



Prepared for:
NORTECH

Prepared by:
**Ziona Austrian, Ph.D.
Jill Taylor**

December 2007

**THE HIGH-TECH
SECTOR IN
NORTHEAST
OHIO:
2007 UPDATE**

**Center for
Economic
Development**



The Ohio Urban University Program

THE HIGH-TECH SECTOR IN NORTHEAST OHIO: 2007 UPDATE

Prepared for:

NORTECH

Prepared by:

Ziona Austrian, Ph.D.

Jill S. Taylor

December 2007

TABLE OF CONTENTS

EXECUTIVE SUMMARY	I
INTRODUCTION.....	I
MAJOR FINDINGS	I
CONCLUDING REMARKS AND POLICY IMPLICATIONS	III
INTRODUCTION.....	1
RELATIONSHIP TO THE DASHBOARD OF ECONOMIC INDICATORS.....	1
METHODOLOGY.....	3
INDUSTRY ANALYSIS.....	3
OCCUPATIONAL ANALYSIS	4
RESEARCH & DEVELOPMENT ANALYSIS.....	4
HIGH-TECH INDUSTRIES BY LEVEL OF TECHNOLOGY INTENSITY	5
EMPLOYMENT	5
AVERAGE WAGES IN HIGH-TECH INDUSTRIES	13
GROSS REGIONAL PRODUCT GENERATED BY HIGH-TECH INDUSTRIES	16
PRODUCTIVITY (GRP PER EMPLOYEE) IN HIGH-TECH INDUSTRIES.....	17
HIGH-TECH INDUSTRIES BY TECHNOLOGY GROUP.....	19
EMPLOYMENT BY TECHNOLOGY GROUP	19
AVERAGE WAGES BY TECHNOLOGY GROUP	24
GROSS REGIONAL PRODUCT GENERATED BY TECHNOLOGY GROUP	25
HIGH-TECH OCCUPATIONS	27
EMPLOYMENT IN HIGH-TECH OCCUPATIONS	27
RESEARCH & DEVELOPMENT	31
INDUSTRY RESEARCH & DEVELOPMENT	31
ACADEMIC RESEARCH & DEVELOPMENT.....	33
INSTITUTIONAL RESEARCH.....	35
CONCLUDING REMARKS AND POLICY IMPLICATIONS.....	37
APPENDIX A	38
NORTECH SERVICE AREA.....	38
APPENDIX B	39

LIST OF TABLES

TABLE 1. EMPLOYMENT IN HIGH-TECH INDUSTRIES: NEO, 2000-2006.....	6
TABLE 2. EMPLOYMENT CHANGE IN HIGH-TECH INDUSTRIES:NEO, THE MIDWEST AND U.S., 2000-2006.....	6
TABLE 3. HIGH-TECH EMPLOYMENT SHARE: NEO, THE MIDWEST AND U.S., 2000-2006	8
TABLE 4. HIGH-TECH EMPLOYMENT SHARE: NEO METROPOLITAN AREAS, 2006.....	11
TABLE 5. AVERAGE WAGES IN HIGH-TECH INDUSTRIES: NEO, THE MIDWEST AND U.S.	15
TABLE 6. GRP IN HIGH-TECH INDUSTRIES: NEO, THE MIDWEST AND U.S., 2000-2006	16
TABLE 7. HIGH-TECH SHARE OF TOTAL GRP: NEO, THE MIDWEST AND U.S.....	17
TABLE 8. PRODUCTIVITY IN HIGH-TECH INDUSTRIES: NEO, THE MIDWEST AND U.S.	17
TABLE 9. EMPLOYMENT BY TECHNOLOGY GROUP: NEO, 2000-2006	20
TABLE 10. EMPLOYMENT CHANGE BY TECHNOLOGY GROUP: NEO, THE MIDWEST AND U.S., 2000-2006.....	21
TABLE 11. EMPLOYMENT SHARE BY TECHNOLOGY GROUP: NEO, MIDWEST AND U.S., 2000 TO 2006	22
TABLE 12. AVERAGE WAGES BY TECHNOLOGY GROUP:NEO, MIDWEST AND U.S.	24
TABLE 13. GRP BY TECHNOLOGY GROUP:NEO, THE MIDWEST AND U.S., 2000-2006	25
TABLE 14. SHARE OF TOTAL GRP BY TECHNOLOGY GROUP: NEO, THE MIDWEST AND U.S.....	26
TABLE 15. EMPLOYMENT IN HIGH-TECH OCCUPATIONS BY OCCUPATIONAL CLUSTER, 2005 AND 2006	27
TABLE 16. EMPLOYMENT IN HIGH-TECH OCCUPATIONAL CLUSTERS AS A SHARE OF TOTAL HIGH-TECH EMPLOYMENT AND TOTAL EMPLOYMENT, 2006	28
TABLE 17. EMPLOYMENT IN HIGH-TECH OCCUPATIONS BY METROPOLITAN AREA, 2005 AND 2006.....	29
TABLE 18. HIGH-TECH EMPLOYMENT BY OCCUPATIONAL CLUSTER: AKRON AND CLEVELAND METROPOLITAN AREAS, 2005 AND 2006.....	29
TABLE 19. SHARE OF HIGH-TECH EMPLOYMENT BY OCCUPATIONAL CLUSTER: AKRON AND CLEVELAND METROPOLITAN AREAS, 2005 AND 2006.....	30
TABLE 20. ESTIMATED INDUSTRY R&D FUNDING BY SUB-REGION, 1993-2004.....	31
TABLE 21. ESTIMATED INDUSTRY R&D FUNDING PER EMPLOYEE	32
TABLE 22. R&D EXPENDITURES AT NEO COLLEGES AND UNIVERSITIES BY FUNDING SOURCE, FY 2005	33
TABLE 23. R&D EXPENDITURES AT NORTHEAST OHIO COLLEGES AND UNIVERSITIES, FY 2000-2005	34
TABLE 24. ACADEMIC R&D EXPENDITURES PER EMPLOYEE.....	35

TABLE B1. CHANGE IN HIGH-TECH EMPLOYMENT BY LEVEL OF HIGH-TECH INTENSITY: NEO, THE MIDWEST AND U.S., 2000-2006.....	40
TABLE B2. CHANGE IN HIGH-TECH EMPLOYMENT BY TECHNOLOGY GROUP: NEO, THE MIDWEST AND U.S., 2000-2006.....	41
TABLE B3. CHANGE IN HIGH-TECH GRP BY LEVEL OF HIGH-TECH INTENSITY: NEO, THE MIDWEST AND U.S., 2000-2006.....	42
TABLE B4. CHANGE IN HIGH-TECH GRP BY TECHNOLOGY GROUP: NEO, THE MIDWEST AND U.S., 2000- 2006.....	43
TABLE B5. HIGH-TECH EMPLOYMENT BY OCCUPATION, 2006	44

LIST OF FIGURES

FIGURE 1. TOTAL EMPLOYMENT AND HIGH-TECH EMPLOYMENT INDEX	5
FIGURE 2. EMPLOYMENT CHANGE: NEO, THE MIDWEST, AND U.S., 2004-2006	7
FIGURE 3. HIGH-TECH EMPLOYMENT SHARE: NEO, MIDWEST AND U.S., 2000 TO 2006	8
FIGURE 4. TOTAL HIGH-TECH EMPLOYMENT BY MSA, 2006	11
FIGURE 5. TOTAL HIGH-TECH EMPLOYMENT BY MSA: PERCENTAGE CHANGE, 2004-2006	12
FIGURE 6. HIGH-TECH EMPLOYMENT IN CLEVELAND AND AKRON MSAs, PERCENTAGE CHANGE: 2004-2006	13
FIGURE 7. AVERAGE WAGES IN HIGH-TECH, NON HIGH-TECH AND ALL INDUSTRIES: NEO, THE MIDWEST AND U.S., 2006	14
FIGURE 8. CHANGE IN AVERAGE WAGES IN HIGH-TECH INDUSTRIES: NEO, THE MIDWEST AND U.S., 2004-2006	15
FIGURE 9. PRODUCTIVITY CHANGES IN HIGH-TECH INDUSTRIES: NEO, THE MIDWEST, AND THE U.S., 2004-2006	18
FIGURE 10. DISTRIBUTION OF EMPLOYMENT BY TECHNOLOGY GROUP: NEO, 2006	19
FIGURE 11. EMPLOYMENT CHANGE BY TECHNOLOGY GROUP: NEO, 2004-2006	20
FIGURE 12. EMPLOYMENT CHANGE BY TECHNOLOGY GROUP: NEO, THE MIDWEST, AND U.S., 2004-2006	21
FIGURE 13. CHANGE IN ESTIMATED INDUSTRY R&D FUNDING	32
FIGURE 14. CHANGE IN ACADEMIC R&D EXPENDITURES	35

EXECUTIVE SUMMARY

INTRODUCTION

This report describes trends in the high-tech sector in Northeast Ohio, focusing on the 2004-2006 time period. It is the first update to a baseline report released in February 2007 that analyzed trends between 2000 and 2005.

This study follows the baseline report in that it examines the high-tech sector in Northeast Ohio from three perspectives — high-tech industries, high-tech occupations, and research and development activity. It assesses the strengths and weaknesses of high-tech industries in terms of employment, average wage, gross regional product (output), and productivity. High-tech occupations are analyzed in terms of employment levels. Research and development activity is analyzed in terms of industry R&D funding and academic R&D expenditures. Trends in Northeast Ohio are compared to the Midwest region as well as to the U.S.

This study reports on changes in the high-tech sector as a whole but also offers further analysis of high-tech industries based on two sub-groupings. The first group is based on high-tech intensity. The second grouping is based on an industry's assignment to a specific technology group. The analyses provided in this report (as well as the baseline study) utilize a definition of high-tech industries and occupations offered by Daniel Hecker, an economist at the U.S. Bureau of Labor Statistics (BLS). An industry is considered high-tech if its employment share in technology-oriented occupations accounts for at least twice the national average. High-tech occupations include 71 scientific, engineering, and technician occupations. It should be noted that the high-tech sector includes industries from various industry sectors. The focus on the high-tech sector does not ignore the traditional strengths of the Northeast Ohio economy.

MAJOR FINDINGS

The high-tech sector in Northeast Ohio (NEO) began to experience some gains after several years of decline. However, NEO's high-tech sector as a whole did not perform as well as the same sector in the Midwest and the U.S.

- ❖ Employment in NEO's high-tech industries increased slightly from over 162,600 in 2004 to 164,400 in 2006. The gain of almost 1,800 jobs followed a large loss of over 23,000 jobs between 2000 and 2004.
- ❖ During the 2000-2004 period, the rates of employment decline in high-tech industries in NEO were similar to those in the Midwest and the U.S. NEO lost 12.5 percent of its employment in high-tech industries, compared to a decline of 11.6 percent in the Midwest and a 10 percent loss for the U.S. However, the growth rates during the recovery years of 2004-2006 differed; NEO's high-tech industries grew more slowly (1.1%) than the Midwest (2.3%) and the U.S. (3.9%).
- ❖ The share of the high-tech sector in the overall economy declined in NEO, the Midwest, and the U.S. between 2000 and 2006 because of large declines in the first four years. However, between 2004 and 2006, the share of the high-tech sector increased slightly in NEO and the Midwest and remained stable in the U.S. NEO's share increased slightly

from 8.1 percent in 2004 to 8.2 percent in 2006; the Midwest share grew from 8.8 percent to 8.9 percent, while the U.S. maintained its share of 9.4 percent. By 2006, the high-tech share in NEO was still lower than the share in the Midwest and nationally, but the gap had narrowed.

- ❖ High-tech jobs are more concentrated in NEO's two largest metro areas than in the region as a whole. In 2006 the Cleveland-Elyria-Mentor MSA accounted for 59 percent of NEO's high-tech jobs, while it accounted for only 51 percent of all jobs. The Akron MSA accounted for 21 percent of NEO's high-tech jobs and almost 16 percent of all jobs. By 2006, the high-tech industries played a more significant role in the Akron area; 10.9 percent of all jobs were in high-tech industries in comparison to 9.4 percent in the Cleveland MSA and the U.S. Both Akron and Cleveland MSAs added employment in high tech industries between 2004 and 2006.
- ❖ The average wage for NEO's high-tech industries (\$67,670) was 77 percent higher than the average wage of all industries (\$38,300). Average wages in NEO's both high-tech industries (as a group) and non high-tech industries were lower than average wages in the Midwest and U.S. However the wage gap between NEO and the U.S. was much higher for high-tech industries. Average wages for non high-tech industries were 11 percent higher in the U.S. than in NEO, while the gap was 24 percent in average wages for high-tech industries. Thus, cost of living is only one explanation for the large gap in average wages in high-tech industries. The relatively lower wages paid to employees of high-tech industries in NEO may be a barrier to attracting the best people to Northeast Ohio's high-tech sector.
- ❖ Gross regional product (GRP) measures value added output for each industry. In 2006, total output for all high-tech industries in NEO was \$22.8 billion, accounting for 12.9 percent of the total economy. This is a higher share than the share of high-tech employment (8.2%). GRP in NEO's high-tech industries increased between 2000 and 2006 in contrast to declining high-tech employment. However, the rate of increase in NEO (2.5%), similar to the Midwest (2.8%), was significantly lower than the U.S. (10.3%). By 2006, total high-tech industries accounted for a lower share of total GRP in NEO than in both the Midwest and nation.
- ❖ Productivity in high-tech industries (measured as GRP per employee) is higher than average productivity for all industries. In 2006, productivity in high-tech industries in NEO was 39 percent higher than overall productivity in the economy. It was 43 percent higher in the Midwest and 64 percent higher in the U.S.
- ❖ Analyzing high-tech occupations in all industries versus all occupations in high-tech industries adds a different dimension to the analysis of the high-tech sector. In 2006, approximately 61,000 workers in Northeast Ohio's metropolitan areas were employed in high-tech occupations, an increase of 4.8 percent from the previous year; however, the share of total employment is still lower in the region (3.2%) than across the Midwest (4.0%) and the nation (4.5%).
- ❖ The region's industry mix is reflected in the distribution of high-tech workers across occupational clusters. When compared to the Midwest and the nation, the region has a larger concentration of workers in the Architecture and Engineering cluster. Many of these individuals are employed in engineering occupations that support the region's strong manufacturing base.

- ❖ Over the long term (1993-2004), industry R&D funding in Northeast Ohio increased 11 percent between 1993 and 2004 compared to a 10 percent decline elsewhere in the state and a seven percent decline in the Midwest. The U.S., however, experienced a 36 percent increase in industry R&D funding over that period. Between 2003 and 2004, Northeast Ohio, Ohio, and the Midwest experienced declines in industrial R&D funding (-11%, -14%, and -2%, respectively). Nationally, industry R&D increased by one percent.
- ❖ NEO's universities and colleges reported \$386.7 million in research expenditures in FY 2005. Academic R&D expenditures in Northeast Ohio increased 42 percent between 2000 and 2005. Colleges and universities across the state reported a 47 percent increase over the same time period. NEO's rate of growth in academic R&D was higher than the Midwest (33%) and the U.S. (34%). Between 2004 and 2005, academic R&D expenditures increased 26 percent in Northeast Ohio, a much higher rate of growth compared to 12 percent for institutions across Ohio, 1.2 percent in the Midwest, and 10 percent nationally.
- ❖ Although NEO experienced solid growth in both industry and academic R&D, NEO significantly lags the state, the Midwest, and the U.S. in R&D when examined in relation to employment levels (calculated as R&D dollars per employee to reflect the relative size of these economies).

CONCLUDING REMARKS AND POLICY IMPLICATIONS

This report provides an ongoing monitoring tool describing changes in the high-tech sector in Northeast Ohio in comparison to Midwest states and the U.S. It is important not only to look at the sector as a whole, but also to identify pockets of strength within the high-tech sector. Tracking a specific set of measures on an annual basis provides policy makers with a method for assessing progress and directing resources.

It should be noted that employment is sometimes a poor measure of industry performance and this is particularly true in the high-tech sector where technological advancements may result in fewer jobs but more competitive companies. Northeast Ohio's high-tech sector accounts for a larger share of gross regional product than its share of employment and is more productive than other sectors of the economy. In addition, high-tech industries have a high average wage relative to other industries.

Two issues revealed in this report deserve attention by civic leaders and policy makers: R&D and average wages are significantly lower in Northeast Ohio when compared to the nation. Although R&D has been growing in Northeast Ohio, levels of university and industry R&D (per employee) are very low relative to the U.S. Since R&D and skilled workforce have been shown to be associated with regional economic growth, the region needs to increase support and stimulate more research activities as well as offer competitive wages to employees in high-tech industries.

It is important to consider changes in NEO's high-tech sector in the context of national trends, which have been shifting in recent years. It is also important to recognize that no single organization can affect widespread change in a large regional economy. However, it is hoped that the additional focus and investment in technology-based economic development will begin to "move the needle" for some of the measures included in this report.

INTRODUCTION

This report describes trends in the high-tech sector in Northeast Ohio, focusing on the 2004-2006 time period. It is the first update to a baseline report released in February 2007 that analyzed trends between 2000 and 2005. These reports were prepared for NorTech by the Center for Economic Development at Cleveland State University's Maxine Goodman Levin College of Urban Affairs.

This study follows the baseline report in that it examines the high-tech sector in Northeast Ohio from three perspectives — high-tech industries, high-tech occupations, and research and development activity. It assesses the strengths and weaknesses of high-tech industries in terms of employment, average wage, gross regional product (output), and productivity. High-tech occupations are analyzed in terms of employment levels. Research and development activity is analyzed in terms of industry R&D funding and academic R&D expenditures.

This study differs from the baseline study by providing additional industry analysis. High-tech industries are not only analyzed according to their level of high-tech intensity (as in the previous report) but also according to their assignment to a specific technology group. This study also differs from the baseline report by expanding the geographic comparison. Trends in Northeast Ohio are compared to the Midwest region as well as to the U.S. The Midwest region is defined as an aggregation of six states including Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

It should be noted that the high-tech sector includes industries from various industry sectors, including Manufacturing; Mining; Utilities; Transportation and Warehousing; Information; Wholesale Trade; Finance and Insurance; and Professional, Scientific, and Technical Services. The focus on the high-tech sector does not ignore the traditional strengths of the Northeast Ohio economy.

RELATIONSHIP TO THE DASHBOARD OF ECONOMIC INDICATORS

This report complements the Dashboard of Economic Indicators project funded by the Fund for Our Economic Future (also one of NorTech's funders). The Dashboard Indicators project is an ongoing effort that tracks economic and social variables that are linked to economic growth. Data for 38 variables were collected for 136 metropolitan areas across the U.S. with populations between 300,000 and 3.5 million. Variables were then grouped statistically into nine factors; the factors associated with economic growth are referred to as Dashboard Indicators. The Dashboard Indicators include Skilled Workforce and R&D, Technology Commercialization, Racial Inclusion & Income Equality, Urban Assimilation, Legacy of Place, Business Dynamics, Individual Entrepreneurship, Locational Amenities, and Urban/Metro Structure. Economic growth is measured in terms of employment, regional product (output), productivity, and per capita income.

This report builds on the Dashboard by using the same four measures of economic growth. It also analyzes some of the same variables used in the Dashboard that are relevant to the high-tech sector, such as industry and academic research and development funding.

This project differs from the Dashboard project in terms of geographic focus. While the Dashboard measures economic performance for metropolitan areas, including four in Northeast

Ohio, this report defines Northeast Ohio as a 21-county area that includes both metropolitan and non-metropolitan counties. Since it is not a statistical region that can be compared to other regions in the country, this study compares Northeast Ohio to the national average and the average of Midwest states. Moreover, this study focuses only on the high-tech sector, while the Dashboard addresses all sectors of the economy. Because of the more narrow focus of this study, it is possible to include an in-depth analysis of the individual industries that comprise the high-tech sector.

METHODOLOGY

This study examines the high-tech sector in Northeast Ohio from three perspectives — an analysis of high-tech industries, high-tech occupations, and research and development activity. Each analysis draws upon a different data set; details are provided below.

