 shows earnings impact by industry sector.

Total household earnings in the state of Ohio increased by $365.2 million as a result of Glenn's spending for goods and services. Of this amount, $123.1 million (34%) is the disposable income and healthcare benefits paid to NASA Glenn employees—change in final demand. $155.0 million (42%) represents monies paid to employees of companies across the state that supply goods and services to Glenn—direct impact. The remaining earnings impact (indirect and induced components), estimated at $87.0 million (24%), occurs as the effects of Glenn spending ripples through the Ohio economy.

Table 11. Earnings Impact Based on Glenn Spending in the State of Ohio, FY 2006

NASA Glenn Expenditures in Ohio: $389,100,133

Industry	Direct	Indirect	Induced	Total
Utilities	$3,384,445	$501,114	$578,550	$4,464,110
Construction	$19,770,479	$1,146,177	$412,080	$21,328,735
Manufacturing	$1,290,183	$3,430,823	$2,427,678	$7,148,684
Transportation & Warehousing	$590,651	$3,022,091	$1,820,080	$5,432,819
Retail Trade	$4,905,043	$2,098,324	$7,465,538	$14,468,905
Information	$8,273,668	$2,227,687	$1,002,237	$11,503,592
Finance & Insurance	$1,595,399	$3,060,891	$4,041,692	$8,697,979
Real Estate, Rental, Leasing	$510,678	$2,957,479	$1,769,010	$5,237,167
Professional, Scientific, Technical Services	$79,078,316	$8,995,626	$2,855,748	$90,929,695
Administrative & Support Services	$11,495,407	$7,343,234	$1,533,189	$20,371,826
Educational Services	$9,283,296	$239,183	$1,140,367	$10,662,845
Health Care & Social Assistance	$9,410,056	$62,619	$12,940,991	$22,413,668
Arts, Entertainment, Recreation	$651,006	$308,203	$976,603	$1,935,809
Accommodation & Food Services	$1,811,124	$755,333	$2,817,661	$5,384,118
Other Services	$2,155,536	$1,590,405	$3,336,358	$7,082,302
Government Enterprises	$585,849	$410,301	$611,164	$1,607,314
Other [a]	$225,186	$1,869,975	$1,327,392	$3,422,558
Total	$155,016,314	$40,019,472	$47,056,339	$242,092,129

Change in Final Demand [b]	$123,112,953
Direct Impact	$155,016,314
Indirect Impact	$40,019,472
Induced Impact	$47,056,339
Total Earnings Impact	**$365,205,077**

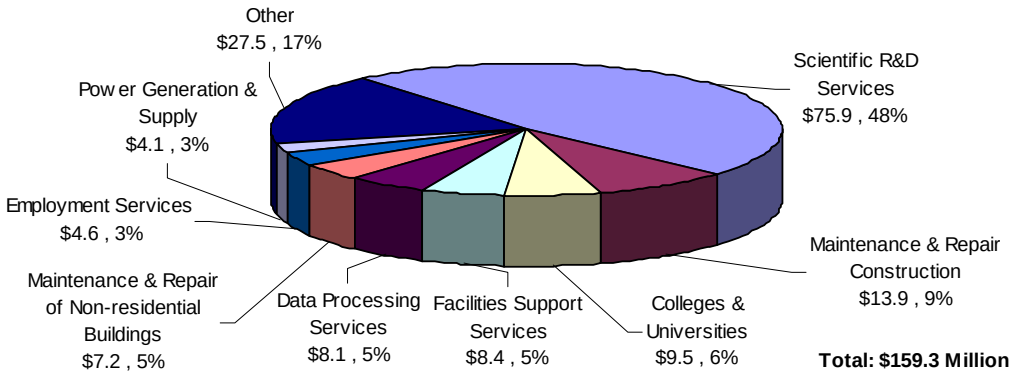
[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.

[b] For earnings impact, change in final demand is equal to the disposable income (75 percent of gross income) plus healthcare benefits paid to Glenn employees.

Of the $242.1 million increase in household earnings attributed to the direct, indirect, and induced components, $159.3 million (66%) was reported in Glenn-driven sectors, $65.2 million (27%) occurred in consumer-driven sectors, and $17.6 million (7%) was reported in other sectors.[22] The household earnings distribution for select industries within the Glenn-driven sectors is shown in Figure 15. The household earnings distribution for select industries within the consumer-driven sectors is shown in Figure 16.