Northeast Ohio (NEO) is defined as a 21-county area to correspond to NorTech's service area. NEO consists of six metropolitan areas that encompass 13 counties (Cleveland-Elyria-Mentor, Akron, Canton-Massillon, Mansfield, Sandusky, and Youngstown-Warren-Boardman) and eight non-metro counties. The Cleveland metro area includes Cuyahoga, Geauga, Lake, Lorain, and Medina Counties; the Akron metro area includes Portage and Summit Counties; the Canton metro area includes Carroll and Stark Counties; the Mansfield metro area includes Richland County; the Sandusky metro area includes Erie County; and the Youngstown metro area includes Mahoning and Trumbull Counties as well as Mercer County, Pennsylvania.¹ The eight non-metro counties include Ashland, Ashtabula, Columbiana, Crawford, Holmes, Huron, Tuscarawas, and Wayne. A list of all Northeast Ohio sub-regions and their counties is also included in Appendix A.

INDUSTRY ANALYSIS

The industry analysis provided in this report (as well as the baseline study) utilizes a definition of high-tech industries offered by Daniel Hecker, an economist at the U.S. Bureau of Labor Statistics (BLS). Hecker identifies 46 four-digit NAICS industries as high-tech. "An industry is considered high-tech if employment in technology-oriented occupations accounted for a proportion of that industry's total employment that was at least twice the 4.9 percent average for all industries."²

This study reports on changes in the high-tech sector as a whole but also offers further analysis of the 46 high-tech industries based on two sub-groupings. The first group is based on high-tech intensity. It also draws upon the work of Hecker, who identified three levels of high-technology industries. Level I includes the 14 most high-tech intensive industries, where employment in high-tech occupations accounts for at least five times the national average. Level II includes 12 moderately high-tech intensive industries, where employment in high-tech occupations accounts for 3.0 to 4.9 times the national average. Level III includes the 20 least intensive high-tech industries, where employment in high-tech occupations accounts for 2.0 to 2.9 times the average. It should be noted that Hecker's definition does not include the healthcare sector. The second grouping is based on an industry's assignment to a specific technology group. NorTech assigned each of the 46 high-tech industries into one of eight technology groups. They include: Advanced Manufacturing; Advanced Materials; Bio Science; Electronics; Energy and Power & Propulsion; Information and Communication Technology; Management, Sales, and Facility Support Services; and Science and Engineering.

Trends are examined for the 2000-2006 time period, with a special focus on the more recent two-year period (2004-2006). Total employment in Northeast Ohio declined from 2000 through 2004, but began to increase in 2005. Thus we use the 2004-2006 time period to track gains in Northeast Ohio during the expansionary years. The analyses rely on data from two sources:

¹ With the exception of the analysis of high-tech occupations, this report excludes Mercer County.

² Daniel E. Hecker "High-technology employment: a NAICS-based update." *Monthly Labor Review*, pp. 57-72, July 2005.

the Quarterly Census of Employment and Wages (ES202) and Moody's economy.com. Employment and wage data are extracted from the ES202 database, and gross product and productivity data are derived from economy.com. Employment data include all workers in high-tech industries — regardless of whether or not they are employed in high-tech occupations.

Northeast Ohio is compared to the Midwest and the U.S. The Midwest region is defined as an aggregation of six states: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. Employment trends are also analyzed for the sub-regions that comprise NEO—the six metropolitan areas and the non-metro counties.

OCCUPATIONAL ANALYSIS

This study reports on changes in the number of workers employed in high-tech occupations in all industries in Northeast Ohio. For example, a computer programmer working for a bank would be included in the high-tech occupational data, but would be excluded from data on high-tech industries because the banking industry is not considered as one of the high-tech industries. The occupational analysis also relies upon the work of Daniel Hecker, who identifies 71 scientific, engineering, and technician occupations as high-tech. According to Hecker, “Workers in these occupations need an in-depth knowledge of the theories and principles of science, engineering, and mathematics underlying technology.”

Employment data for the 71 high-tech occupations was obtained from the U.S. Department of Labor, Bureau of Labor Statistics. Employment levels by occupation are estimated by BLS based on a semi-annual survey of establishments. Approximately 200,000 establishments are surveyed every six months, taking three years to fully collect a sample of 1.2 million establishments.³ The smallest geographic level for which data is available is the metropolitan statistical area (MSA), therefore this analysis presents data for the six MSAs that are within NorTech's service area. The eight non-metro counties that are within the service area could not be included in the occupational analysis. Data is presented for 2005 and 2006 — definitional changes in occupations and metropolitan areas preclude long-term trend analysis. Northeast Ohio is compared to the Midwest region (as previously defined) and the U.S.

RESEARCH & DEVELOPMENT ANALYSIS

The study examines research and development activity in the region by looking at industry R&D funding and R&D expenditures of academic institutions. In addition, some data are provided regarding the R&D activity of two other large research institutions in Northeast Ohio. Data on industry and academic R&D were obtained from the National Science Foundation (NSF), Division of Science Resources Statistics. Industry R&D funding is only available at the state level. The level of funding in Northeast Ohio is estimated by distributing statewide funding according to each county's share of employment in one industry—Scientific Research and Development Services (NAICS 5417). This industry includes private sector companies with a primary function of research and development; therefore, employment levels are used to develop a proxy of industry R&D funding at the regional level. Employment counts are derived from Moody's economy.com data. Academic R&D expenditures are provided for individual institutions in Northeast Ohio that reported data to NSF. The latest data available for industry R&D is 2004, and the latest data available for academic R&D are 2005. R&D data for the other research intuitions (the Cleveland Clinic and NASA Glenn Research Center) were provided by each institution.

³ The Occupational Employment Statistics program produces employment and wage estimates for more than 800 occupations. Information and data can be found at: <http://www.bls.gov/oes/>

HIGH-TECH INDUSTRIES BY LEVEL OF TECHNOLOGY INTENSITY

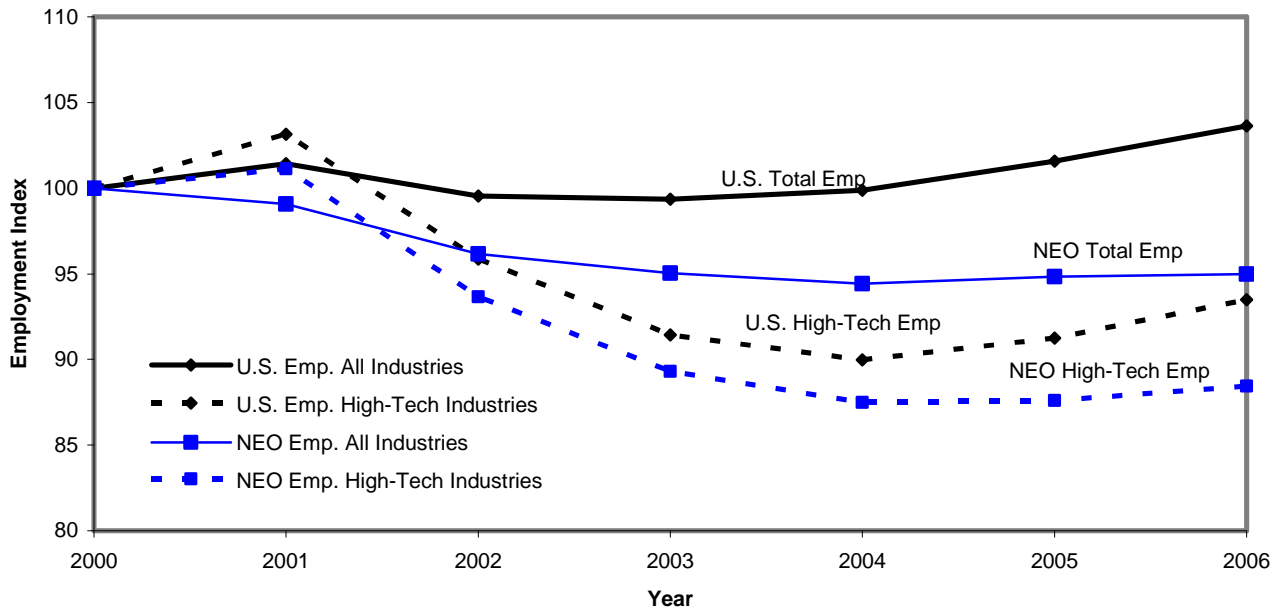
This section analyzes high-tech industries in terms of employment, average wages, gross regional product, and productivity for the high-tech sector as a whole and the three levels of technology intensity defined by Hecker. The analysis compares Northeast Ohio to the Midwest and the U.S.; all three geographies include small and large metropolitan areas as well as rural (non-metro) counties.

EMPLOYMENT

High-Tech Employment in Northeast Ohio (NEO), the Midwest, and the U.S.

NEO's overall employment declined between 2000 and 2006 in contrast to growing employment in the U.S. Between 2000 and 2003, employment in NEO fell at a higher rate than the nation. The U.S. began to register employment growth in 2004, while NEO saw its first slight increase in 2005. As a result of the deeper decline during the earlier years and sluggish employment growth in the later years, NEO lost five percent of its employment base between 2000 and 2006, while the U.S. gained 3.6 percent (Figure 1).

Figure 1. Total Employment and High-Tech Employment Index, 2000=100



Employment in high-tech industries peaked in both the U.S. and NEO in 2001. It declined through 2004 following similar trends; employment in U.S. high-tech industry fell by 12.8 percent while the number of jobs in NEO's high-tech industries declined by 13.5 percent. Although employment in high-tech industries increased in both NEO and the U.S. between 2004 and 2006, the national rate of growth (3.9%) exceeded that of NEO (1.1%).⁴

Total high-tech employment in NEO increased slightly from 162,625 in 2004 to 164,394 in 2006. The overall period between 2000 and 2006 shows a large decline through 2004 (-23,271), followed by a small increase of 1,769 between 2004 and 2006 (Table 1). The data indicate that the high-tech sector in Northeast Ohio began to experience some gains after several years of decline.

Table 1. Employment in High-Tech Industries: NEO, 2000-2006

Industry	Employment	Employment Change		
	2006	2000-2004	2004-2006	2000-2006
Level I High-Tech Industries	49,479	-10,597	2,728	-7,869
Level II High-Tech Industries	36,648	-6,192	105	-6,086
Level III High-Tech Industries	78,268	-6,483	-1,064	-7,547
Total High-Tech Employment	164,394	-23,271	1,769	-21,502
Total Employment, All Industries	2,013,644	-118,044	11,822	-106,222

How do NEO's high-tech industries compare to the average of the Midwest states? In general, employment growth in the Midwest fell between that of NEO and the U.S. During the declining years between 2000 and 2004, NEO lost 12.5 percent of its employment in high-tech industries, compared to a decline of 11.6 percent in the Midwest and a 10 percent loss for the U.S. (Table 2). In the recovery years of 2004 to 2006, high-tech industries in the Midwest grew faster (2.3%) than in NEO (1.1%), but not as fast as in the U.S. (3.9%).

Table 2. Employment Change in High-Tech Industries: NEO, the Midwest and U.S., 2000-2006

Industry	Employment Change (2000-2004)			Employment Change (2004-2006)			Employment Change (2000-2006)		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Level I High-Tech Industries	-18.5%	-14.9%	-10.8%	5.8%	3.2%	5.9%	-13.7%	-12.2%	-5.5%
Level II High-Tech Industries	-14.5%	-12.5%	-6.2%	0.3%	4.2%	4.3%	-14.2%	-8.9%	-2.1%
Level III High-Tech Industries	-7.6%	-7.5%	-11.4%	-1.3%	0.3%	0.7%	-8.8%	-7.2%	-10.9%
Total High-Tech	-12.5%	-11.6%	-10.0%	1.1%	2.3%	3.9%	-11.6%	-9.6%	-6.5%
Total Employment, all industries	-5.6%	-3.8%	-0.1%	0.6%	1.6%	3.7%	-5.0%	-2.3%	3.6%

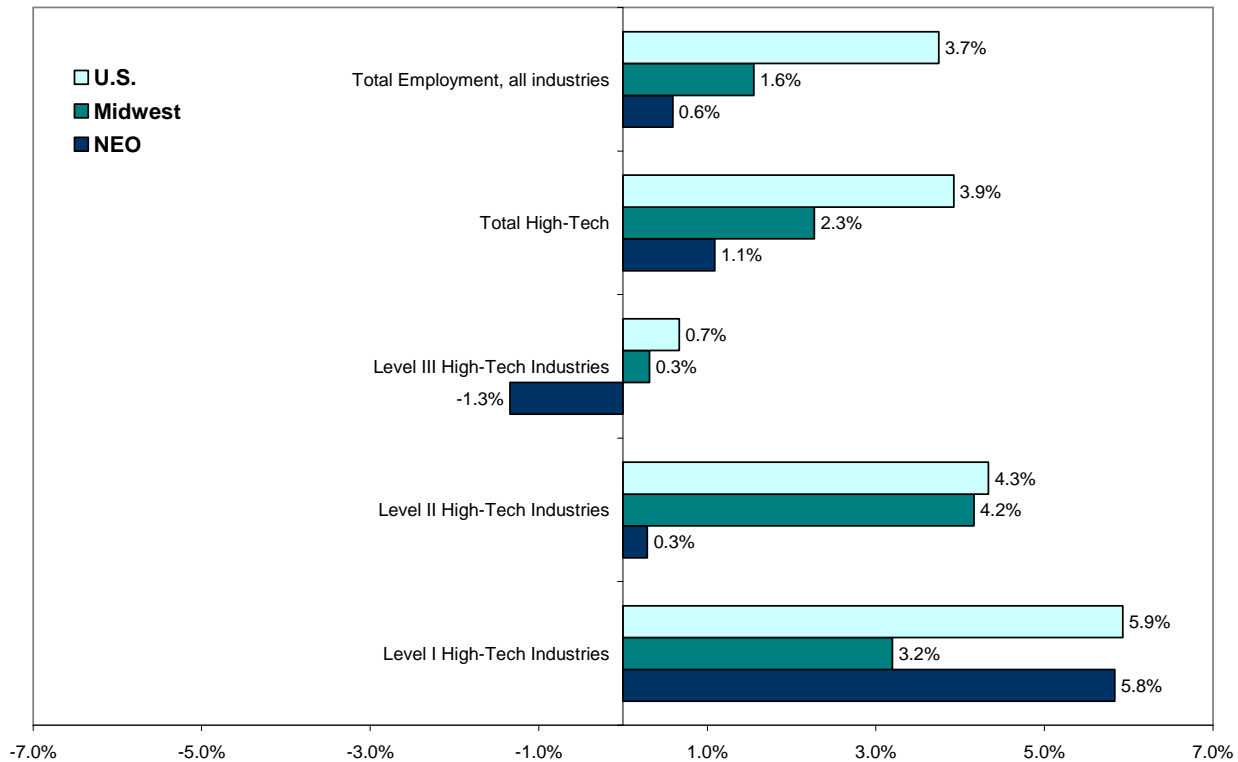
The largest high-tech category in NEO is level III, while level I is the largest high-tech category in the Midwest and in the U.S. Level II is the smallest category in all three geographies. Between 2000 and 2004, employment declined in all three levels in NEO, the Midwest, and the U.S. (Table 2). While NEO suffered higher rates of job losses in level I and level II high-tech industries than the Midwest and the U.S., the rate of decline in level III was similar to the Midwest, and both experienced smaller rates of decline than the U.S. Although level III industries continued to lose jobs in NEO in the following two years (-1.3%), levels I and II

⁴ The definition of the high-tech sector employed in this study does not include the health care sector. NASA Glenn Research Center is also excluded because it is classified as part of the Public Administration sector.

industries added jobs between 2004 and 2006. Moreover, level I jobs in NEO grew by 5.8 percent, similar to the U.S. (5.9%) and much faster than the Midwest (3.2%).

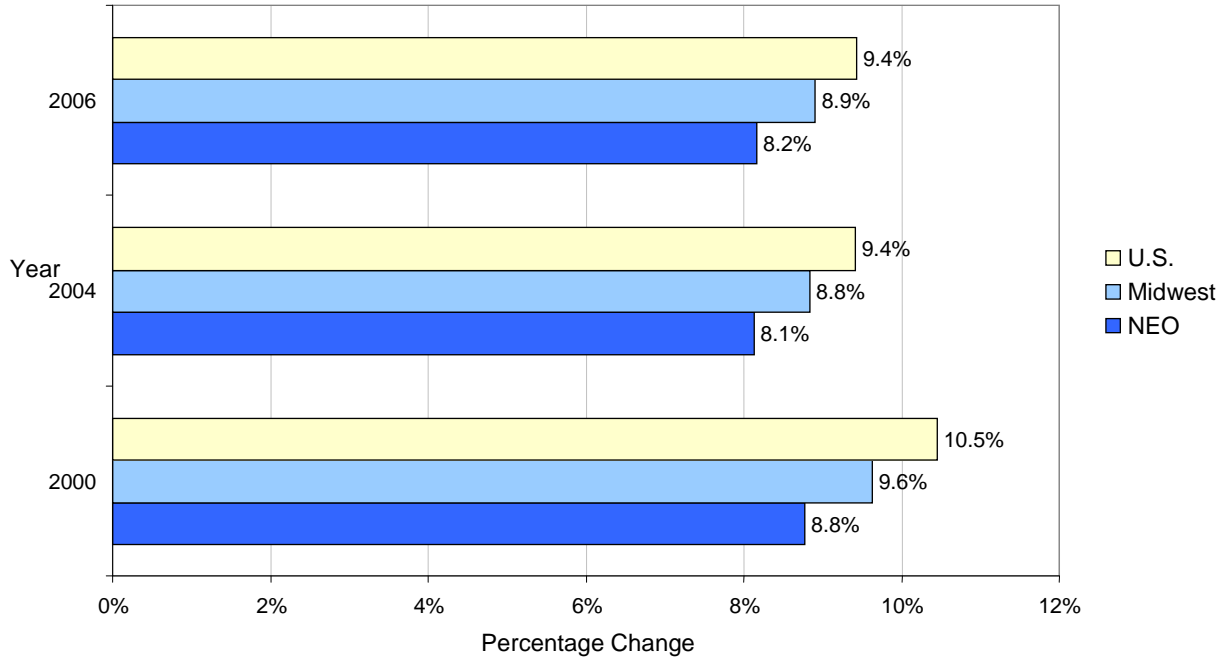
Figure 2 shows the rates of change by technology level in NEO, the Midwest, and the U.S. between 2004 and 2006. It highlights the fact that among the three levels, level I industries grew at the fastest rate in NEO.

Figure 2. Employment Change: NEO, the Midwest, and U.S., 2004-2006



The share of total employment in high-tech industries increased slightly between 2004 and 2006 in NEO and the Midwest and remained stable in the U.S. Following declining shares in all three areas during the early 2000s, NEO's share of employment in high-tech industries increased slightly from 8.1 percent in 2004 to 8.2 percent in 2006 (Table 3 and Figure 3). However, the share in NEO is still lower than in the U.S. In 2006, 8.2 percent of all jobs in NEO were found in high-tech industries in comparison to 8.9 percent in the Midwest and 9.4 percent in the U.S. Although the high-tech share in NEO is lower, the gap between NEO and the U.S. is narrowing: in 2000, the share of employment in high-tech industries was 1.7 percentage points lower than in the U.S. in comparison to 1.2 percentage points in 2006.

Figure 3. High-Tech Employment Share: NEO, Midwest and U.S., 2000 to 2006



The difference between NEO and U.S. shares is more pronounced in level I high-tech industries, the most high-tech intensive industries. Although NEO’s employment share in level I industries increased, level I jobs accounted for 2.5 percent of all jobs in 2006 compared to 4.5 percent in the U.S. In contrast, NEO’s share of level III high-tech jobs (3.9%) was higher than in the Midwest (3.4%) and the U.S. (2.9%). This is consistent with NEO’s competitive clusters and industry mix.

Table 3. High-Tech Employment Share: NEO, the Midwest and U.S., 2000-2006

Industry	Share of Total Employment, 2000			Share of Total Employment, 2004			Share of Total Employment, 2006		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Level I High-Tech Industries	2.7%	3.9%	4.9%	2.3%	3.5%	4.4%	2.5%	3.5%	4.5%
Level II High-Tech Industries	2.0%	2.1%	2.2%	1.8%	1.9%	2.0%	1.8%	1.9%	2.1%
Level III High-Tech Industries	4.0%	3.6%	3.3%	4.0%	3.5%	3.0%	3.9%	3.4%	2.9%
Total High-Tech Employment	8.8%	9.6%	10.5%	8.1%	8.8%	9.4%	8.2%	8.9%	9.4%
Total Employment, All Industries	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

To understand the performance of the three industry levels, one needs to see the individual industries included in each (according to Hecker’s definition). Table B1 in Appendix B provides the list of industries in each level and compares employment trends in NEO, the Midwest, and the U.S. between 2000 and 2006. Although employment in high-tech industries declined in NEO, the Midwest, and the U.S., there was growth in eight industries in NEO over the six-year period. Many more high-tech industries gained employment between 2004 and 2006.

Level I High-Tech Industries

Three level I high-tech industries added jobs in Northeast Ohio between 2000 and 2006: Scientific Research and Development Services grew 74.5 percent (1,450 jobs), a significantly larger increase than in the Midwest (3.4%) and the U.S. (14.5%); Pharmaceutical and Medicine Manufacturing gained 67 percent (nearly 600 jobs) in comparison to a 6.4 percent gain in the Midwest and a 6.9 percent increase in the U.S.; and Data Processing, Hosting, and Related Services increased slightly by 2.2 percent, while the Midwest and the U.S. experienced declines of 23.9 and 16.7 percent, respectively. These three industries added jobs in NEO even during the recessionary years.

Seven of the 13 level I high-tech industries added jobs in NEO between 2004 and 2006. The four fastest-growing industries grew faster in NEO than the Midwest and the U.S.:

- ✓ Scientific Research and Development Services (31.8% in NEO versus 3.7% in the Midwest and 8.6% in the U.S.)
- ✓ Pharmaceutical and Medicine Manufacturing (23.2% in NEO versus a decline of 2.8% in the Midwest and an increase of 0.7% in the U.S.)
- ✓ Computer System Design and Related Service (14.7% in NEO versus 9.7% in the Midwest, and 11.4% in the U.S.)
- ✓ Semiconductor and Other Electronic Component Manufacturing (12.1% in NEO versus 2.8% in the Midwest and 1.2% in the U.S.)

Two other industries grew in NEO, but at slower rates than the U.S.: Aerospace Product and Parts Manufacturing and Architectural, Engineering, and Related Services. The seventh level I industry that gained employment, Computer and Peripheral Equipment Manufacturing, increased only slightly (0.8%) in NEO in contrast to employment losses in both the Midwest and the U.S. Two of the seven growing industries each employed more than 10,000 employees in NEO in 2006, and each of four other growing industries employed between 1,400 and 3,700 employees. One has almost 600 employees.

Level II high-Tech Industries

Employment in level II industries also declined in both NEO and the U.S. between 2000 and 2006, but one industry added jobs in NEO during this period. Management, Scientific, and Technical Consulting Services grew by 9.9 percent, faster than in the Midwest (7.5%), but slower than nationally (31.1%).

While NEO's level II industries as a group showed a very small employment increase between 2004 and 2006 (0.3%), three industries experienced more substantial growth. One of these performed better in NEO than in the Midwest and the U.S. The growing industries include:

- ✓ Management, Scientific, and Technical Consulting Services (15.5% growth in NEO, 12.8% in the Midwest, and 18.4% in the U.S.)
- ✓ Industrial Machinery Manufacturing (5.7% in NEO, lower than the Midwest growth of 8.3%, but higher than the 1.5% growth in the U.S.)
- ✓ Manufacturing and Reproducing, Magnetic and Optical Media (2.2% in NEO versus declines of 3.1% in the Midwest and 11.2% in the U.S.).

Level III Industries

Level III industries, the least intensive high-tech industries, lost employment in both the recessionary and expansionary periods. Between 2000 and 2006, NEO's level III industries as a group lost 8.8 percent of their jobs, a smaller decline than nationally (-10.9%), but larger than

the Midwest (-7.2%). However, three industries added jobs throughout this period in NEO, all performing better than the U.S. and one performing better than in the Midwest. The three industries include:

- ✓ Facilities Support Services (54.3% in NEO versus 64.9% in the Midwest and 26.2% in the U.S.)
- ✓ Telecommunication Resellers (22.1% in NEO versus declines of 20.3% in the Midwest and 32.7% in the U.S.)
- ✓ Management of Companies and Enterprises (8.7% in NEO versus 13.6% in the Midwest and 0.2% in the U.S.).

Although the group as a whole lost employment in NEO in the most recent two years, 2004-2006 (-1.3%), only eight of the 16 industries presented in Table B1 (Appendix B) lost employment. The fastest-growing level III industries in NEO, with a growth rate exceeding five percent growth include:

- ✓ Facilities Support Services grew by 17 percent in NEO; growth rates were 25.4 percent in the Midwest and 8.8 percent in the U.S. By 2006, the industry employed nearly 1,850 people.
- ✓ Engine, turbine, and power transmission equipment manufacturing grew by 6.5 percent in NEO; faster growth than in the Midwest, 4.1 percent, and slower than in the U.S., 8.8 percent. The industry had 1,630 jobs by 2006.
- ✓ Electrical Equipment Manufacturing grew by 5.1 percent in NEO, while it declined in the Midwest by 2.7 percent and remained stable nationally. The industry employed about 4,800 people in 2006.

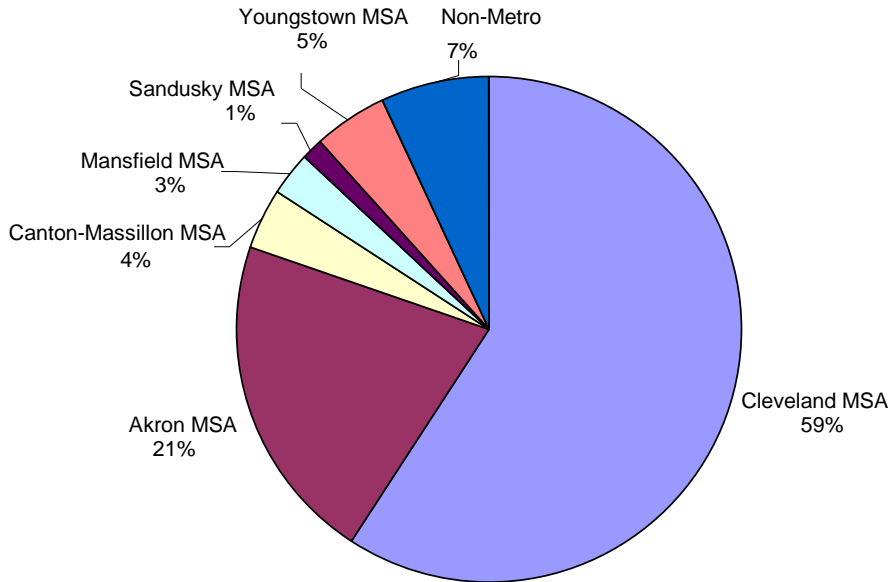
High-Tech Employment in NEO's Sub-Regions

NEO is not a unified economic region and thus an analysis of the high-tech sector in the individual sub-regions is useful. The Cleveland-Elyria-Mentor metropolitan area is by far the largest economy in Northeast Ohio. In 2006, it accounted for one-half (51%) of all jobs and 59 percent of all high-tech employment (Figure 4). Thus, high-tech jobs are more concentrated in the Cleveland area in comparison to the larger regional economy.

The second-largest high-tech area is the Akron MSA, accounting for one-fifth (21%) of all high-tech jobs in NEO. The Akron area accounts for 15.8 percent of NEO's total employment, thus high-tech jobs are more heavily concentrated in the Akron area than any other metro area in Northeast Ohio.⁵

⁵ The location quotient for high-tech employment in the Cleveland MSA relative to Northeast Ohio is 1.16. The location quotient for high-tech employment in the Akron MSA is 1.33. Location quotient is the measure of concentration of an industry or sector in a local economy (in this case, the MSA) relative to a reference economy (in this case, Northeast Ohio). A location quotient greater than 1.0 indicates that the industry is more concentrated in the local economy than the reference economy.

Figure 4. Total High-Tech Employment by MSA, 2006



Moreover, high-tech industries play a more significant role in Akron than in the other regions as measured by the share of high-tech jobs in the metropolitan economy. In the Akron MSA, 10.9 percent of all jobs are in high-tech industries (Table 4); this is higher than the 9.4 percent share in the Cleveland-Elyria-Mentor MSA and the nation. The Canton-Massillon and Youngstown-Warren-Boardman metropolitan areas have the lowest shares of high-tech employment in their respective economies, both registering less than half of the regional share.

Table 4. High-Tech Employment Share: NEO Metropolitan Areas, 2006

	Industry			Total High-Tech
	Level I	Level II	Level III	
Cleveland MSA	3.1%	2.0%	4.3%	9.4%
Akron MSA	2.9%	2.2%	5.8%	10.9%
Canton-Massillon MSA	1.0%	1.2%	1.5%	3.7%
Mansfield MSA	2.9%	1.6%	3.6%	8.2%
Sandusky MSA	0.6%	2.9%	3.2%	6.7%
Youngstown MSA	1.0%	0.8%	2.4%	4.2%
Non-Metro Counties	1.4%	1.5%	2.4%	5.2%
NEO	2.5%	1.8%	3.9%	8.2%
U.S.	4.5%	2.1%	2.9%	9.4%

Among the smaller metropolitan areas, Mansfield has the largest share of high-tech employment at 8.2 percent. However, the Mansfield MSA has only 57,000 employees, of whom 4,650 are employed in high-tech industries.

The Akron and Cleveland metropolitan areas, as well as NEO's non-metro counties, added employment in high-tech industries between 2004 and 2006 (Figure 5). The Cleveland area added nearly 2,000 jobs in high-tech industries for a gain of 2.1 percent, while the Akron area

added 665 employees in high-tech industries for an increase of 2.0 percent. In contrast, NEO's smaller metropolitan areas lost employment in high-tech industries, but their combined losses were smaller than the gains in the other sub-regions resulting in a net increase of close to 1,800 jobs (or 1.1%) in high-tech industries in Northeast Ohio.

Figure 5. Total High-Tech Employment by MSA: Percentage Change, 2004-2006

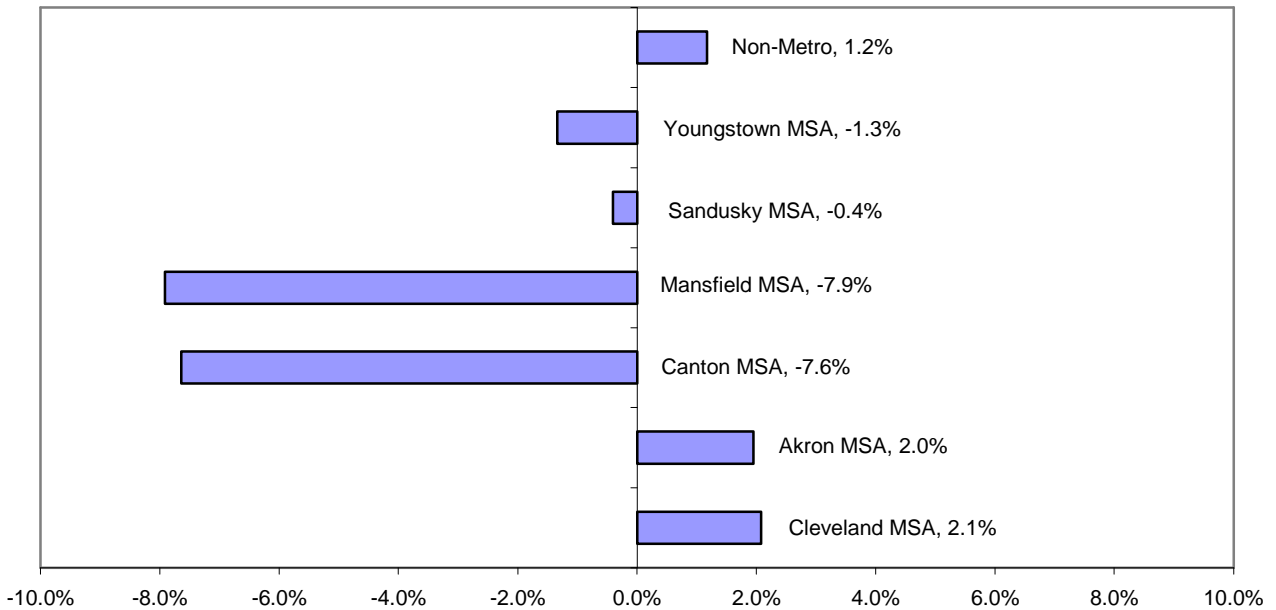
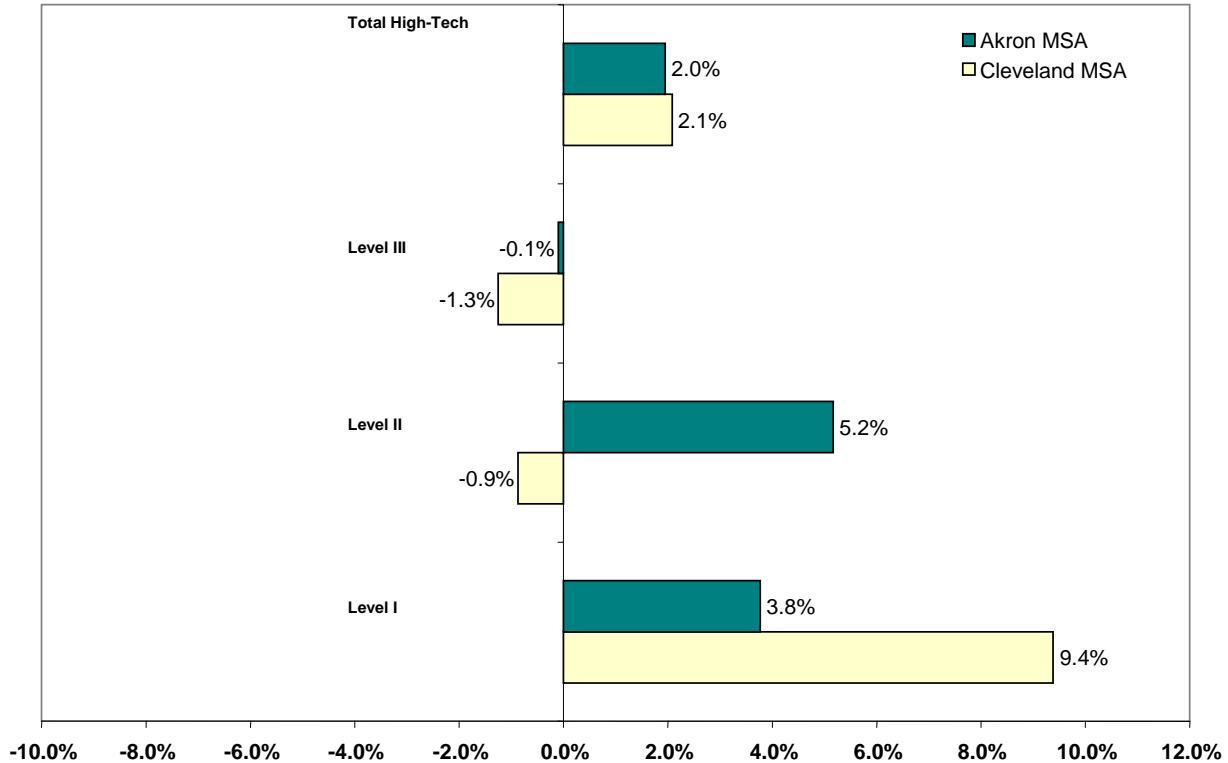


Figure 6 shows employment changes by technology level between 2004 and 2006 in the two largest metropolitan areas, Cleveland and Akron. It is evident that although the overall employment growth in high-tech industries in the Cleveland and Akron areas is similar, their gains and losses are attributed to different industries. The Cleveland-Elyria-Mentor MSA added more than 2,700 jobs (a 9.4% growth rate) in level I high-tech industries between 2004 and 2006, while the Akron area gained level I jobs at a slower pace (3.8%). Of the 13 level I industries in the Cleveland MSA, seven added jobs. One industry added more than 1,500 jobs—Computer Systems Design and Related Services—while five other industries added more than 150 jobs each: Scientific Research and Development Services (+680); Architectural, Engineering, and Related Services (+320); Aerospace Products and Parts Manufacturing (+200); Pharmaceutical and Medicine Manufacturing (+170); and Semiconductor and Other Electronic Component Manufacturing (+170). Seven level I high-tech industries also added jobs in the Akron area, with four industries each adding between 100 and 150 jobs.

Figure 6. High-Tech Employment in Cleveland and Akron MSAs: Percentage Change, 2004-2006



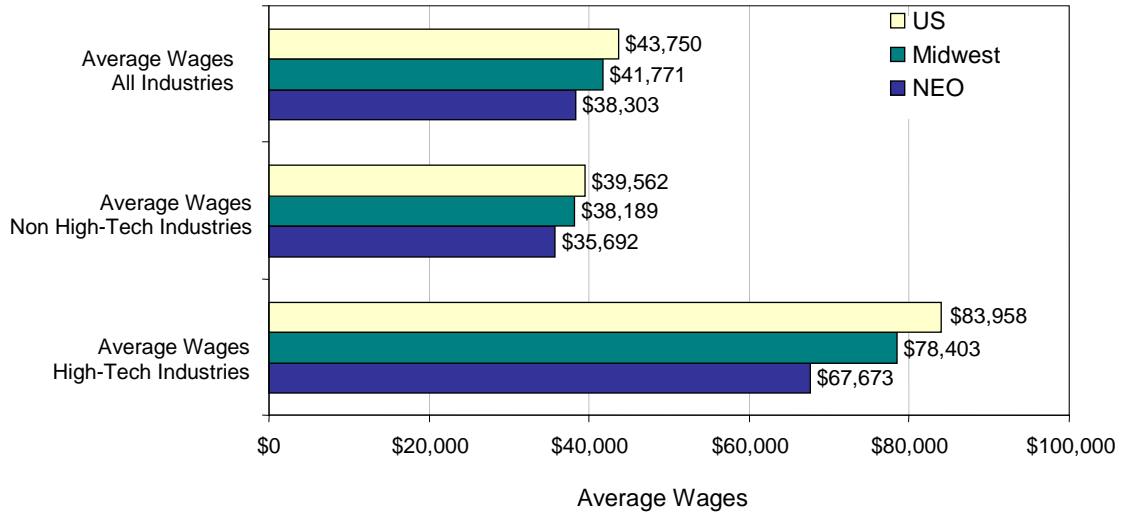
The Cleveland area lost jobs in level II industries combined (-0.9%), while the Akron MSA experienced 5.2 percent growth. Analyzing individual industries shows that two level II industries added jobs in the Cleveland metro area: Industrial Machinery Manufacturing added 75 employees and Management, Scientific, and Technical Consulting Services gained more than 800 jobs. In the Akron metro area, four level II industries added jobs, of which three added fewer than 100 jobs each and one industry gained more than 400 employees—Professional and Commercial Equipment and Supplies, Merchant Wholesalers.

The Cleveland area lost 1.3 percent of its employment in level III high-tech industries. Of the 16 industries, only five added jobs: Other General-Purpose Machinery Manufacturing (+130); Electrical Equipment Manufacturing (+90); Petroleum and Coal Products Manufacturing (+80); and Engine, Turbine, and Power Transmission Equipment Manufacturing (+65). Akron’s total employment in level III high-tech industries remained the same. However, Other General-Purpose Machinery Manufacturing gained 140 employees and two industries added nearly 50 employees each (Electrical Equipment Manufacturing and Electronic and Precision Equipment Repair and Maintenance).

AVERAGE WAGES IN HIGH-TECH INDUSTRIES

In 2006, the average wage in NEO’s high-tech industries was \$67,673. This is 77 percent higher than the average wage of \$38,303 for all industries; the average wage for non high-tech industries in NEO was \$35,692 (Figure 7).

Figure 7. Average Wages in High-Tech, Non High-Tech and All Industries: NEO, the Midwest and U.S., 2006



Average wages in NEO are lower than in the Midwest and the U.S. in both high-tech and non high-tech industries. However, the wage gap is much larger for high-tech industries. For example, the U.S. average wage in non high-tech industries was 11 percent higher than in NEO, while the U.S. wage for high-tech industries was 24 percent higher than in NEO. The wage gap is found in all three levels but is most pronounced in level I industries (Table 5). It is obvious that the difference in cost of living is not the only reason for the wage difference and one might ask whether the relatively low wages in NEO's high-tech industries restrict the ability of local business to attract employees.