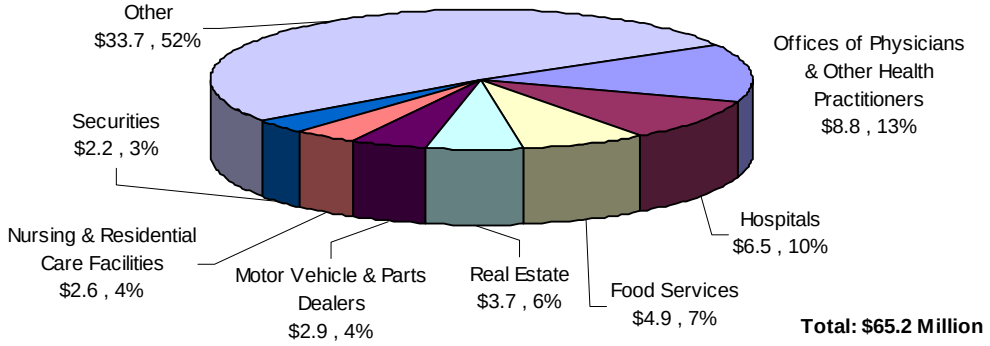
[22] See section D.2.1 Output Impact on Northeast Ohio for detailed definitions of Glenn-driven, consumer-driven, and other sectors.

Figure 15. Increase in Earnings for Select Industries in Glenn-Driven Sectors, Ohio



Employees in facilities support services industries (administrative and support services sector) across the state of Ohio saw their household earnings increase by $8.4 million in FY 2006 (Figure 15). These earnings are the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by NASA Glenn for facilities support services. The $8.4 million represents a five percent share of the $159.3 million earnings increase that occurred in all industries within the Glenn-driven sectors.

Figure 16. Increase in Earnings for Select Industries in Consumer-Driven Sectors, Ohio



Persons working for motor vehicle and parts dealers (retail trade sector) experienced an increase in household earnings of $2.9 million in FY 2006 (Figure 16). This amount is the summation of the direct, indirect, and induced impacts generated primarily by Glenn employees and other workers on spending for automobiles and other types of motor vehicles. The $2.9 million represents a four percent share of the $65.2 million earnings increase that was reported by all industries within the consumer-driven sectors.

D.3.4 Ohio Impact Summary

Economic activity generated by the Glenn Research Center produced the following impacts on the state of Ohio (2006 dollars):

- Total Output Impact: $1.1 billion
- Total Employment Impact: 7,360 jobs
- Total Earnings Impact: $365.2 million

The impact of NASA Glenn's expenditure in the state of Ohio is only slightly higher than the impact on Northeast Ohio. This is due to the fact that the majority of Glenn's Ohio expenditures are in Northeast Ohio (including all of Glenn's payroll expenditures). In FY 2006, NASA Glenn's expenditures in the state of Ohio, excluding the eight-county Northeast Ohio region, were only $67 million. Almost all of this spending (98 percent) was allocated to just four industries: scientific R&D ($35.6 million), other maintenance and repair ($10.8 million), miscellaneous technical support ($10 million), and colleges and universities ($9 million). The result is that Ohio businesses, excluding those located in the eight-county Northeast Ohio region, experienced an increase in sales of $143.4 million, added 1,314 jobs, and saw an increase in household earnings of $60.0 million.

Since major Glenn expenditures elsewhere in the state of Ohio mirrored expenditures in Northeast Ohio, industries across Ohio that derive the most benefit from Glenn spending and spending by NASA Glenn employees and other workers are similar to those reported for Northeast Ohio.[23]

[23] A close examination of the IMPLAN results show that a few industry sectors have slightly higher values for the direct impact for Northeast Ohio than for the state of Ohio. The reason for this is the distribution of disposable income (Glenn payroll) by IMPLAN to those industries from which households typically make purchases. When making this distribution for the state of Ohio, IMPLAN assumes that households have the same distribution as the population across the state. Persons living in the Appalachian area of southeast Ohio or the farming regions of western Ohio do not have the same spending patterns as their counterparts in Greater Cleveland. For example, persons living in Appalachia do not spend as much on the arts and financial services as people living in suburban Cleveland. The IMPLAN results simply reflect this reality.