Within the high-tech sector, the highest average wage is paid by level III industries in NEO, the Midwest, and the U.S. Thus, on average, the most high-tech intensive industries do not pay the highest wages. The highest-paying level III industries in NEO are Other Pipeline Transportation (\$126,000) and Management of Companies and Enterprises (\$91,200).

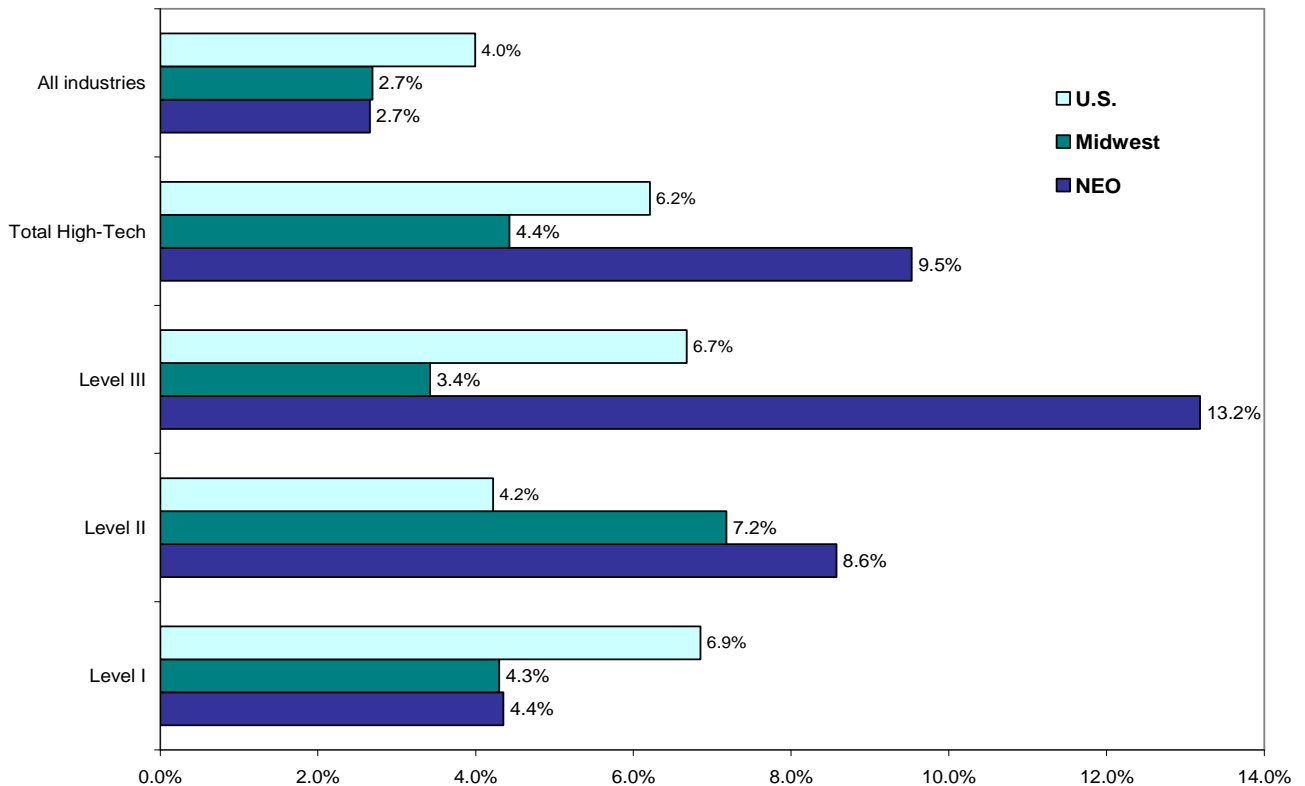
NEO's highest-paying level I industries in 2006 were Scientific Research and Development Services (\$81,500) and Pharmaceutical and Medicine Manufacturing (\$76,200). The highest-paying level II industries were Manufacturing and Reproducing, Magnetic and Optical Media (\$119,400); Electric Power Generation, Transmission, and Distribution (\$88,600); and Basic Chemical Manufacturing (\$87,100).

Table 5. Average Wages in High-Tech Industries: NEO, the Midwest and U.S.

Industry	2006			Percent Change (2004-2006)		
	NEO	MW	U.S.	NEO	MW	U.S.
Level I High-Tech Industries	\$57,939	\$75,418	\$84,104	4.4%	4.3%	6.9%
Level II High-Tech Industries	\$67,805	\$75,503	\$81,156	8.6%	7.2%	4.2%
Level III High-Tech Industries	\$73,765	\$83,126	\$85,736	13.2%	3.4%	6.7%
Total High-Tech	\$67,673	\$78,403	\$83,958	9.5%	4.4%	6.2%
All industries	\$38,303	\$41,771	\$43,750	2.7%	2.7%	4.0%

Between 2004 and 2006, average wages, after adjusting for inflation, increased in NEO, the Midwest, and the U.S. The average wage of level II and III high-tech industries in NEO increased at a faster rate than in the Midwest and the U.S. (Table 5 and Figure 8). However, the average wage in NEO in level I industries rose at a similar rate to the Midwest, both rising slower than the average wage in the U.S.

Figure 8. Change in Average Wages in High-Tech Industries: NEO, the Midwest and U.S., 2004-2006



GROSS REGIONAL PRODUCT GENERATED BY HIGH-TECH INDUSTRIES

Gross regional product (GRP) measures value added output for each industry.⁶ In 2006, total GRP for all high-tech industries in NEO was \$22.8 billion, accounting for 12.9 percent of the total economy. This is a much higher share than the share of high-tech employment in NEO (8.2%). In the Midwest, these shares are 15.5 percent and 8.9 percent, respectively, and in the U.S., these shares are 17.9 percent and 9.4 percent, respectively.

NEO differs from the Midwest and the U.S. in the importance that level III high-tech industries play in the high-tech sector. Within the high-tech sector in NEO, level III accounted for 45 percent of all high-tech GRP in 2006, followed by level II (35%) and level I (20%). In the Midwest and the U.S., the GRP of high-tech industries is more evenly distributed among the three levels, although in the Midwest (like in Northeast Ohio) level III is the largest category.⁷ In the U.S., level I is the largest category of high-tech industries, accounting for 37 percent of GRP produced by the national high-tech sector.

Between 2000 and 2006, GRP of NEO's high-tech sector increased by 5.5 percent after adjusting for inflation (Table 6). This is a slightly higher rate than in the Midwest (5.0%) but lower than the nation (10.3%). The trends in the high-tech sector are close to the trends in the overall economy, where Northeast Ohio tends to grow at a slower pace than in the Midwest and the U.S. In this case, however, Northeast Ohio performed at a slightly better rate. It is interesting to note that NEO's GRP in the high-tech sector grew during the first four years but declined in the latest period studied, 2004 to 2006. It grew in both periods in the Midwest and U.S.

Table 6. GRP in High-Tech Industries: NEO, the Midwest and U.S., 2000-2006

Industry	Change in GRP (2000-2004)			Change in GRP (2004-2006)			Change in GRP (2000-2006)		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Level I High-Tech Industries	-14.3%	-4.3%	-5.3%	-6.3%	7.8%	9.9%	-19.8%	3.1%	4.1%
Level II High-Tech Industries	14.8%	9.7%	13.2%	-2.6%	-3.3%	6.7%	11.8%	6.0%	20.8%
Level III High-Tech Industries	12.7%	5.6%	3.7%	3.8%	0.3%	3.2%	16.9%	5.9%	7.1%
Total High-Tech	6.2%	3.4%	3.2%	-0.7%	1.5%	6.9%	5.5%	5.0%	10.3%
Total in All Industries	4.4%	4.8%	8.8%	2.6%	2.1%	6.0%	7.1%	7.0%	15.3%

Focusing on the performance of the different technology levels in NEO in comparison to the Midwest and the U.S. reveals that between 2000 and 2006, GRP in level III industries grew much faster in NEO than in the Midwest and U.S., however there was a sharp decline in level I industries while the Midwest and U.S. experienced modest gains. GRP in level II industries

⁶ To improve their accuracy, estimates of GRP have been revised since the baseline study was completed. Thus, the reader cannot compare the analyses of GRP and GRP per employee (productivity) between the two studies. For example, using the revised data to analyze changes between 2000 and 2005 (the years analyzed in the original study), shows that GRP in NEO's high-tech sector increased by 1.9 percent in comparison to 7.4 percent reported in the original study. In the U.S., the revised data shows an increase of 6.9 percent, while the original study showed 7.9 percent. GRP in all industries in NEO increased by 3.1 percent using the revised data in comparison to 5.7 percent reported in the first study and GRP in the U.S. for all industries is 11.9 percent after the revision, compared to 14.1 percent in the first study.

⁷ In the Midwest, GRP of level I industries accounts for 34% of all high-tech output, level II accounts for 31% and level III for 36%. In the U.S. level I is the largest category, accounting for 37% of high-tech output; level II accounts for 35%, while level III accounts for only 28%.

grew faster in NEO than in the Midwest but slower than in the U.S. A detailed table on changes in GRP by industry is included in Table B3 in Appendix B.

Analyzing output trends in NEO's largest two sub-regions—Cleveland-Elyria-Mentor and Akron metropolitan areas—between 2004 and 2006 shows that GRP growth follows different patterns. In the Akron area, total high-tech GRP declined by 2.5 percent, while it increased by 2.5 percent in the Cleveland metro area. In the Akron area, the declining high-tech output was a result of falling output in level II industries that was not offset by increased GRP in levels I and III. In the Cleveland area, levels II and III grew at higher rates than the declining level I industries.

Table 7 shows the share of high-tech GRP in the total economy for NEO, the Midwest, and the U.S. Between 2000 and 2006, the GRP share of the high-tech sector declined slightly in NEO, the Midwest, and the U.S. The decline was more significant in U.S., especially in level I industries. The share of NEO GRP that is accountable by level II and level III industries increased.

Table 7. High-Tech Share of Total GRP: NEO, the Midwest and U.S.

Industry	2000			2004			2006		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Level I High-Tech Industries	3.5%	5.4%	7.4%	2.9%	5.0%	6.4%	2.6%	5.3%	6.7%
Level II High-Tech Industries	4.3%	4.8%	5.9%	4.8%	5.0%	6.2%	4.5%	4.7%	6.2%
Level III High-Tech Industries	5.3%	5.6%	5.3%	5.7%	5.6%	5.1%	5.8%	5.5%	5.0%
Total High-Tech	13.1%	15.8%	18.7%	13.3%	15.6%	17.7%	12.9%	15.5%	17.9%
Total in all industries	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

PRODUCTIVITY (GRP PER EMPLOYEE) IN HIGH-TECH INDUSTRIES

GRP per employee is used as a proxy for productivity. Not surprisingly, productivity in high-tech industries is higher than average productivity for all industries. In 2006, productivity in high-tech industries in NEO was 39 percent higher than overall productivity in the economy (it was 43% higher in the Midwest and 64% higher in the U.S.). Within NEO's high-tech sector, level II industries have the highest productivity, followed by level III and level I (Table 8). However, in both the Midwest and the U.S., level III industries have the highest GRP per employee, followed by level I. GRP per employee is higher in the U.S. than in NEO in each high-tech industry level; a comparison between NEO and the Midwest shows that NEO has higher productivity in level II industries but lower in levels I and III.

Table 8. Productivity in High-Tech Industries: NEO, the Midwest and U.S.

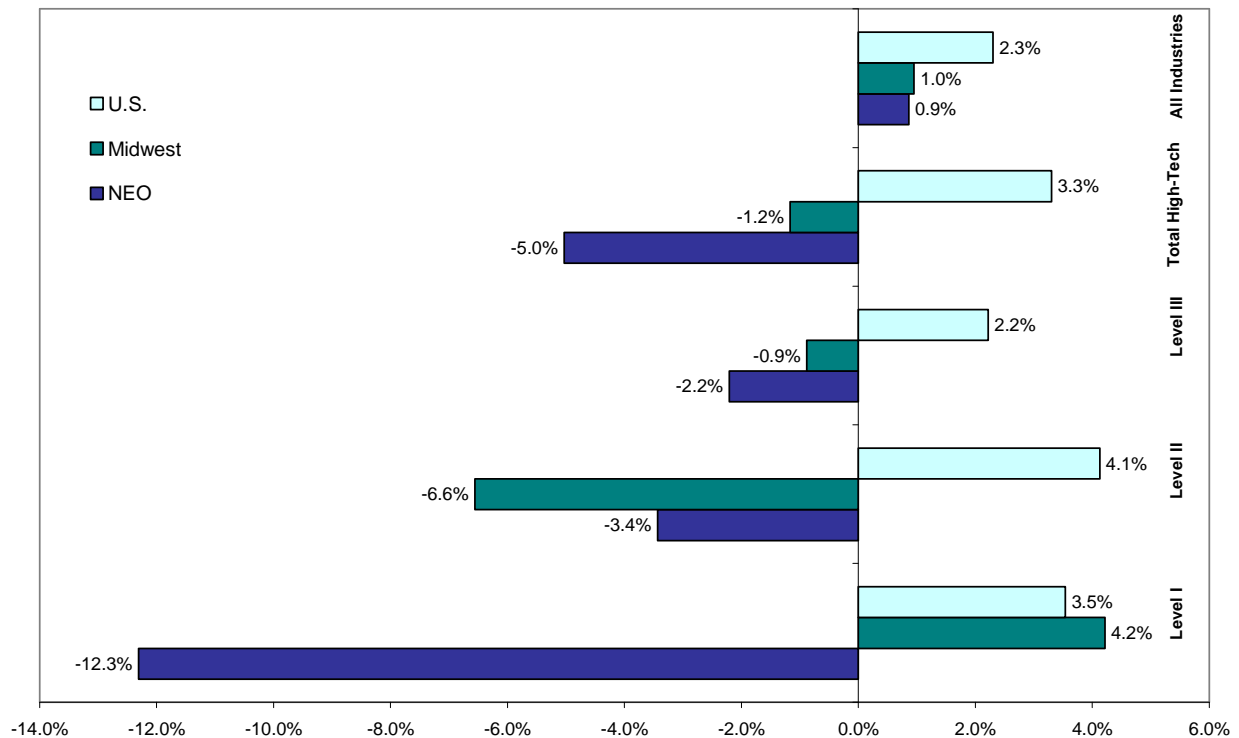
Industry	2006 (in thousands)			Percent Change (2000-2004)			Percent Change (2004-2006)			Percent Change (2000-2006)		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Level I High-Tech Industries	\$87.2	\$129.2	\$148.9	4.7%	9.9%	7.3%	-12.3%	4.2%	3.5%	-8.2%	14.6%	11.1%
Level II High-Tech Industries	\$125.5	\$100.5	\$138.2	23.2%	22.6%	20.5%	-3.4%	-6.6%	4.1%	19.0%	14.6%	25.5%
Level III High-Tech Industries	\$119.0	\$138.0	\$170.4	12.2%	16.4%	17.7%	-2.2%	-0.9%	2.2%	9.7%	15.4%	20.3%
Total High-Tech	\$112.7	\$121.4	\$150.1	14.6%	16.1%	14.3%	-5.0%	-1.2%	3.3%	8.8%	14.8%	18.0%
Total in All Industries	\$81.1	\$85.1	\$91.4	8.4%	8.7%	9.2%	0.9%	1.0%	2.3%	9.4%	9.7%	11.7%

Productivity in NEO's high-tech sector grew by 8.8 percent between 2000 and 2006, half the national growth rate and lower than the Midwest. Between 2000 and 2004, productivity in NEO grew at a rate similar to the national growth rate. It declined in the following two years but continued to grow in the U.S. Between 2004 and 2006, productivity in the high-tech sector fell in NEO and the Midwest while growing nationally.

Productivity grew in NEO's high-tech sector between 2000 and 2006 as a result of growth in level II and III industries, which offset a decline in productivity in level I industries. In the Midwest and the U.S., all three levels of high-tech industries experienced gains in productivity.

Between 2004 and 2006, NEO experienced declines in productivity in each of the three levels (Figure 9). In level I industries, NEO experienced losses, while the Midwest and the U.S. showed gains. In levels II and III, both NEO and the Midwest lost productivity, while the U.S. gained.

**Figure 9. Productivity Changes in High-Tech Industries:
NEO, the Midwest, and the U.S., 2004-2006**



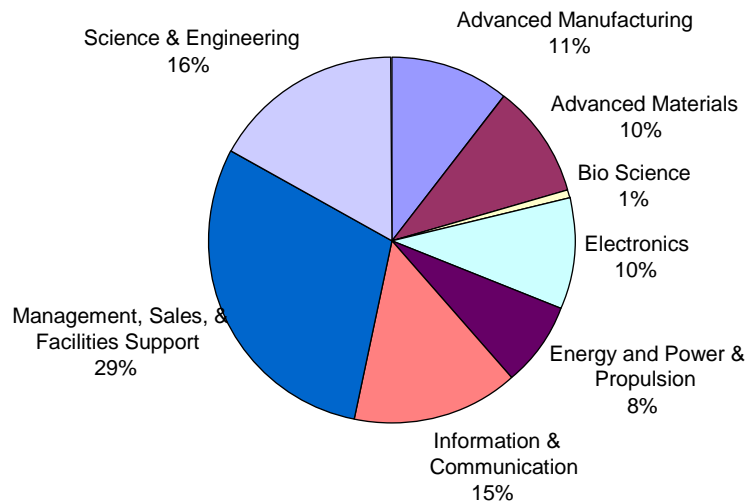
HIGH-TECH INDUSTRIES BY TECHNOLOGY GROUP

This section analyzes high-tech industries in terms of employment, average wages, and gross regional product for the high-tech sector as a whole as well as eight technology groups that are prominent in Northeast Ohio. Table B2 in Appendix B provides the list of industries by technology group. Again, Northeast Ohio will be compared to the Midwest and the U.S.

EMPLOYMENT BY TECHNOLOGY GROUP

Analyzing the high-tech sector in Northeast Ohio by eight technology groups reveals that the largest group is Management, Sales, and Facilities Support accounting for 29 percent of all jobs in high-tech industries (Figure 10). Other large technology groups are Science & Engineering (16%) and Information & Communication (15%). Advanced Manufacturing and Advanced Materials, the next largest technology groups, are composed of manufacturing industries; the two groups combined account for 21 percent.

Figure 10. Distribution of Employment by Technology Group: NEO, 2006



Northeast Ohio experienced large job losses between 2000 and 2004 in most technology groups but then saw recovery between 2004 and 2006 (Table 9 and Figure 11). Total high-tech employment in Northeast Ohio declined between 2000 and 2006 due to the early losses, but a turnaround is evident.

While only two technology groups gained jobs during the recessionary period (2000 to 2004), four groups in NEO added jobs between 2004 and 2006. The Advanced Manufacturing, Bio Science, and Science and Engineering groups each added a substantial number of employees in the later time period, and the Energy and Power & Propulsion industries showed a small increase. Four technology groups in NEO had declining employment between 2004 and 2006 but in most cases, the losses were relatively small compared to the prior four-year period.

NEO's two largest groups — Management, Sales, and Facilities Support Services and Science & Engineering — were among the three technology groups that showed growth over the longer time period (2000 to 2006).

Figure 11. Employment Change by Technology Group: NEO, 2004-2006

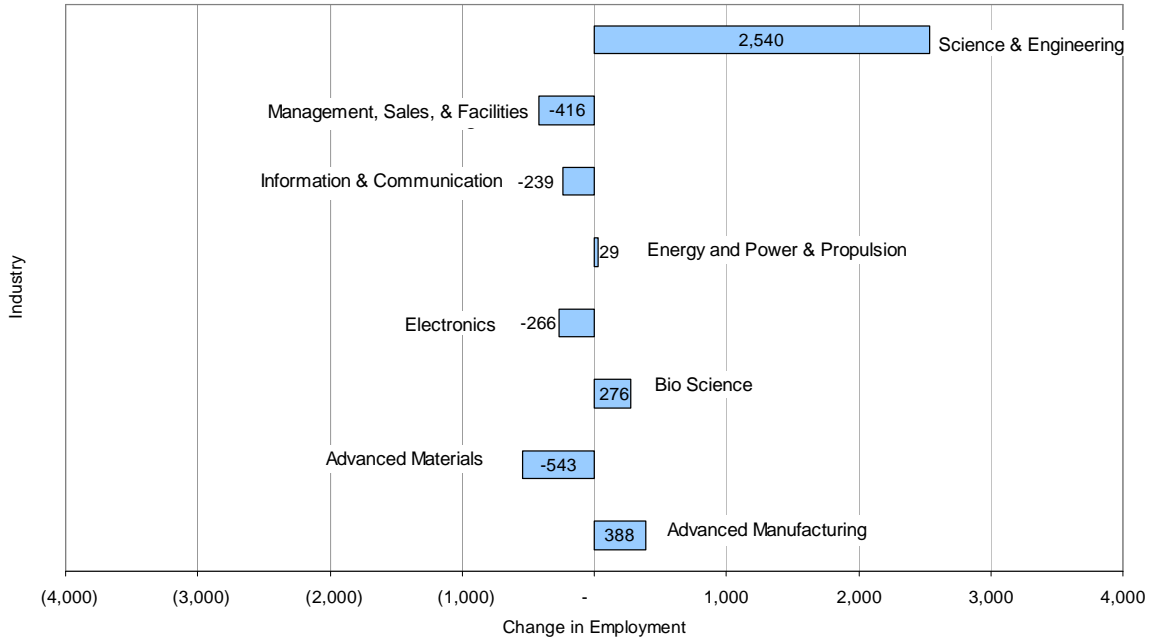


Table 9. Employment by Technology Group: NEO, 2000-2006

Industry	Employment	Employment Change		
	2006	2000-2004	2004-2006	2000-2006
Advanced Manufacturing	17,455	-6,076	388	-5,688
Advanced Materials	16,287	-3,418	-543	-3,961
Bio Science	1,465	310	276	586
Electronics	15,873	-8,531	-266	-8,797
Energy and Power & Propulsion	12,526	-1,900	29	-1,871
Information & Communication Technology	23,979	-4,191	-239	-4,430
Mgmt, Sales, & Facilities Support Services	49,164	2,375	-416	1,959
Science & Engineering	27,645	-1,841	2,540	699
Total High-Tech	164,394	-23,271	1,769	-21,502
Total Employment, all industries	2,013,644	-118,044	11,822	-106,222

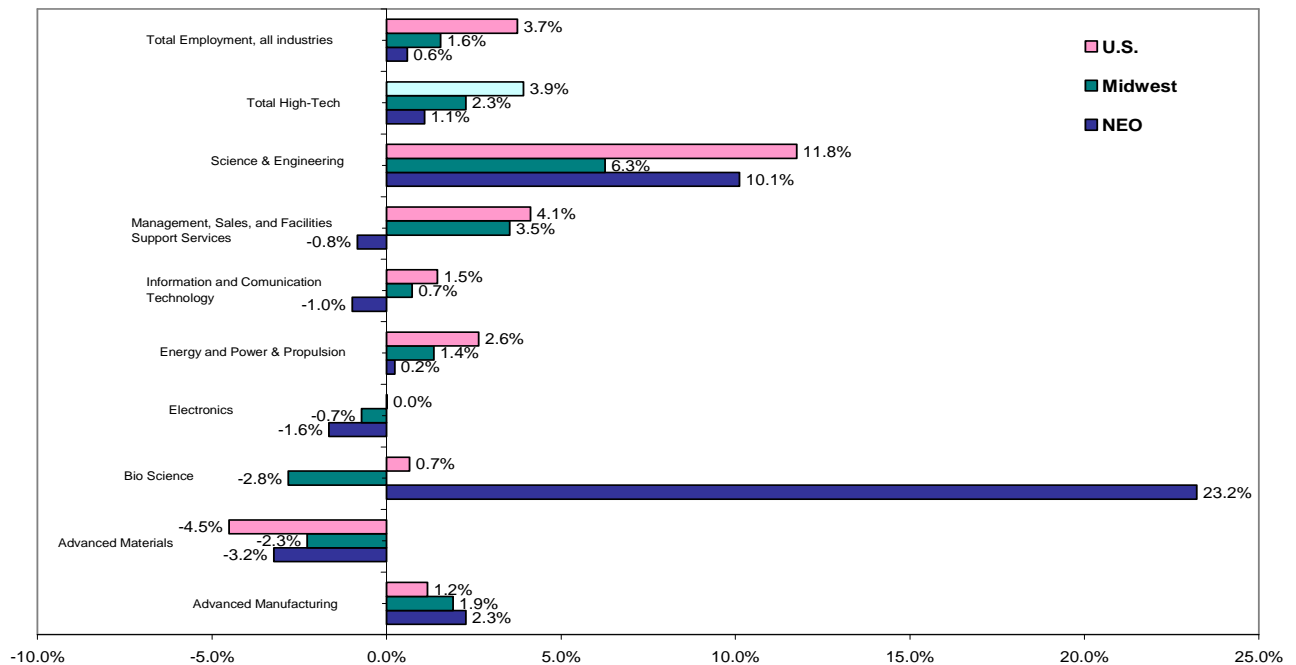
Table 10 compares rates of change in Northeast Ohio to rates of change in the Midwest and U.S. during the recessionary and expansionary periods. Between 2000 and 2004, NEO experienced a higher rate of job loss in Advanced Manufacturing, but the growth rate after 2004 was slightly higher in NEO than in either the Midwest or U.S. In contrast, Management, Sales, and Facilities Support Services grew faster in NEO between 2000 and 2004 but declined slightly after 2004 while growing in the Midwest and U.S.

Table 10. Employment Change by Technology Group: NEO, the Midwest and U.S., 2000-2006

Industry	Percent Employment Change (2000-2004)			Percent Employment Change (2004-2006)			Percent Employment Change (2000-2006)		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Advanced Manufacturing	-26.3%	-24.5%	-23.1%	2.3%	1.9%	1.2%	-24.6%	-23.0%	-22.2%
Advanced Materials	-16.9%	-13.3%	-16.7%	-3.2%	-2.3%	-4.5%	-19.6%	-15.3%	-20.4%
Bio Science	35.3%	9.5%	6.2%	23.2%	-2.8%	0.7%	66.8%	6.4%	6.9%
Electronics	-34.6%	-27.4%	-24.7%	-1.6%	-0.7%	0.0%	-35.7%	-27.9%	-24.7%
Energy and Power & Propulsion	-13.2%	-16.3%	-10.9%	0.2%	1.4%	2.6%	-13.0%	-15.2%	-8.5%
Information & Communication Technology	-14.8%	-14.6%	-14.3%	-1.0%	0.7%	1.5%	-15.6%	-14.0%	-13.0%
Mgmt, Sales, & Facilities Support Svcs	5.0%	4.3%	-4.4%	-0.8%	3.5%	4.1%	4.2%	8.0%	-0.4%
Science & Engineering	-6.8%	-7.8%	5.3%	10.1%	6.3%	11.8%	2.6%	-2.1%	17.7%
Total High-Tech	-12.5%	-11.6%	-10.0%	1.1%	2.3%	3.9%	-11.6%	-9.6%	-6.5%
Total Employment, all industries	-5.6%	-3.8%	-0.1%	0.6%	1.6%	3.7%	-5.0%	-2.3%	3.6%

Figure 12 displays the rates of change by technology group in NEO, the Midwest, and the U.S. between 2004 and 2006. Bio Science grew the fastest in Northeast Ohio (23.2%), but it is the smallest technology group in the region (in terms of employment). Science & Engineering, the second-largest technology group in NEO, grew at a similar pace as the nation.

Figure 12. Employment Change by Technology Group: NEO, the Midwest, and U.S., 2004-2006



The share of total employment in high-tech industries in Northeast Ohio increased slightly between 2004 and 2006. NEO, the Midwest, and U.S. all saw their share of employment in high-tech industries decrease between 2000 and 2004 and then stabilize after 2004 (Table 11).

In 2006, NEO held a higher share of high-tech employment than the Midwest and U.S. in the Advanced Manufacturing; Advanced Materials; and Management, Sales, & Facilities Support Services technology groups. The three technology groups with the highest share of employment in NEO are also the groups with the highest share in the Midwest and U.S. (Information & Communication Technology; Management, Sales & Facilities Support Services; and Science and Engineering).

Table 11. Employment Share by Technology Group: NEO, Midwest and U.S., 2000 to 2006

Industry	Share of Total Employment, 2000			Share of Total Employment, 2004			Share of Total Employment, 2006		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Advanced Manufacturing	1.1%	0.9%	0.5%	0.9%	0.7%	0.4%	0.9%	0.7%	0.4%
Advanced Materials	1.0%	0.5%	0.5%	0.8%	0.4%	0.4%	0.8%	0.4%	0.4%
Bio Science	0.0%	0.2%	0.2%	0.1%	0.3%	0.2%	0.1%	0.3%	0.2%
Electronics	1.2%	1.4%	1.6%	0.8%	1.0%	1.2%	0.8%	1.0%	1.1%
Energy and Power & Propulsion	0.7%	0.9%	1.1%	0.6%	0.8%	1.0%	0.6%	0.8%	1.0%
Information & Communication Technology	1.3%	1.9%	2.5%	1.2%	1.7%	2.2%	1.2%	1.7%	2.1%
Mgmt, Sales, & Facilities Support Svcs	2.2%	2.0%	2.0%	2.5%	2.2%	2.0%	2.4%	2.2%	2.0%
Science & Engineering	1.3%	1.9%	1.9%	1.3%	1.8%	2.0%	1.4%	1.9%	2.2%
Total High-Tech	8.8%	9.6%	10.5%	8.1%	8.8%	9.4%	8.2%	8.9%	9.4%
Total Employment, All Industries	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

More detailed information on changes within the eight technology groups is provided below. Table B2 in Appendix B provides industry-specific data.

Advanced Manufacturing

The Advanced Manufacturing technology group employed 17,455 people in 2006. Although this group experienced a large decline in employment between 2000 and 2004 (-26.3%), there was a small increase (2.3%) between 2004 and 2006.

In NEO, Other General Purpose Machinery Manufacturing accounts for 69 percent of employment in the Advanced Manufacturing group, and while job losses in this industry were significant between 2000 and 2004 (24.4%), they followed national trends. After 2004, the industry recovered; between 2004 and 2006, NEO added jobs at a faster rate than the Midwest and U.S.

Advanced Materials

In 2006, more than 16,000 workers were employed in Advanced Materials industries. As a group, they suffered employment losses of 16.9 percent between 2000 and 2004; this is similar to the rate of decline that occurred across the U.S. (-16.7%), but higher than the rate of decline in the Midwest (-13.3%). Job losses continued after 2004; between 2004 and 2006, the rate of loss in NEO was 3.2 percent versus -2.3 percent in the Midwest and -4.5 percent in the U.S.

Several mid-size industries constitute this technology group, and most lost jobs at a rate similar to the nation. In NEO, the greatest losses between 2000 and 2004 were in Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing (-28.5%) and Other

Chemical Product and Preparation Manufacturing (-24.4%). These losses continued after 2004, but at a much lower rate. Paint, Coating, and Adhesive Manufacturing declined 10 percent in NEO between 2000 and 2004 but had stabilized by 2004 (there was almost no change in employment between 2004 and 2006).

Bio Science

The Bio Science technology group includes only Pharmaceutical and Medicine Manufacturing. This industry is relatively small in NEO (1,465 jobs in 2006), but grew at a fast pace throughout the longer time period (35.3% between 2000 and 2004 and 23.2% between 2004 and 2006). This far outpaced growth in the Midwest and U.S.

Electronics

In 2006, the Electronics technology group employed nearly 16,000 people in NEO. Following national trends, this group experienced significant losses in NEO between 2000 and 2004 (-34.6%), but industries began to recover after 2004. Between 2004 and 2006, the group experienced a job loss rate of only 1.6 percent. The recovery was also seen in the Midwest and U.S., where employment stabilized after 2004.

All industries in the Electronics technology group reported large job losses between 2000 and 2004 in NEO, the Midwest, and U.S. NEO showed the greatest recovery in Semiconductor and Other Electronic Component manufacturing, which declined 32.9 percent between 2000 and 2004 and then grew 12.1 percent between 2004 and 2006. The Midwest and U.S. also posted job gains in the later two years, but the rate of increase was lower.

Energy and Power & Propulsion

In 2006, Energy and Power & Propulsion industries employed approximately 12,500 people in Northeast Ohio. The region experienced jobs losses in this technology group between 2000 and 2004 (-13.2%) but again recovered after 2004; employment levels were steady between 2004 and 2006 (0.2%). NEO's rate of job loss (-13%) for the entire time period (2000 to 2006) was greater than the U.S. (-8.5%), but slightly less than the Midwest (-15.2%). Both the Midwest and U.S. reported modest growth after 2004 (1.4% and 2.6%, respectively).

Between 2000 and 2004, NEO experienced losses in most industries in this technology group, however, the largest industry — Electric Power Generation, Transmission, and Distribution — reported a small increase (2.1%). Three other industries, employing more than 6,600 people combined, all reported large losses (Petroleum and Coal Products Manufacturing; Engine, Turbine, and Power Transmission Equipment Manufacturing; and Aerospace Product and Parts Manufacturing). After 2004, the Electric Power Generation, Transmission, and Distribution industry experienced job losses (-6.1%), but the other three industries that had been declining recovered and posted gains.

Information and Communication Technology

The Information and Communication Technology group employed nearly 24,000 people in Northeast Ohio in 2006. This group experienced a large loss in employment between 2000 and 2004 (-14.8%) but reported only a 1.0% loss between 2004 and 2006, indicating that industries have begun to turnaround. The trends are similar in the Midwest and U.S.

Between 2000 and 2004, all industries had declining employment in NEO except Telecommunications Resellers and Data Processing, Hosting and Related Services. Many industries were still reporting losses after 2004 but to a lesser degree. The largest industry in this group — Computer Systems Design and Related Services — fully recovered after 2004, posting a 14.7 percent gain between 2004 and 2006.

Management, Sales and Facilities Support Services

Accounting for nearly 50,000 jobs, Management, Sales and Facilities Support Services is the largest of the eight technology groups. NEO reported a five percent employment increase between 2000 and 2004 and only a slight loss (0.8%) between 2004 and 2006. Between 2000 and 2006, NEO fared better than the U.S. (-0.4%) in this technology group, although the Midwest (8.0%) outperformed NEO (4.2%).

Management of Companies and Enterprises, by far the largest industry in this group, added jobs between 2000 and 2004 (10.4%), but there was a small decline between 2004 and 2006 (-1.5%). Professional and Commercial Equipment and Supplies, Merchant Wholesalers, also a large industry in this group, reported losses during both time periods.

Science and Engineering

Science and Engineering industries employed 27,645 people in NEO in 2006, making it the region's second-largest technology group. It experienced a decline in employment between 2000 and 2004 (-6.8%) but grew in the later years (employment grew by 10.1% between 2004 and 2006). The U.S. did not experience job losses during either period of time and therefore reported larger employment gains (17.7% between 2000 and 2006), but the Midwest did not perform as well as NEO. The Midwest reported slightly larger losses prior to 2004 (-7.8%) and did not grow as fast after 2004 (it gained 6.3%).

Between 2004 and 2006, NEO experienced substantial growth in Scientific Research and Development Services (31.8%) and Management, Scientific, and Technical Consulting Services (15.5%), accompanied by small growth in the largest industry in this group — Architectural, Engineering, and Related Services (3.5%).

AVERAGE WAGES BY TECHNOLOGY GROUP

Average wages for high-tech industries in Northeast Ohio, the Midwest, and U.S. in 2006 were significantly higher than the average wage for all industries (Table 12). The highest average wage in Northeast Ohio was paid by Management, Sales, & Facilities Support Services (\$84,623). The highest wages in the Midwest and U.S. were in the Bio Science group (\$107,619 and \$110,402), which ranked second highest in Northeast Ohio (\$76,176).

Table 12. Average Wages by Technology Group: NEO, Midwest and U.S.

Industry	2006			Percent Change (2004-2006)		
	NEO	MW	U.S.	NEO	MW	U.S.
Advanced Manufacturing	\$52,203	\$55,470	\$57,177	6.5%	2.0%	2.4%
Advanced Materials	\$67,882	\$70,756	\$72,666	6.1%	8.5%	4.4%
Bio Science	\$76,176	\$107,619	\$110,402	4.7%	12.8%	7.2%
Electronics	\$51,553	\$60,612	\$83,749	6.1%	3.5%	9.0%
Energy and Power & Propulsion	\$71,836	\$89,439	93,820	15.3%	12.1%	9.6%
Information & Communication Technology	\$62,883	\$74,372	\$85,070	0.1%	3.4%	4.8%
Mgmt, Sales, & Facilities Support Svcs	\$84,623	\$95,918	\$94,660	18.0%	2.7%	6.9%
Science & Engineering	\$58,248	\$72,859	\$73,065	4.0%	2.9%	5.1%
Total High-Tech	\$67,673	\$78,403	\$83,958	9.5%	4.4%	6.2%
Total Employment, all industries	\$38,303	\$41,771	\$43,750	2.7%	2.7%	4.0%

After adjusting for inflation, average wages increased in NEO, the Midwest, and U.S. between 2004 and 2006. The average wage for Management, Sales, & Facilities Support Services; Energy and Power & Propulsion; and Advanced Manufacturing increased at a faster rate in Northeast Ohio than in both the Midwest and U.S. NEO saw lower increases than the Midwest and U.S. in only the Information and Communication Technology group.

GROSS REGIONAL PRODUCT GENERATED BY TECHNOLOGY GROUP

Between 2000 and 2004, gross regional product (GRP) generated by high-tech industries in Northeast Ohio increased faster than in the Midwest and U.S. (Table 13); however, between 2004 and 2006, NEO was the only area that saw a decline in GRP. Between 2000 and 2006, three technology groups reported a decline in GRP — Electronics (-28.3%), Information and Communication Technology (-19.1%), and Advanced Manufacturing (-7.7%). Gross product also declined in the Midwest and U.S. in each of these technology groups.

Despite the overall decline in GRP in the later years (2004 to 2006), four technology groups show an increase in GRP during this time — Advanced Manufacturing, Advanced Materials, Electronics, and Science & Engineering. Growth in Advanced Manufacturing and Advanced Materials far outpaced the rate of growth in these groups in the Midwest and U.S. Detailed data on GRP changes by each technology group and their industries is included in Table B4 in Appendix B.

Table 13. GRP by Technology Group: NEO, the Midwest and U.S., 2000-2006

Industry	Percent GRP Change (2000-2004)			Percent GRP Change (2004-2006)			Percent GRP Change (2000-2006)		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Advanced Manufacturing	-14.6%	-10.8%	-15.0%	8.1%	4.0%	3.5%	-7.7%	-7.2%	-12.0%
Advanced Materials	10.0%	5.3%	6.2%	12.5%	-1.7%	1.1%	23.8%	3.4%	7.3%
Bio Science	41.8%	15.9%	28.8%	-2.9%	1.4%	9.6%	37.7%	17.4%	41.2%
Electronics	-31.6%	-16.5%	-33.6%	4.8%	1.9%	5.3%	-28.3%	-14.9%	-30.1%
Energy and Power & Propulsion	29.2%	7.0%	20.0%	-12.9%	3.9%	16.0%	12.6%	11.2%	39.2%
Information & Communication Technology	-12.0%	-7.0%	-5.4%	-8.1%	6.7%	4.5%	-19.1%	-0.8%	-1.2%
Mgmt, Sales, & Facilities Support Svcs	29.0%	17.9%	9.1%	-3.0%	-8.2%	-1.6%	25.2%	8.2%	7.4%
Science & Engineering	0.6%	1.8%	15.7%	11.9%	10.8%	12.9%	12.5%	12.9%	30.6%
Total High-Tech	6.2%	3.4%	3.2%	-0.7%	1.5%	6.9%	5.5%	5.0%	10.3%
Total, All Industries	4.4%	4.8%	8.8%	2.6%	2.1%	6.0%	7.1%	7.0%	15.3%

Between 2000 and 2006, the share of total GRP accounted for by high-tech industries declined slightly in Northeast Ohio, the Midwest, and the U.S., however, changes were minimal (Table 14). Although high-tech industries account for a lower share of total GRP in NEO than in both the Midwest and nation, there are two technology groups for which the share of total GRP is greater in NEO than the other two areas — Advanced Manufacturing and Advanced Materials. This is consistent with the concentration of manufacturing in Northeast Ohio.

Table 14. Share of Total GRP by Technology Group: NEO, the Midwest and U.S.