APPENDIX A: DATA TABLES

Table A.1 Glenn Spending by State, FY 2006

Table A.2 Glenn Monies Allocated to Academic Institutions, FY 2006

Table A.3 NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2006

Table A.4 NASA Glenn Detailed Expenditures in the State of Ohio, FY 2006

Table A.1. Glenn Spending by State, FY 2006

State	Spending	Share
Ohio	$265,982,723	61.1%
California	$25,035,335	5.8%
Maryland	$16,213,844	3.7%
New York	$15,854,646	3.6%
Florida	$13,892,981	3.2%
Colorado	$8,650,920	2.0%
Virginia	$8,363,405	1.9%
Massachusetts	$8,094,318	1.9%
New Jersey	$6,954,082	1.6%
Washington DC	$5,970,667	1.4%
Illinois	$5,646,790	1.3%
Texas	$5,586,728	1.3%
Georgia	$5,517,861	1.3%
Pennsylvania	$5,420,378	1.2%
Washington	$5,148,940	1.2%
Connecticut	$4,338,457	1.0%
Michigan	$4,284,734	1.0%
Arizona	$4,095,393	0.9%
Alabama	$2,482,871	0.6%
Tennessee	$2,458,350	0.6%
Indiana	$2,305,423	0.5%
Missouri	$2,038,599	0.5%
New Hampshire	$1,108,800	0.3%
North Carolina	$1,094,356	0.3%
Iowa	$983,200	0.2%
Minnesota	$940,003	0.2%
Louisiana	$935,290	0.2%
New Mexico	$849,356	0.2%
Wisconsin	$748,723	0.2%
Oregon	$730,081	0.2%
Arkansas	$591,256	0.1%
Kansas	$523,130	0.1%
Mississippi	$430,738	0.1%
Oklahoma	$361,686	0.1%
Montana	$273,704	0.1%
Utah	$257,252	0.1%
Rhode Island	$249,520	0.1%
Delaware	$157,629	0.0%
Nevada	$147,829	0.0%
Kentucky	$104,634	0.0%
South Carolina	$104,107	0.0%
Vermont	$94,527	0.0%
Idaho	$57,354	0.0%
Nebraska	$49,156	0.0%
Hawaii	$44,306	0.0%
Wyoming	$2,684	0.0%
Maine	$795	0.0%
South Dakota	$0	0.0%
West Virginia	($908)	0.0%
Outside U.S.	$1,251,879	0.3%
Total	**$436,428,532**	

Spending in Ohio excludes Glenn employee payroll and benefits.

Table A.2. Glenn Monies Allocated to Academic Institutions, FY 2006

STATE	AMOUNT	SHARE
Ohio	$ 15,174,357	20.5%
Florida	$ 11,575,074	15.6%
Maryland	$ 10,175,773	13.7%
Georgia	$ 4,757,051	6.4%
California	$ 4,497,662	6.1%
New York	$ 4,263,756	5.7%
Virginia	$ 2,528,155	3.4%
Illinois	$ 2,436,698	3.3%
Michigan	$ 2,104,993	2.8%
Massachusetts	$ 1,872,205	2.5%
Colorado	$ 1,600,296	2.2%
Pennsylvania	$ 1,557,461	2.1%
Tennessee	$ 1,525,466	2.1%
Missouri	$ 1,366,321	1.8%
Puerto Rico	$ 1,066,352	1.4%
Louisiana	$ 933,391	1.3%
Indiana	$ 847,437	1.1%
New Jersey	$ 773,028	1.0%
Washington	$ 653,091	0.9%
Texas	$ 631,037	0.9%
Alabama	$ 607,614	0.8%
Kansas	$ 503,149	0.7%
Indiana	$ 483,657	0.7%
North Carolina	$ 339,955	0.5%
Arizona	$ 289,505	0.4%
Oklahoma	$ 227,578	0.3%
Connecticut	$ 225,997	0.3%
Rhode Island	$ 209,856	0.3%
Oregon	$ 163,623	0.2%
Washington DC	$ 157,970	0.2%
Wisconsin	$ 150,932	0.2%
Montana	$ 105,412	0.1%
New Mexico	$ 101,666	0.1%
Kentucky	$ 95,335	0.1%
Idaho	$ 54,380	0.1%
Mississippi	$ 49,196	0.1%
Hawaii	$ 44,306	0.1%
Minnesota	$ 20,690	0.0%
South Carolina	$ 25,368	0.0%
Arkansas	-	0.0%
Nebraska	-	0.0%
West Virginia	-	0.0%
Utah	$ (88)	0.0%
TOTAL	$ 74,195,705	100.0%