Industry	2000			2004			2006		
	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Advanced Manufacturing	1.1%	0.9%	0.6%	0.9%	0.8%	0.4%	0.9%	0.8%	0.4%
Advanced Materials	1.5%	0.8%	0.9%	1.6%	0.8%	0.9%	1.8%	0.8%	0.8%
Bio Science	0.1%	0.7%	0.6%	0.2%	0.8%	0.7%	0.2%	0.8%	0.7%
Electronics	1.4%	1.2%	2.1%	0.9%	0.9%	1.3%	0.9%	0.9%	1.3%
Energy and Power & Propulsion	1.8%	2.3%	3.3%	2.3%	2.3%	3.6%	1.9%	2.4%	3.9%
Information & Communication Technology	2.4%	3.4%	4.8%	2.1%	3.0%	4.2%	1.8%	3.1%	4.1%
Mgmt, Sales, & Facilities Support Svcs	3.2%	4.0%	3.9%	3.9%	4.4%	3.9%	3.7%	4.0%	3.6%
Science & Engineering	1.6%	2.5%	2.6%	1.5%	2.4%	2.8%	1.7%	2.7%	2.9%
Total High-Tech	13.1%	15.8%	18.7%	13.3%	15.6%	17.7%	12.9%	15.5%	17.9%
Total High-Tech	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

HIGH-TECH OCCUPATIONS

Whereas the previous section examined employment in high-tech industries, this section examines employment in high-tech occupations (across all industries). It reports on employment in high-tech occupations in 2005 and 2006 for the sum of Northeast Ohio's metropolitan areas as well as each individual MSA. It also analyzes the distribution of high-tech employment within distinct occupational clusters.

EMPLOYMENT IN HIGH-TECH OCCUPATIONS

In 2006, approximately 61,000 workers in Northeast Ohio's metropolitan areas were employed in high-tech occupations (Table 15).⁸ This is an increase of 4.8 percent from the previous year—substantially higher than the increase for the Midwest (0.9%) and the national increase (1.9%).⁹

Table 15. Employment in High-Tech Occupations by Occupational Cluster, 2005 and 2006

High-Tech Occupations	Employment, NEO MSAs			Midwest	U.S.
	2005	2006	Percent change	Percent change	Percent change
Management	5,220	5,120	-1.9%	-4.3%	-2.7%
Computer and Mathematical	27,270	28,540	4.7%	3.4%	2.0%
Architecture and Engineering	21,870	22,420	2.5%	-2.3%	1.8%
Life and Physical Science	4,010	5,070	26.4%	6.7%	5.5%
Total High-Tech	58,370	61,150	4.8%	0.9%	1.9%

Northeast Ohio gained jobs in all occupational clusters with the exception of Management Occupations, which follows the national trend. In addition, when compared to the Midwest and the nation, the region experienced a higher rate of growth (or lower rate of decline) in each occupational category. The Life and Physical Science occupational cluster experienced a high rate of growth (26%) between 2005 and 2006, but it remains the smallest occupational cluster in NEO (the Management cluster is only slightly larger).

The 61,000 high-tech workers in Northeast Ohio represent 3.2 percent of all workers in the region (Table 16).¹⁰ Despite recent gains, this share of total employment is still lower in the

⁸ The definition of high-tech occupations employed by this study does not include healthcare practitioners.

⁹ Totals for occupational clusters are based on aggregations of individual occupations. In both 2005 and 2006, employment estimates for some specific occupations in one or more Northeast Ohio metropolitan areas and Midwest states were not released. This often occurs when the number of employees is relatively small and therefore likely accounts for a small percentage of total employment, however, comparisons between 2005 and 2006 employment levels are problematic as a result. For example, an occupation may be suppressed in an MSA for one year but not the following year, resulting in an artificial increase in the total for that occupational cluster. Likewise, if data is suppressed in the later year, it may result in an artificial decline in the total for that occupational cluster. Table B5 in Appendix B indicates the occupations for which data have been suppressed.

¹⁰ BLS estimates that Northeast Ohio's metro areas have about 31,000 IT jobs (from Table B5). This estimate is significantly lower than the estimate of 96,000 IT jobs described in a recent report titled "Information Technology Workforce Conditions in Northeast Ohio." The large difference in the estimated number of IT jobs is primarily due to

region than across the Midwest (4.0%) and the nation (4.5%), and the region lags in each occupational category (with the exception of management occupations where Northeast Ohio and the Midwest have an equal share).

Table 16. Employment in High-Tech Occupational Clusters as a Share of Total High-Tech Employment and Total Employment, 2006

	Share of High-Tech Employment			Share of Total Employment		
	NEO MSAs	Midwest	U.S.	NEO MSAs	Midwest	U.S.
Management	8.4%	8.5%	7.9%	0.3%	0.3%	0.4%
Computer and Mathematical	46.7%	46.8%	48.1%	1.5%	1.9%	2.2%
Architecture and Engineering	36.7%	35.5%	33.0%	1.2%	1.4%	1.5%
Life and Physical Science	8.3%	9.3%	11.0%	0.3%	0.4%	0.5%
Total High-Tech	100%	100%	100%	3.2%	4.0%	4.5%

The region's industry mix is reflected in the distribution of high-tech workers across occupational clusters. When compared to the Midwest and the nation, the region has a larger concentration of workers in the Architecture and Engineering cluster. Many of these individuals are employed in engineering occupations that support the region's strong manufacturing base.

Employment by detailed occupation can be found in Appendix B, Table B5. It further indicates the region's industry structure. There are several specific occupations within the Architecture and Engineering cluster for which the number of employees per 100,000 employees in NEO exceeds the national number, including chemical engineers, industrial engineers, materials engineers, mechanical engineers, mechanical engineering technicians, mechanical drafters, and environmental engineering technicians. In the Life and Physical Science cluster, NEO has a greater number of chemists, materials scientists, and chemical technicians (when normalized by total employment), although NEO's share of employment in the occupational cluster as a whole is lower than the nation. These data reflect NEO's manufacturing strengths and are consistent with the 2005 data.

The distribution of high-tech workers did not change significantly between 2005 and 2006, although the growth in Life and Physical Science occupations is reflected in the fact that the share of high-tech employment in this cluster increased from 6.9 to 8.3 percent.

The Akron and Cleveland-Elyria-Mentor metropolitan areas have the largest share of employment in high-tech occupations in NEO (both with 3.9%) and both experienced gains in high-tech employment between 2005 and 2006 (Table 17). In 2005, Akron slightly lagged the Cleveland area in terms of the share of total employment in high-tech occupations, but Akron experienced a higher rate of increase between 2005 and 2006 (9.0% versus 4.3%). The Youngstown-Warren-Boardman MSA experienced the same rate of growth in high-tech employment as the Cleveland MSA, but the share of total employment in high-tech occupations remained much lower. The smaller metro areas of Northeast Ohio have relatively few workers in high-tech occupations.

the fact that the two studies used a different definition of IT jobs. Our report focuses on high-tech occupations and includes only the IT occupations that are designated as high-tech, according to BLS' Daniel Hecker. The IT workforce study includes a much broader range of IT functions. Examples of occupations that are included in the IT study, but are not included in the high-tech study, are Business Application Specialists, Project managers, Product Managers, Tech Program Managers, Quality Assurance, Technical Sales, and Technical Writers. It is estimated that close to one-half of the IT jobs, broadly defined, are not included in the high-tech IT occupations analyzed in this study.

Table 17. Employment in High-Tech Occupations by Metropolitan Area, 2005 and 2006

NEO Metropolitan Areas	High-Tech Employment			Share of Total Employment		
	2005	2006	Percent change	2005	2006	Percent change
Akron MSA	11,840	12,910	9.0%	3.6%	3.9%	0.3%
Canton-Massillon MSA	2,370	2,600	9.7%	1.3%	1.5%	0.2%
Cleveland-Elyria Mentor MSA	39,630	41,320	4.3%	3.8%	3.9%	0.1%
Mansfield MSA	860	720	-16.3%	1.5%	1.2%	-0.3%
Sandusky MSA	420	210	-50.0%	1.1%	0.6%	-0.5%
Youngstown-Warren-Boardman MSA	3,250	3,390	4.3%	1.3%	1.4%	0.1%
Total NEO MSAs	58,370	61,150	4.8%	3.1%	3.2%	0.1%
U.S.	5,889,590	6,002,180	1.9%	4.5%	4.5%	0.0%

Different patterns of growth are found in the Akron and Cleveland MSAs. Between 2005 and 2006, the Akron area added jobs in all high-tech occupational clusters, with the exception of Management occupations (Table 18). The Cleveland metro area added jobs in all occupational categories during this time period, however, the Akron MSA reported much faster growth in Computer and Mathematical and Architecture and Engineering employment. For both metro areas, the largest percentage increase was in the Life and Physical Science cluster. Cleveland added 900 workers in this cluster (an increase of 38%), while Akron added 200 workers (a 15.7% increase).

Table 18. High-Tech Employment by Occupational Cluster: Akron and Cleveland Metropolitan Areas, 2005 and 2006

High-Tech Occupations	Total High-Tech Employment					
	Akron MSA			Cleveland-Elyria-Mentor MSA		
	2005	2006	Percent change	2005	2006	Percent change
Management	980	900	-8.2%	3,590	3,660	1.9%
Computer and Mathematical	5,080	5,620	10.6%	19,500	19,740	1.2%
Architecture and Engineering	4,510	4,920	9.1%	14,170	14,650	3.4%
Life and Physical Science	1,270	1,470	15.7%	2,370	3,270	38.0%
Total High-Tech	11,840	12,910	9.0%	39,630	41,320	4.3%

Differences in the magnitude of employment increases between 2005 and 2006 led to slight changes in the distribution of jobs across high-tech occupations clusters (Table 19). In the Akron area, the share of high-tech employment in Computer and Mathematical occupations increased from 42.9 percent to 43.5 percent and the share in Life and Physical Science occupations increased from 10.7 percent to 11.4 percent. There was no change in the share of high-tech jobs found in Architecture and Engineering occupations, and the share in Management occupations fell from 8.3 percent to 7.0 percent.

In the Cleveland area, the share of high-tech employment in the Life and Physical Science cluster increased from 6.0 percent to 7.9 percent. The share of jobs in the Architecture and Engineering cluster remained nearly constant, and there was a slight decline in the share of Management and Computer and Mathematical jobs. The declining share of high-tech

employment in Management occupations in both the Akron and Cleveland metro areas is consistent with the national trend.

Table 19. Share of High-Tech Employment by Occupational Cluster: Akron and Cleveland Metropolitan Areas, 2005 and 2006

High-Tech Occupations	Share of High-Tech Employment, 2005			Share of High-Tech Employment, 2006		
	Akron MSA	Cleveland-Elyria-Mentor MSA	U.S.	Akron MSA	Cleveland-Elyria-Mentor MSA	U.S.
Management	8.3%	9.1%	8.3%	7.0%	8.9%	7.9%
Computer and Mathematical	42.9%	49.2%	48.0%	43.5%	47.8%	48.1%
Architecture and Engineering	38.1%	35.8%	33.1%	38.1%	35.5%	33.0%
Life and Physical Science	10.7%	6.0%	10.6%	11.4%	7.9%	11.0%
Total High-Tech	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Compared to the nation, both the Akron and Cleveland-Elyria-Mentor metropolitan areas have a greater share of high-tech employment in Architecture and Engineering occupations, again reflecting the strong manufacturing base. Cleveland also has a higher share than the nation in Management occupations, while Akron has a slightly higher share in Life and Physical Science occupations.

When the Akron and Cleveland metro areas are compared to each other, Akron has a larger share of high-tech employment in the Architecture and Engineering and Life and Physical Science clusters, while Cleveland has a larger share in the Management and Computer and Mathematical clusters.

RESEARCH & DEVELOPMENT

Research and development activity in Northeast Ohio is primarily assessed in terms of industry R&D funding and academic R&D expenditures. Industry R&D is examined from 1993 to 2004. Academic R&D expenditures are examined in terms of funding source and shorter-term trends (2000 to 2005). This section also provides some information on the R&D activity of two of the region's major non-academic research institutions—the Cleveland Clinic and NASA Glenn Research Center.

INDUSTRY RESEARCH & DEVELOPMENT

Over the longer-term (1993 to 2004), industry R&D funding in Northeast Ohio increased 11 percent compared to a 10 percent decline elsewhere in the state and a seven percent decline in the Midwest.¹¹ The U.S., however, experienced a 36 percent increase in industrial R&D funding between 1993 and 2004. The Cleveland-Elyria-Mentor MSA experienced a slight decline in funding over this time period (-5%) but still captures the vast majority of Northeast Ohio's industrial R&D funding (two-thirds in 2004). The Akron area experienced the largest percentage increase between 1993 and 2004 (214%).

Table 20. Estimated Industry R&D Funding by Sub-Region, 1993-2004

(Dollars in millions, 2004\$)

	1993	1997	1998	2000	2001	2002	2003	2004	change 1993- 2004	change 2003- 2004
Akron	35.8	91.8	125.8	172.9	171.7	133.4	127.8	112.2	214%	-12%
Canton Massillon	19.0	49.8	61.9	148.9	152.7	139.7	86.9	39.0	105%	-55%
Cleveland-Elyria-Mentor	809.2	922.2	877.3	736.2	865.1	839.0	820.0	767.2	-5%	-6%
Mansfield	47.3	64.8	68.9	76.5	83.2	71.4	65.0	63.3	34%	-3%
Sandusky	23.4	19.2	17.0	16.1	15.9	6.2	12.7	10.4	-56%	-18%
Youngstown-Warren*	8.8	12.4	13.5	22.4	20.7	17.7	15.9	10.0	14%	-37%
Non-Metro Counties	110.4	197.1	218.1	245.2	223.7	210.1	186.0	171.3	55%	-8%
Northeast Ohio	1,053.9	1,357.4	1,382.4	1,418.3	1,533.0	1,427.5	1,314.4	1,165.7	11%	-11%
Remainder of Ohio	4,821.0	5,242.9	5,272.0	5,432.3	5,607.1	5,114.2	5,112.3	4,350.3	-10%	-15%
Ohio Total	5,874.9	6,600.3	6,654.4	6,850.6	7,140.0	6,541.7	6,426.7	5,516.0	-6%	-14%
Midwest	44,528.3	37,714.4	38,780.4	44,918.7	41,862.7	39,769.0	42,095.3	41,292.0	-7%	-2%
U.S.	153,473.1	185,415.1	196,062.0	221,548.3	215,477.2	203,566.8	206,069.4	208,301.0	36%	1%

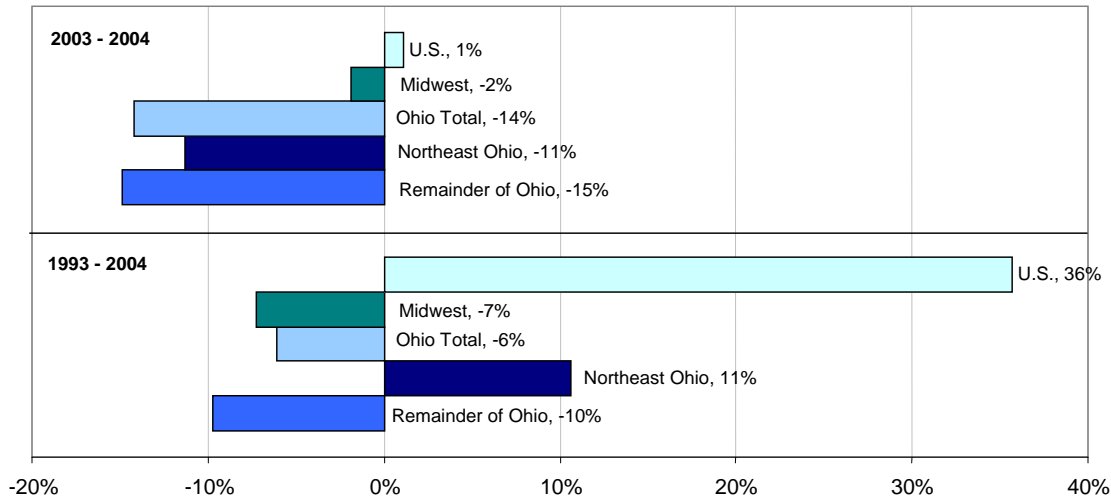
*Does not include Mercer County, PA

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Industrial Research and Development

¹¹ Industry R&D funding at the regional level is estimated from state-level data. See methodology section for further detail. Funding is reported in 2004 dollars, adjusting for inflation.

Over the most recent year for which data is available (2003-2004), Northeast Ohio, Ohio, and the Midwest experienced a decline in industrial R&D funding (-11% in the region, -14% across Ohio, and -2% in the Midwest). The decline was relatively small in the Cleveland metro area (-6%). Nationally, there was a one percent increase in industrial R&D funding during this time period.

Figure 13. Change in Estimated Industry R&D Funding



When industry R&D funding is calculated per employee, Northeast Ohio significantly lags the state, Midwest, and U.S. (Table 21). In 2004, industry R&D funding per employee in Northeast Ohio was just over half the amount for the state as a whole, approximately a third of the R&D for the Midwest and the nation. Over the long-term, industry R&D funding in Northeast Ohio grew faster than the rest of the state and the Midwest, which narrowed the gap slightly but the difference remains considerable. However, industry R&D funding grew much faster in the U.S., widening the gap between Northeast Ohio and the nation.

Table 21. Estimated Industry R&D Funding per Employee

	1993	2000	2001	2002	2003	2004
Northeast Ohio	\$ 559	\$ 669	\$ 730	\$ 700	\$ 652	\$ 582
Remainder of Ohio	\$ 1,726	\$ 1,650	\$ 1,700	\$ 1,589	\$ 1,610	\$ 1,371
Ohio Total	\$ 1,256	\$ 1,265	\$ 1,323	\$ 1,244	\$ 1,238	\$ 1,066
Midwest	\$ 2,085	\$ 1,810	\$ 1,691	\$ 1,644	\$ 1,753	\$ 1,724
U.S.	\$ 1,397	\$ 1,691	\$ 1,626	\$ 1,560	\$ 1,584	\$ 1,596

ACADEMIC RESEARCH & DEVELOPMENT

Northeast Ohio's colleges and universities reported \$386.7 million in research expenditures in FY 2005.¹² Case Western Reserve University is the dominant educational research institution in the region, accounting for 84 percent of Northeast Ohio's academic R&D expenditures. Northeast Ohio accounted for 25 percent of the academic R&D expenditures in Ohio, although it accounts for nearly 40 percent of the state population.¹³ However, it should also be noted that a large amount of research activity in Northeast Ohio takes place outside academic institutions, such as the Cleveland Clinic Lerner Research Institute and NASA Glenn Research Center.

The federal government supported 63 percent of the research that was undertaken by the region's academic institutions in 2005. It is the primary source of R&D funding at all NEO academic institutions with the exception of The University of Akron and Cleveland State University, which have a smaller share of federal funding.

Table 22. R&D Expenditures at NEO Colleges and Universities by Funding Source, FY 2005

(Dollars in thousands)

Institution	Total	Federal Government	State and Local government	Industry	Institutional funds	All other sources
U.S.	45,750,413	29,167,128 63.8%	2,939,962	2,292,401	8,258,292	3,092,630
Midwest	7,075,155	4,212,122 59.5%	466,175	359,148	1,538,302	499,408
Ohio	1,530,915	892,144 58.3%	167,576	128,113	231,990	111,092
Northeast Ohio Institutions	386,655	243,614 63.0%	28,358	23,663	17,723	73,194
U. Akron	26,888	10,246 38.1%	551	3,408	9,126	3,557
Case Western Reserve U.	323,618	212,485 65.7%	22,926	18,646	1,179	68,382
Cleveland State U.	15,884	7,206 45.4%	3,704	318	3,803	853
John Carroll U.	506	345 68.2%	81	80	0	0
Kent State U.	11,045	7,619 69.0%	775	879	1,772	0
NEO Univ. C. of Medicine	5,703	3,267 57.3%	227	84	1,723	402
Oberlin C.	1,059	841 79.4%	0	154	64	0
C. Wooster	570	467 81.9%	0	0 ⁱ	0 ⁱ	103 ⁱ
Youngstown State U.	1,382	1,138 82.3%	94	94	56	0

i = data point imputed by NSF

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Research and Development Expenditures at Universities and Colleges, FY 2005. http://www.nsf.gov/statistics/nsf07318/content.cfm?pub_id=3767&id=2

Academic R&D expenditures in Northeast Ohio increased 42 percent between 2000 and 2005 (Table 23 and Figure 14).¹⁴ Colleges and universities across Ohio reported a 47 percent increase in research expenditures over the same time period. Case Western Reserve reported a large increase (48%), driving the overall increase for the region, however, three of Northeast

¹² The Ohio Agricultural Research and Development Center (OARDC), located in Wooster, Ohio (Wayne County) is part of The Ohio State University and therefore its research activities are not captured in data on Northeast Ohio institutions. In FY05, OARDC attracted \$31.9 million in contracts and grants. (Source: OARDC 2005 Annual Report, <http://oardcreport.osu.edu/2005>)

¹³ Source: U.S. Census Bureau, Population Estimates Program (July 1, 2006 estimates)

¹⁴ Expenditures are reported in 2005 dollars, adjusting for inflation.

Ohio's four largest research institutions — Cleveland State University, The University of Akron, and Case Western Reserve University — all reported increases (Kent State University experienced a small decline).

Table 23. R&D Expenditures at Northeast Ohio Colleges and Universities, FY 2000-2005

(Dollars in thousands)

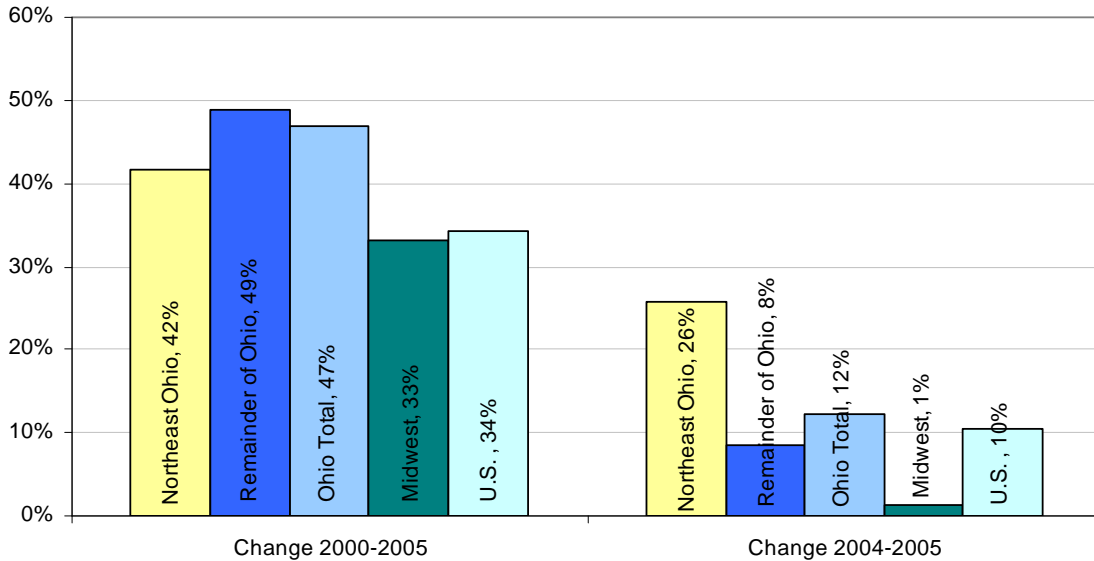
Institution	2000	2001	2002	2003	2004	2005	Change 2000-2005	Change 2004-2005
U.S.	34,103,770	33,160,188	35,613,225	38,618,983	41,432,444	45,750,413	34.2%	10.4%
Midwest	5,313,903	5,699,017	6,243,904	6,785,381	6,990,869	7,075,155	33.1%	1.2%
Ohio	1,041,713	1,098,325	1,212,572	1,346,704	1,363,089	1,530,915	47.0%	12.3%
Northeast Ohio Institutions	272,742	277,156	305,329	333,683	307,538	386,655	41.8%	25.7%
U. Akron	22,110	24,554	30,484	29,670	28,419	26,888	21.6%	-5.4%
Case Western Reserve U.	218,955	218,627	237,793	266,069	239,653	323,618	47.8%	35.0%
Cleveland State U.	11,584	14,321	15,041	14,979	17,460	15,884	37.1%	-9.0%
John Carroll U.	1,216 ^e	568	893	469	494	506	-58.4%	2.4%
Kent State U.	12,268	12,479	13,970	15,442	13,143	11,045	-10.0%	-16.0%
NEO Univ. C. of Medicine	4,549	4,998	4,912	4,632	5,791	5,703	25.4%	-1.5%
Oberlin C.	784	358	477	500	394	1,059	35.1%	168.8%
C. Wooster	673	315	393	438	291 ^e	570	-15.2%	96.2%
Youngstown State U.	603	936	1,367	1,484	1,893	1,382	129.0%	-27.0%

e = estimated by NSF

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Research and Development Expenditures at Universities and Colleges, FY 2000-2005

Over the most recent year for which data is available (2004 to 2005), R&D expenditures of Northeast Ohio academic institutions increased 26 percent—a significant increase for a one-year period. This compares to just 12 percent for institutions across Ohio. Again, this increase was primarily driven by Case Western Reserve University, which experienced a 35 percent increase during this period.

Figure 14. Change in Academic R&D Expenditures



Although Northeast Ohio has experienced solid growth in academic R&D, Northeast Ohio again lags the state, the Midwest, and the U.S. in its level of funding when R&D expenditures are calculated per employee (Table 24). In 2005, per employee expenditures in Northeast Ohio were about two-thirds the Ohio total and the Midwest, and just over half of the nation. Northeast Ohio may have an advantage over many other areas in terms of research conducted at institutions not captured in this data (see below), however the lack of comparable data prevents further analysis.

Table 24. Academic R&D Expenditures per Employee

	2000	2001	2002	2003	2004	2005
Northeast Ohio	\$ 129	\$ 132	\$ 150	\$ 166	\$ 154	\$ 192
Remainder of Ohio	\$ 234	\$ 249	\$ 282	\$ 319	\$ 333	\$ 359
Ohio Total	\$ 192	\$ 203	\$ 231	\$ 259	\$ 263	\$ 295
Midwest	\$ 214	\$ 230	\$ 258	\$ 282	\$ 292	\$ 293
U.S.	\$ 260	\$ 250	\$ 273	\$ 297	\$ 317	\$ 345

INSTITUTIONAL RESEARCH

Industry funding and academic research expenditures capture only a portion of the research activity being conducted in Northeast Ohio. Directly comparable data on R&D expenditures is not available for the Cleveland Clinic and NASA Glenn Research Center; however, both institutions conduct a significant amount of research.

The Cleveland Clinic's Lerner Research Institute reported annual research expenditures of \$183.7 million in 2005 and \$196.6 million in 2006. Due to the affiliation between the Cleveland Clinic and the medical school at Case Western Reserve University, a large portion of these

research expenditures are captured in the data reported for Case Western Reserve University. This includes all research expenditures based on awards by the National Institutes of Health (NIH); however research conducted at the Cleveland Clinic that is not funded by NIH is not reflected in the totals for Case Western Reserve University.

Scientists and engineers at the NASA Glenn Research Center investigate space operations, aerospace technology, and technologies needed for space exploration. In FY 2006, Glenn Research Center reported annual research expenditures of \$597.2 million.¹⁵ However, it is important to note that NASA contracts with local universities to conduct research and includes these contract dollars in its reported research expenditures, therefore some of the same dollars are captured in NASA and university research expenditures.

¹⁵ Source: NASA Glenn Research Center, Resources Analysis & Management Office, August 2007.

CONCLUDING REMARKS AND POLICY IMPLICATIONS

This report provides an ongoing monitoring tool describing changes in the high-tech sector in Northeast Ohio. Tracking a specific set of measures on an annual basis provides policy makers with a method for assessing progress and directing resources.

The high-tech sector in Northeast Ohio has faced challenges over the last several years, but some of these challenges reflect national trends. In both the region and the nation, employment in high-tech industries peaked in 2001 and then declined for the few years that followed. By 2004, both the regional and national economies began to recover, although the region rebounded more slowly. The rate of job loss between 2000 and 2004 was similar, but the rate of increase between 2004 and 2006 was slower in Northeast Ohio.

It is important to note that employment is sometimes a poor measure of industry performance and this is particularly true in the high-tech sector where technological advancements may result in fewer jobs but more competitive companies. Northeast Ohio's high-tech sector accounts for a larger share of gross regional product than its share of employment and is more productive than other sectors of the economy. In addition, high-tech industries have a high average wage relative to other industries.

The occupational analysis presented in this report also indicates that the region is becoming more reliant on high-tech workers. There was a substantial increase in employment in high-tech occupations between 2005 and 2006 (and the rate of increase was considerably higher in Northeast Ohio than in the Midwest region and the U.S.). However, the share of workers in high-tech occupations is still lower in Northeast Ohio than in the Midwest and U.S.

Research and development activity may indicate the future direction of the economy and estimates of industry R&D suggest that Northeast Ohio has seen increased investment over the last ten years despite declines statewide. Academic R&D has also been steadily increasing in the region, although Ohio's largest research institutions are located elsewhere in the state. However, the level of R&D funding in Northeast Ohio is much lower than the rest of Ohio, the Midwest and U.S. when viewed in relation to employment levels (reflecting the relative size of the economies).

Two issues revealed in this report deserve attention by civic leaders and policy makers: R&D and average wages are significantly lower in Northeast Ohio when compared to the nation. Since R&D and skilled workforce have been shown to be associated with regional economic growth, the region needs to increase support and stimulate more research activities as well as offer competitive wages to employees in high-tech industries.

It is important to consider changes in NEO's high-tech sector in the context of national trends, which have been shifting in recent years. It is also important to recognize that no single organization can affect widespread change in a large regional economy. However, it is hoped that the additional focus and investment in technology-based economic development is beginning to "move the needle" for some of the measures included in this report.

APPENDIX A

NORTECH SERVICE AREA

Metropolitan Areas

Akron MSA

Portage County
Summit County

Canton-Massillon MSA

Carroll County
Stark County

Cleveland-Elyria-Mentor MSA

Cuyahoga County
Geauga County
Lake County
Lorain County
Medina County

Mansfield MSA

Richland County

Sandusky MSA

Erie County

Youngstown-Warren-Boardman MSA

Mahoning County
Trumbull County
Mercer County, PA*

Non-Metro Counties

Ashland County
Ashtabula County
Columbiana County
Crawford County
Holmes County
Huron County
Tuscarawas County
Wayne County

* Mercer County is not included in the analyses, with the exception of the section on employment in high-tech occupations.

APPENDIX B

Table B1. Change in High-Tech Employment by Level of High-Tech Intensity: NEO, the Midwest and U.S., 2000-2006

Table B2. Change in High-Tech Employment by Technology Group: NEO, the Midwest and U.S., 2000-2006

Table B3. Change in High-Tech GRP by Level of High-Tech Intensity: NEO, the Midwest and U.S., 2000-2006

Table B4. Change in High-Tech GRP by Technology Group: NEO, the Midwest and U.S., 2000-2006

Table B5. High-Tech Employment by Occupation, 2006

Table B1. Change in High-Tech Employment by Level of High-Tech Intensity: NEO, the Midwest and U.S., 2000-2006

NAICS Code	Industry	Employment 2006	% Employment Change (2000-2004)			% Employment Change (2004-2006)			% Employment Change (2000-2006)		
			NEO	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW
Total Level 1		49,479	-18.5%	-14.9%	-10.8%	5.8%	3.2%	5.9%	-13.7%	-12.2%	-5.5%
3254	Pharmaceutical and medicine manufacturing	1,465	35.3%	9.5%	6.2%	23.2%	-2.8%	0.7%	66.8%	6.4%	6.9%
3341	Computer and peripheral equipment manufacturing	582	-71.0%	-30.0%	-26.2%	0.8%	-1.0%	-7.0%	-70.8%	-30.7%	-31.3%
3342	Communications equipment manufacturing	1,233	-48.4%	-40.9%	-39.4%	-6.9%	-5.5%	-1.3%	-52.0%	-44.2%	-40.1%
3344	Semiconductor and other electronic component manufacturing	2,730	-32.9%	-35.8%	-31.1%	12.1%	2.8%	1.2%	-24.9%	-34.0%	-30.3%
3345	Navigational, measuring, electromedical, and control instruments mfg	5,410	-29.4%	-14.4%	-10.6%	-9.5%	-0.5%	1.8%	-36.1%	-14.8%	-8.9%
3364	Aerospace product and parts manufacturing	3,652	-19.7%	-19.9%	-16.4%	7.2%	5.3%	7.6%	-13.9%	-15.7%	-10.0%
5112	Software publishers	643	-0.1%	-6.2%	-7.2%	-4.2%	3.8%	2.1%	-4.3%	-2.6%	-5.3%
5181	Internet service providers and web search portals	955	-23.2%	-22.1%	-25.8%	-6.9%	-8.4%	0.7%	-28.5%	-28.6%	-25.3%
5182	Data processing, hosting, and related services	2,025	8.7%	-20.6%	-15.7%	-6.0%	-4.1%	-1.2%	2.2%	-23.9%	-16.7%
5413	Architectural, engineering, and related services	15,273	-12.3%	-12.1%	2.4%	3.5%	3.5%	9.2%	-9.3%	-9.0%	11.8%
5415	Computer systems design and related services	11,888	-17.0%	-15.9%	-9.8%	14.7%	9.7%	11.4%	-4.9%	-7.7%	0.4%
5417	Scientific research-and-development services	3,401	32.4%	-0.3%	5.3%	31.8%	3.7%	8.6%	74.5%	3.4%	14.5%
Total Level 2		36,648	-14.5%	-12.5%	-6.2%	0.3%	4.2%	4.3%	-14.2%	-8.9%	-2.1%
2111	Oil and gas extraction	385	-13.4%	-75.0%	-3.5%	-3.4%	-5.8%	7.9%	-16.4%	-76.4%	4.1%
2211	Electric power generation, transmission, and distribution	5,283	2.1%	0.9%	-4.5%	-6.1%	-0.9%	-3.3%	-4.1%	0.0%	-7.6%
3251	Basic chemical manufacturing	4,324	-10.2%	-13.5%	-17.2%	-6.6%	-3.8%	-6.8%	-16.1%	-16.8%	-22.8%
3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments mfg	3,042	-28.5%	-17.2%	-21.1%	-2.1%	17.2%	-3.4%	-30.0%	-3.0%	-23.7%
3332	Industrial machinery manufacturing	3,643	-33.3%	-25.5%	-25.0%	5.7%	8.3%	1.5%	-29.5%	-19.4%	-23.8%
3333	Commercial and service industry machinery manufacturing	1,667	-21.8%	-16.5%	-23.1%	-16.1%	-7.7%	-5.2%	-34.4%	-22.9%	-27.2%
3346	Manufacturing and reproducing, magnetic and optical media	157	-50.6%	-24.3%	-27.1%	2.2%	-3.1%	-11.2%	-49.6%	-26.7%	-35.3%
4234	Professional and commercial equipment and supplies, merchant wholesalers	9,133	-14.5%	-11.4%	-6.6%	-2.5%	1.8%	1.0%	-11.6%	-9.7%	-5.6%
5416	Management, scientific, and technical consulting services	8,971	-4.8%	-4.7%	10.8%	15.5%	12.8%	18.4%	9.9%	7.5%	31.1%
Total Level 3		78,268	-7.6%	-7.5%	-11.4%	-1.3%	0.3%	0.7%	-8.8%	-7.2%	-10.9%
3241	Petroleum and coal products manufacturing	1,353	-31.4%	-21.1%	-11.0%	3.3%	0.4%	-0.1%	-29.1%	-20.8%	-11.1%
3253	Pesticide, fertilizer, and other agricultural chemical manufacturing	545	-6.8%	-5.9%	-13.0%	-19.3%	-19.6%	-8.2%	-24.7%	-24.4%	-20.1%
3255	Paint, coating, and adhesive manufacturing	5,255	-10.0%	-9.5%	-11.7%	0.1%	-5.3%	-2.8%	-9.9%	-14.3%	-14.2%
3259	Other chemical product and preparation manufacturing	3,121	-24.4%	-15.8%	-15.6%	-1.5%	-5.3%	-2.0%	-25.5%	-20.3%	-17.3%
3336	Engine, turbine, and power transmission equipment manufacturing	1,632	-22.4%	-22.2%	-20.4%	6.5%	4.1%	8.8%	-17.4%	-19.0%	-13.3%
3339	Other general-purpose machinery manufacturing	11,981	-24.4%	-25.8%	-23.7%	4.5%	2.5%	3.1%	-20.9%	-23.9%	-21.3%
3353	Electrical equipment manufacturing	4,791	-32.3%	-30.2%	-27.2%	5.1%	-2.7%	0.0%	-28.8%	-32.1%	-27.2%
3369	Other transportation equipment manufacturing	163	-39.3%	-26.1%	-10.7%	-5.2%	0.0%	6.4%	-42.5%	-26.1%	-5.0%
4862	Pipeline transportation of natural gas	164	-32.5%	-29.6%	-19.8%	0.4%	2.0%	-0.8%	-32.2%	-28.1%	-20.5%
4869	Other pipeline transportation	52	1.2%	69.4%	-4.3%	-4.9%	10.5%	7.1%	-3.7%	87.2%	2.5%
5171	Wired telecommunications carriers	5,778	-25.6%	-15.0%	-22.1%	-10.5%	-14.9%	-12.6%	-33.4%	-27.7%	-31.9%
5172	Wireless telecommunications carriers (except satellite)	1,372	-24.9%	12.2%	8.2%	3.4%	4.7%	4.6%	-22.3%	17.4%	13.1%
5173	Telecommunications resellers	888	134.4%	-15.3%	-19.7%	-47.9%	-5.9%	-16.2%	22.1%	-20.3%	-32.7%
5511	Management of companies and enterprises	37,275	10.4%	9.6%	-4.7%	-1.5%	3.6%	5.1%	8.7%	13.6%	0.2%
5612	Facilities support services	1,842	31.8%	31.5%	16.0%	17.0%	25.4%	8.8%	54.3%	64.9%	26.2%
8112	Electronic and precision equipment repair and maintenance	1,127	-1.1%	-12.0%	-8.1%	-11.1%	0.8%	3.7%	-12.0%	-11.3%	-4.7%
Total High-Tech		164,394	-12.5%	-11.6%	-10.0%	1.1%	2.3%	3.9%	-11.6%	-9.6%	-6.5%
Total Employment in all industries		2,013,644	-5.6%	-3.8%	-0.1%	0.6%	1.6%	3.7%	-5.0%	-2.3%	3.6%

Note: Industries with fewer than 50 employees in Northeast Ohio are not shown, however, employment in these industries is included in the totals.