Table A.3. NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2006

Description	IMPLAN Sector [a]	Expenditure [b]	Basis [c]
Utilities		**$15,428,619**	
Electricity	30	$14,832,736	Industry
Natural Gas	31	$572,564	Industry
Water & Sewage	32	$23,318	Industry
Construction		**$25,476,661**	
Water, Sewer & Pipeline Construction	40	$4,091	Industry
Maintenance & Repair of Nonresidential Buildings	43	$13,802,429	Industry
Maintenance & Repair of Transportation Infrastructure	44	$117,811	Industry
Other Maintenance & Repair	45	$11,552,331	Industry
Manufacturing		**$1,449,402**	
Cut & Sew Apparel	107	$3,075	Commodity
Stationery & Related Products	133	$10,029	Commodity
Commercial Printing	139	$83,603	Industry
All Other Petroleum & Coal Products	146	$27,599	Commodity
Industrial Gas	148	$400,444	Commodity
Organic Chemicals	151	$540	Commodity
Paint & Coatings	161	$842	Commodity
Adhesives	162	$266	Commodity
Miscellaneous Chemical Products	171	$16,107	Commodity
Tire Manufacturing	179	$3,900	Commodity
Rubber & Plastics Hose & Belting	180	$17,336	Commodity
Other Rubber Products	181	$193	Commodity
Aluminum Sheet, Plate & Foil Manufacturing	211	$5,680	Commodity
Primary Nonferrous Metals	215	$126,839	Commodity
Machine Shops	243	$207,855	Industry
Metal Coating	246	$600	Commodity
Electroplating, Anodizing & Coloring Metal	247	$2,409	Commodity
Metal Valves	248	$93,554	Commodity
Fabricated Pipe & Pipe Fitting	252	$33,632	Commodity
Miscellaneous Fabricated Metal Products	255	$40,451	Commodity
Air Purification Equipment	275	$17,156	Commodity
Industrial & Commercial Fan & Blowers	276	$2,595	Commodity
Heating Equipment	277	$8,328	Commodity
Pump & Pumping Equipment	288	$3,540	Commodity
Other Computer Peripheral Equipment	305	$25,824	Commodity
Broadcast & Wireless Communications Equipment	307	$7,488	Commodity
Other Communications Equipment	308	$11,859	Commodity
All Other Electronic Components	312	$81,883	Commodity
Industrial Process Variable Instruments	316	$8,396	Commodity
Analytical Laboratory Instruments	319	$150,171	Commodity
Lighting Fixtures	326	$1,060	Commodity
Relay & Industrial Controls	336	$28,830	Commodity
Other Communication & Energy Wires	340	$4,475	Commodity
Wiring Devices	341	$21,501	Commodity
Carbon & Graphite Products	342	$1,089	Commodity
Office Furniture	370	$252	Commodity
Transportation & Warehousing		**$28,330**	
Truck Transportation	394	$13,850	Industry
Transit & Ground Passenger Transportation	395	$14,480	Industry

Retail Trade		**$475,993**	
Electronics & Appliance Stores	403	$11,994	Commodity
Building Material Supply Stores	404	$14,694	Commodity
Gasoline Stations	407	$73	Commodity
Miscellaneous Retail Stores	411	$449,233	Commodity
Information		**$26,180,956**	
Telecommunications	422	$142,034	Industry
Data Processing Services	424	$26,038,922	Industry
Real Estate and Rental & Leasing		**$88,588**	
Machinery & Equipment Rental & Leasing	434	$88,588	Industry
Professional, Scientific & Technical Services		**$102,933,718**	
Legal Services	437	$203,401	Industry
Architectural & Engineering Services	439	$7,913	Industry
Management Consulting Services	444	$19,555	Industry
Environmental & Other Technical Consulting Services	445	$4,300	Industry
Scientific Research & Development Services	446	$76,836,370	Industry
Miscellaneous Professional & Technical Services	450	$25,862,179	Industry
Administrative & Support and Waste Management Services		**$19,023,364**	
Facilities Support Services	453	$14,226,545	Industry
Travel Arrangement & Reservation Services	456	$420,870	Industry
Investigation & Security Services	457	$4,375,948	Industry
Education		**$6,215,062**	
Colleges & Universities	462	$6,215,062	Industry
Health Care & Social Assistance		**$1,350,115**	
Ambulatory Health Care Services	466	$1,350,115	Industry
Accommodation & Food Services		**$6,375**	
Food Services & Drinking Places	481	$6,375	Industry
Other Services		**$19,575**	
Civic, Social, Professional & Similar Organizations	493	$19,575	Industry
Government Enterprises		**$250,744**	
Federal Government Enterprises	496	$250,455	Industry
State & Local Government Enterprises	499	$290	Industry
Households		**$123,112,953**	
Household Spending [d]	10007	$123,112,953	
TOTAL EXPENDITURES		**$322,040,455**	

[a] **Sector:** Industry classification code used by IMPLAN. It is analogous to the North American Industry Classification System (NAICS). IMPLAN provides a cross-reference table bridging their sector numbers and NAICS codes.

[b] **Expenditure:** Actual dollar value for a product or service spent by NASA Glenn Research Center (Glenn) in FY 2006. Values shown in Table A-3 are limited to expenditures made in Northeast Ohio.

[c] **Basis:** Industries consist of businesses producing goods and services; commodities are the goods and services. An **industry** impact gives the entire sector dollar value to the industry that has been selected. For example, Glenn spent $25.5 million for maintenance and repairs of its buildings and infrastructure. Therefore, the entire dollar value spent for this work in the impact analysis is assigned to the construction sector. A **commodity** impact splits the sector dollar value among all industries producing that commodity. For example, Glenn spent $41,000 on valves. Since Glenn purchased these valves from distributors rather than the actual manufacturer, IMPLAN splits the dollar value among all industries that produce valves. If these industries are located outside Northeast Ohio, IMPLAN only assigns margin values (transportation, wholesale, and retail) in the impact analysis.

[d] **Households:** Household expenditures include Glenn employee payroll and medical insurance. Payments have been reduced to include only disposable income. In this analysis, disposable income equals 75 percent of the gross amount. Disposable income excludes income that is used for savings and to pay taxes.

Table A.4. NASA Glenn Detailed Expenditures in the State of Ohio, FY 2006

Description	IMPLAN Sector [a]	Expenditure [b]	Basis [c]
Utilities		**$15,487,325**	
Electricity	30	$14,854,700	Industry
Natural Gas	31	$566,747	Industry
Water & Sewage	32	$65,878	Industry
Construction		**$36,955,019**	
Water, Sewer & Pipeline Construction	40	$4,091	Industry
Maintenance & Repair of Non-residential Buildings	43	$14,435,248	Industry
Maintenance & Repair of Transportation Infrastructure	44	$117,811	Industry
Other Maintenance & Repair	45	$22,397,869	Industry
Manufacturing		**$2,064,353**	
Cut & Sew Apparel	107	$3,075	Commodity
Footwear	110	$2,210	Commodity
Stationery & Related Products	133	$10,029	Commodity
Commercial Printing	139	$83,603	Industry
All Other Petroleum & Coal Products	146	$6,382	Commodity
Industrial Gas	148	$423,399	Commodity
Other Basic Inorganic Chemicals	150	$226	Commodity
Organic Chemicals	151	$470	Commodity
Paint & Coatings	161	$842	Commodity
Adhesives	162	$266	Commodity
Miscellaneous Chemical Products	171	$29,448	Commodity
Tire Manufacturing	179	$3,900	Commodity
Rubber & Plastics Hose & Belting	180	$22,680	Commodity
Other Rubber Products	181	$193	Commodity
Ferroalloy & Related Products	204	$15,500	Commodity
Aluminum Sheet, Plate & Foil Manufacturing	211	$5,680	Commodity
Primary Nonferrous Metals	215	$245,676	Commodity
Power Boiler & Heat Exchangers	238	$22,270	Commodity
Machine Shops	243	$363,088	Industry
Metal Coating	246	$9,560	Commodity
Electroplating, Anodizing & Coloring Metal	247	$2,799	Commodity
Metal Valves	248	$101,293	Commodity
Fabricated Pipe & Pipe Fitting	252	$33,632	Commodity
Miscellaneous Fabricated Metal Products	255	$55,598	Commodity
Construction Machinery	259	$11,000	Commodity
Air Purification Equipment	275	$17,156	Commodity
Industrial & Commercial Fan & Blowers	276	$2,595	Commodity
Heating Equipment	277	$8,328	Commodity
Rolling Mill & Other Metalworking Machinery	284	$79,300	Commodity
Pump & Pumping Equipment	288	$40,891	Commodity
Air & Gas Compressors	289	$8,050	Commodity
Other Computer Peripheral Equipment	305	$31,992	Commodity
Broadcast & Wireless Communications Equipment	307	$7,488	Commodity
Other Communications Equipment	308	$17,563	Commodity
All Other Electronic Components	312	$92,996	Commodity
Industrial Process Variable Instruments	316	$8,396	Commodity
Analytical Laboratory Instruments	319	$232,026	Commodity
Lighting Fixtures	326	$1,060	Commodity
Relay & Industrial Controls	336	$28,830	Commodity
Other Communication & Energy Wires	340	$4,449	Commodity
Wiring Devices	341	$21,501	Commodity

Carbon & Graphite Products	342	$1,089	Commodity
Office Furniture	370	$7,823	Commodity
Transportation & Warehousing		**$28,330**	
Truck Transportation	394	$13,850	Industry
Transit & Ground Passenger Transportation	395	$14,480	Industry
Retail Trade		**$685,299**	
Electronics & Appliance Stores	403	$11,994	Industry
Building Material Supply Stores	404	$14,694	Industry
Gasoline Stations	407	$73	Industry
Miscellaneous Store Retailers	411	$658,539	Industry
Information		**$26,227,456**	
Telecommunications	422	$142,034	Industry
Data Processing Services	424	$26,085,422	Industry
Real Estate and Rental & Leasing		**$98,488**	
Automotive Equipment Rental & Leasing	432	$9,900	Industry
Machinery & Equipment Rental & Leasing	434	$88,588	Industry
Professional, Scientific & Technical Services		**$148,611,441**	
Legal Services	437	$213,901	Industry
Architectural & Engineering Services	439	$86,071	Industry
Management Consulting Services	444	$19,555	Industry
Environmental & Other Technical Consulting Services	445	$4,300	Industry
Scientific Research & Development Services	446	$112,409,885	Industry
Miscellaneous Professional & Technical Services	450	$35,877,729	Industry
Administrative & Support and Waste Management Services		**$19,023,664**	
Facilities Support Services	453	$14,226,545	Industry
Travel Arrangement & Reservation Services	456	$420,870	Industry
Investigation & Security Services	457	$4,376,248	Industry
Education		**$15,174,356**	
Colleges & Universities	462	$15,174,356	Industry
Health Care & Social Assistance		**$1,350,115**	
Ambulatory Health Care Services	466	$1,350,115	Industry
Accommodation & Food Services		**$6,375**	
Food Services & Drinking Places	481	$6,375	Industry
Other Services		**$19,575**	
Civic, Social, Professional & Similar Organizations	493	$19,575	Industry
Government Enterprises		**$255,384**	
Federal Government Enterprises	496	$248,275	Industry
State & Local Government Enterprises	499	$7,110	Industry
Households		**$123,112,953**	
Household Spending [d]		$ 123,112,953	
TOTAL EXPENDITURES		**$389,100,133**	

[a] **Sector:** Industry classification code used by IMPLAN. It is analogous to the North American Industry Classification System (NAICS). IMPLAN provides a cross-reference table bridging their sector numbers and NAICS codes.

[b] **Expenditure:** Actual dollar value for a product or service spent by NASA Glenn Research Center (Glenn) in FY 2004. Values shown in Table A-4 are limited to expenditures made in the state of Ohio.

[c] **Basis:** Industries consist of businesses producing goods and services; commodities are the goods and services. An **industry** impact gives the entire sector dollar value to the industry that has been selected. A **commodity** impact splits the sector dollar value among all industries producing that commodity.

[d] **Households:** Household expenditures include Glenn employee payroll and medical insurance. Payments have been reduced to include only disposable income. In this analysis, disposable income equals 75 percent of the gross amount. Disposable income excludes income that is used for savings and to pay taxes.