Table B2. Change in High-Tech Employment by Technology Group: NEO, the Midwest and U.S., 2000-2006

NAICS Code	Industry	Employment 2006	% Employment Change (2000-2004)			% Employment Change (2004-2006)			% Employment Change (2000-2006)		
		NEO	NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Total Advanced Manufacturing		17,455	-26.3%	-24.5%	-23.1%	2.3%	1.9%	1.2%	-24.6%	-23.0%	-22.2%
3332	Industrial machinery manufacturing	3,643	-33.3%	-25.5%	-25.0%	5.7%	8.3%	1.5%	-29.5%	-19.4%	-23.8%
3333	Commercial and service industry machinery manufacturing	1,667	-21.8%	-16.5%	-23.1%	-16.1%	-7.7%	-5.2%	-34.4%	-22.9%	-27.2%
3339	Other general-purpose machinery manufacturing	11,981	-24.4%	-25.8%	-23.7%	4.5%	2.5%	3.1%	-20.9%	-23.9%	-21.3%
3369	Other transportation equipment manufacturing	163	-39.3%	-26.1%	-10.7%	-5.2%	0.0%	6.4%	-42.5%	-26.1%	-5.0%
Total Advanced Materials		16,287	-16.9%	-13.3%	-16.7%	-3.2%	-2.3%	-4.5%	-19.6%	-15.3%	-20.4%
3251	Basic chemical manufacturing	4,324	-10.2%	-13.5%	-17.2%	-6.6%	-3.8%	-6.8%	-16.1%	-16.8%	-22.8%
3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments mfg	3,042	-28.5%	-17.2%	-21.1%	-2.1%	17.2%	-3.4%	-30.0%	-3.0%	-23.7%
3253	Pesticide, fertilizer, and other agricultural chemical manufacturing	545	-6.8%	-5.9%	-13.0%	-19.3%	-19.6%	-8.2%	-24.7%	-24.4%	-20.1%
3255	Paint, coating, and adhesive manufacturing	5,255	-10.0%	-9.5%	-11.7%	0.1%	-5.3%	-2.8%	-9.9%	-14.3%	-14.2%
3259	Other chemical product and preparation manufacturing	3,121	-24.4%	-15.8%	-15.6%	-1.5%	-5.3%	-2.0%	-25.5%	-20.3%	-17.3%
Total Bio Science		1,465	35.3%	9.5%	6.2%	23.2%	-2.8%	0.7%	66.8%	6.4%	6.9%
3254	Pharmaceutical and medicine manufacturing	1,465	35.3%	9.5%	6.2%	23.2%	-2.8%	0.7%	66.8%	6.4%	6.9%
Total Electronics		15,873	-34.6%	-27.4%	-24.7%	-1.6%	-0.7%	0.0%	-35.7%	-27.9%	-24.7%
3341	Computer and peripheral equipment manufacturing	582	-71.0%	-30.0%	-26.2%	0.8%	-1.0%	-7.0%	-70.8%	-30.7%	-31.3%
3342	Communications equipment manufacturing	1,233	-48.4%	-40.9%	-39.4%	-6.9%	-5.5%	-1.3%	-52.0%	-44.2%	-40.1%
3344	Semiconductor and other electronic component manufacturing	2,730	-32.9%	-35.8%	-31.1%	12.1%	2.8%	1.2%	-24.9%	-34.0%	-30.3%
3345	Navigational, measuring, electromedical, and control instruments mfg	5,410	-29.4%	-14.4%	-10.6%	-9.5%	-0.5%	1.8%	-36.1%	-14.8%	-8.9%
3353	Electrical equipment manufacturing	4,791	-32.3%	-30.2%	-27.2%	5.1%	-2.7%	0.0%	-28.8%	-32.1%	-27.2%
8112	Electronic and precision equipment repair and maintenance	1,127	-1.1%	-12.0%	-8.1%	-11.1%	0.8%	3.7%	-12.0%	-11.3%	-4.7%
Total Energy and Power & Propulsion		12,526	-13.2%	-16.3%	-10.9%	0.2%	1.4%	2.6%	-13.0%	-15.2%	-8.5%
2111	Oil and gas extraction	385	-13.4%	-75.0%	-3.5%	-3.4%	-5.8%	7.9%	-16.4%	-76.4%	4.1%
2211	Electric power generation, transmission, and distribution	5,283	2.1%	0.9%	-4.5%	-6.1%	-0.9%	-3.3%	-4.1%	0.0%	-7.6%
3241	Petroleum and coal products manufacturing	1,353	-31.4%	-21.1%	-11.0%	3.3%	0.4%	-0.1%	-29.1%	-20.8%	-11.1%
3336	Engine, turbine, and power transmission equipment manufacturing	1,632	-22.4%	-22.2%	-20.4%	6.5%	4.1%	8.8%	-17.4%	-19.0%	-13.3%
3364	Aerospace product and parts manufacturing	3,652	-19.7%	-19.9%	-16.4%	7.2%	5.3%	7.6%	-13.9%	-15.7%	-10.0%
4862	Pipeline transportation of natural gas	164	-32.5%	-29.6%	-19.8%	0.4%	2.0%	-0.8%	-32.2%	-28.1%	-20.5%
4869	Other pipeline transportation	52	1.2%	69.4%	-4.3%	-4.9%	10.5%	7.1%	-3.7%	87.2%	2.5%
Total Information and Communication Technology		23,979	-14.8%	-14.6%	-14.3%	-1.0%	0.7%	1.5%	-15.6%	-14.0%	-13.0%
3346	Manufacturing and reproducing, magnetic and optical media	157	-50.6%	-24.3%	-27.1%	2.2%	-3.1%	-11.2%	-49.6%	-26.7%	-35.3%
5112	Software publishers	643	-0.1%	-6.2%	-7.2%	-4.2%	3.8%	2.1%	-4.3%	-2.6%	-5.3%
5171	Wired telecommunications carriers	5,778	-25.6%	-15.0%	-22.1%	-10.5%	-14.9%	-12.6%	-33.4%	-27.7%	-31.9%
5172	Wireless telecommunications carriers (except satellite)	1,372	-24.9%	12.2%	8.2%	3.4%	4.7%	4.6%	-22.3%	17.4%	13.1%
5173	Telecommunications resellers	888	134.4%	-15.3%	-19.7%	-47.9%	-5.9%	-16.2%	22.1%	-20.3%	-32.7%
5181	Internet service providers and web search portals	955	-23.2%	-22.1%	-25.8%	-6.9%	-8.4%	0.7%	-28.5%	-28.6%	-25.3%
5182	Data processing, hosting, and related services	2,025	8.7%	-20.6%	-15.7%	-6.0%	-4.1%	-1.2%	2.2%	-23.9%	-16.7%
5415	Computer systems design and related services	11,888	-17.0%	-15.9%	-9.8%	14.7%	9.7%	11.4%	-4.9%	-7.7%	0.4%
Total Management, Sales and Facilities Support Services		49,164	5.0%	4.3%	-4.4%	-0.8%	3.5%	4.1%	4.2%	8.0%	-0.4%
4234	Professional and commercial equipment and supplies, merchant wholesalers	9,133	-14.5%	-11.4%	-6.6%	-2.5%	1.8%	1.0%	-16.6%	-9.7%	-5.6%
5511	Management of companies and enterprises	34,302	10.4%	9.6%	-4.7%	-1.5%	3.6%	5.1%	8.7%	13.6%	0.2%
5612	Facilities support services	1,842	31.8%	31.5%	16.0%	17.0%	25.4%	8.8%	54.3%	64.9%	26.2%
Total Science & Engineering		27,645	-6.8%	-7.8%	5.3%	10.1%	6.3%	11.8%	2.6%	-2.1%	17.7%
5413	Architectural, engineering, and related services	15,273	-12.3%	-12.1%	2.4%	3.5%	3.5%	9.2%	-9.3%	-9.0%	11.8%
5416	Management, scientific, and technical consulting services	8,971	-4.8%	-4.7%	10.8%	15.5%	12.8%	18.4%	9.9%	7.5%	31.1%
5417	Scientific research-and-development services	3,401	32.4%	-0.3%	5.3%	31.8%	3.7%	8.6%	74.5%	3.4%	14.5%
Total High-Tech		164,394	-12.5%	-11.6%	-10.0%	1.1%	2.3%	3.9%	-11.6%	-9.6%	-6.5%
Total Employment, all industries		2,013,644	-5.6%	-3.8%	-0.1%	0.6%	1.6%	3.7%	-5.0%	-2.3%	3.6%

Note: Industries with fewer than 50 employees in Northeast Ohio are not shown, however, employment in these industries is included in the totals.

Table B3. Change in High-Tech GRP by Level of High-Tech Intensity: NEO, the Midwest and U.S., 2000-2006

NAICS Code	Industry	Percent GRP Change (2000-2004)			Percent GRP Change (2004-2006)			Percent GRP Change (2000-2006)	
		NEO	MW	U.S.	NEO	MW	U.S.	MW	U.S.
Total Level 1		-14.3%	-4.3%	-5.3%	-6.3%	7.8%	9.9%	3.1%	4.1%
3254	Pharmaceutical and medicine manufacturing	41.8%	15.9%	28.8%	-2.9%	1.4%	9.6%	17.4%	41.2%
3341	Computer and peripheral equipment manufacturing	-70.9%	-26.9%	-45.1%	-21.5%	1.1%	3.8%	-26.1%	-43.0%
3342	Communications equipment manufacturing	-45.5%	-40.6%	-46.3%	-26.2%	-2.8%	-0.6%	-42.3%	-46.7%
3344	Semiconductor and other electronic component manufacturing	-61.5%	-33.7%	-42.1%	-17.7%	5.6%	7.9%	-30.0%	-37.6%
3345	Navigational, measuring, electromedical, and control instruments mfg	-36.6%	0.3%	-13.4%	6.4%	2.4%	4.1%	2.7%	-9.8%
3364	Aerospace product and parts manufacturing	0.9%	-4.1%	-8.6%	-58.5%	9.1%	5.6%	4.6%	-3.5%
5112	Software publishers	-7.7%	-5.8%	-9.9%	-46.7%	10.0%	12.4%	3.6%	1.3%
5181	Internet service providers and web search portals	4.4%	6.2%	4.0%	-23.4%	11.4%	16.0%	18.2%	20.6%
5182	Data processing, hosting, and related services	44.1%	32.1%	58.6%	8.2%	17.2%	12.9%	54.9%	79.1%
5413	Architectural, engineering, and related services	-3.6%	-1.0%	13.4%	7.3%	7.5%	11.0%	6.5%	25.9%
5415	Computer systems design and related services	-25.7%	-17.0%	-10.4%	-8.6%	9.9%	11.5%	-8.8%	-0.1%
5417	Scientific research-and-development services	30.0%	13.2%	21.0%	-11.4%	10.5%	11.2%	25.1%	34.5%
Total Level 2		14.8%	9.7%	13.2%	-2.6%	-3.3%	6.7%	6.0%	20.8%
2111	Oil and gas extraction	56.8%	51.3%	31.0%	16.0%	12.2%	38.4%	69.7%	81.3%
2211	Electric power generation, transmission, and distribution	57.8%	10.4%	15.1%	-10.4%	1.7%	4.3%	12.3%	20.1%
3251	Basic chemical manufacturing	11.8%	4.7%	6.0%	1.0%	-2.6%	0.2%	2.1%	6.3%
3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments mfg	13.4%	-1.4%	2.0%	40.7%	13.4%	2.2%	11.8%	4.2%
3332	Industrial machinery manufacturing	-21.2%	-17.7%	-22.4%	-7.7%	9.8%	5.4%	-9.6%	-18.3%
3333	Commercial and service industry machinery manufacturing	-37.5%	-7.4%	-17.9%	-46.3%	-4.3%	-1.3%	-11.4%	-18.9%
3346	Manufacturing and reproducing, magnetic and optical media	-53.6%	-20.9%	-34.8%	-44.2%	-20.1%	-16.0%	-36.7%	-45.2%
4234	Professional and commercial equipment and supplies, merchant wholesalers	-9.8%	-4.6%	-5.3%	-14.0%	1.7%	3.4%	-3.0%	-2.1%
5416	Management, scientific, and technical consulting services	-1.4%	-1.6%	15.1%	27.8%	15.9%	16.9%	14.0%	34.6%
Total Level 3		12.7%	5.6%	3.7%	3.8%	0.3%	3.2%	5.9%	7.1%
3241	Petroleum and coal products manufacturing	-48.4%	-10.8%	86.8%	1.7%	10.0%	21.0%	-1.8%	126.0%
3253	Pesticide, fertilizer, and other agricultural chemical manufacturing	9.0%	3.3%	9.9%	-21.6%	-10.6%	-8.3%	-7.7%	0.7%
3255	Paint, coating, and adhesive manufacturing	19.5%	12.8%	12.4%	32.2%	-6.3%	2.9%	5.6%	15.7%
3259	Other chemical product and preparation manufacturing	-6.4%	5.4%	6.4%	-10.0%	-3.8%	4.3%	1.4%	10.9%
3336	Engine, turbine, and power transmission equipment manufacturing	-1.7%	4.2%	-5.1%	-15.7%	5.8%	12.3%	10.3%	6.6%
3339	Other general-purpose machinery manufacturing	-8.9%	-10.2%	-11.5%	25.1%	7.8%	7.6%	-3.2%	-4.8%
3353	Electrical equipment manufacturing	-10.9%	-4.4%	-15.9%	11.7%	0.5%	10.4%	-3.9%	-7.2%
3369	Other transportation equipment manufacturing	17.4%	-2.0%	4.9%	-14.3%	-14.5%	-15.7%	-16.2%	-11.5%
4862	Pipeline transportation of natural gas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4869	Other pipeline transportation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5171	Wired telecommunications carriers	3.3%	-3.4%	-9.0%	-9.6%	-6.7%	-9.8%	-9.8%	-17.9%
5172	Wireless telecommunications carriers (except satellite)	-27.1%	18.4%	13.3%	-18.5%	22.0%	12.2%	44.5%	27.2%
5173	Telecommunications resellers	-23.8%	7.1%	-6.4%	-31.4%	10.5%	-10.2%	18.3%	-16.0%
5511	Management of companies and enterprises	54.1%	15.2%	4.7%	1.9%	-1.8%	6.4%	13.1%	11.4%
5612	Facilities support services	78.1%	59.4%	25.8%	58.2%	27.3%	8.8%	102.9%	36.9%
8112	Electronic and precision equipment repair and maintenance	-8.4%	-10.4%	-10.3%	3.7%	5.3%	4.5%	-5.7%	-6.3%
Total High-Tech		6.2%	3.4%	3.2%	-0.7%	1.5%	6.9%	5.0%	10.3%
Total Employment in all industries		4.4%	4.8%	8.8%	2.6%	2.1%	6.0%	7.0%	15.3%

Note: Industries with fewer than 50 employees in Northeast Ohio are not shown, however, employment in these industries is included in the totals.

Table B4. Change in High-Tech GRP by Technology Group: NEO, the Midwest and U.S., 2000-2006

NAICS Code	Industry	Percent GRP Change (2000-2004)			Percent GRP Change (2004-2006)			Percent GRP Change (2000-2006)		
		NEO	MW	U.S.	NEO	MW	U.S.	NEO	MW	U.S.
Total Advanced Manufacturing		-14.6%	-10.8%	-15.0%	8.1%	4.0%	3.5%	-7.7%	-7.2%	-12.0%
3332	Industrial machinery manufacturing	-21.2%	-17.7%	-22.4%	-7.7%	9.8%	5.4%	-27.2%	-9.6%	-18.3%
3333	Commercial and service industry machinery manufacturing	-37.5%	-7.4%	-17.9%	-46.3%	-4.3%	-1.3%	-66.4%	-11.4%	-18.9%
3339	Other general-purpose machinery manufacturing	-8.9%	-10.2%	-11.5%	25.1%	7.8%	7.6%	13.9%	-3.2%	-4.8%
3369	Other transportation equipment manufacturing	17.4%	-2.0%	4.9%	-14.3%	-14.5%	-15.7%	0.6%	-16.2%	-11.5%
Total Advanced Materials		10.0%	5.3%	6.2%	12.5%	-1.7%	1.1%	23.8%	3.4%	7.3%
3251	Basic chemical manufacturing	11.8%	4.7%	6.0%	1.0%	-2.6%	0.2%	12.8%	2.1%	6.3%
3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments mfg	13.4%	-1.4%	2.0%	40.7%	13.4%	2.2%	59.6%	11.8%	4.2%
3253	Pesticide, fertilizer, and other agricultural chemical manufacturing	9.0%	3.3%	9.9%	-21.6%	-10.6%	-8.3%	-14.5%	-7.7%	0.7%
3255	Paint, coating, and adhesive manufacturing	19.5%	12.8%	12.4%	32.2%	-6.3%	2.9%	57.9%	5.6%	15.7%
3259	Other chemical product and preparation manufacturing	-6.4%	5.4%	6.4%	-10.0%	-3.8%	4.3%	-15.8%	1.4%	10.9%
Total Bio Science		41.8%	15.9%	28.8%	-2.9%	1.4%	9.6%	37.7%	17.4%	41.2%
3254	Pharmaceutical and medicine manufacturing	41.8%	15.9%	28.8%	-2.9%	1.4%	9.6%	37.7%	17.4%	41.2%
Total Electronics		-31.6%	-16.5%	-33.6%	4.8%	1.9%	5.3%	-28.3%	-14.9%	-30.1%
3341	Computer and peripheral equipment manufacturing	-70.9%	-26.9%	-45.1%	-21.5%	1.1%	3.8%	-77.2%	-26.1%	-43.0%
3342	Communications equipment manufacturing	-45.5%	-40.6%	-46.3%	-26.2%	-2.8%	-0.6%	-59.8%	-42.3%	-46.7%
3344	Semiconductor and other electronic component manufacturing	-61.5%	-33.7%	-42.1%	-17.7%	5.6%	7.9%	-68.3%	-30.0%	-37.6%
3345	Navigational, measuring, electromedical, and control instruments mfg	-36.6%	0.3%	-13.4%	6.4%	2.4%	4.1%	-32.5%	2.7%	-9.8%
3353	Electrical equipment manufacturing	-10.9%	-4.4%	-15.9%	11.7%	0.5%	10.4%	-0.5%	-3.9%	-7.2%
8112	Electronic and precision equipment repair and maintenance	-8.4%	-10.4%	-10.3%	3.7%	5.3%	4.5%	-5.0%	-5.7%	-6.3%
Total Energy and Power & Propulsion		29.2%	7.0%	20.0%	-12.9%	3.9%	16.0%	12.6%	11.2%	39.2%
2111	Oil and gas extraction	56.8%	51.3%	31.0%	16.0%	12.2%	38.4%	81.9%	69.7%	81.3%
2211	Electric power generation, transmission, and distribution	57.8%	10.4%	15.1%	-10.4%	1.7%	4.3%	41.5%	12.3%	20.1%
3241	Petroleum and coal products manufacturing	-48.4%	-10.8%	86.8%	1.7%	10.0%	21.0%	-47.5%	-1.8%	126.0%
3336	Engine, turbine, and power transmission equipment manufacturing	-1.7%	4.2%	-5.1%	-15.7%	5.8%	12.3%	-17.1%	10.3%	6.6%
3364	Aerospace product and parts manufacturing	0.9%	-4.1%	-8.6%	-58.5%	9.1%	5.6%	-58.2%	4.6%	-3.5%
4862	Pipeline transportation of natural gas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4869	Other pipeline transportation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Information and Communication Technology		-12.0%	-7.0%	-5.4%	-8.1%	6.7%	4.5%	-19.1%	-0.8%	-1.2%
3346	Manufacturing and reproducing, magnetic and optical media	-53.6%	-20.9%	-34.8%	-44.2%	-20.1%	-16.0%	-74.1%	-36.7%	-45.2%
5112	Software publishers	-7.7%	-5.8%	-9.9%	-46.7%	10.0%	12.4%	-50.8%	3.6%	1.3%
5171	Wired telecommunications carriers	3.3%	-3.4%	-9.0%	-9.6%	-6.7%	-9.8%	-6.7%	-9.8%	-17.9%
5172	Wireless telecommunications carriers (except satellite)	-27.1%	18.4%	13.3%	-18.5%	22.0%	12.2%	-40.6%	44.5%	27.2%
5173	Telecommunications resellers	-23.8%	7.1%	-6.4%	-31.4%	10.5%	-10.2%	-47.7%	18.3%	-16.0%
5181	Internet service providers and web search portals	4.4%	6.2%	4.0%	-23.4%	11.4%	16.0%	-20.0%	18.2%	20.6%
5182	Data processing, hosting, and related services	44.1%	32.1%	58.6%	8.2%	17.2%	12.9%	55.9%	54.9%	79.1%
5415	Computer systems design and related services	-25.7%	-17.0%	-10.4%	-8.6%	9.9%	11.5%	-32.1%	-8.8%	-0.1%
Total Management, Sales and Facilities Support Services		29.0%	17.9%	9.1%	-3.0%	-8.2%	-1.6%	25.2%	8.2%	7.4%
4234	Professional and commercial equipment and supplies, merchant wholesalers	-9.8%	-4.6%	-5.3%	-14.0%	1.7%	3.4%	-22.5%	-3.0%	-2.1%
5511	Management of companies and enterprises	54.1%	15.2%	4.7%	1.9%	-1.8%	6.4%	57.0%	13.1%	11.4%
5612	Facilities support services	78.1%	59.4%	25.8%	58.2%	27.3%	8.8%	181.8%	102.9%	36.9%
Total Science & Engineering		0.6%	1.8%	15.7%	11.9%	10.8%	12.9%	12.5%	12.9%	30.6%
5413	Architectural, engineering, and related services	-3.6%	-1.0%	13.4%	7.3%	7.5%	11.0%	3.4%	6.5%	25.9%
5416	Management, scientific, and technical consulting services	-1.4%	-1.6%	15.1%	27.8%	15.9%	16.9%	26.0%	14.0%	34.6%
5417	Scientific research-and-development services	30.0%	13.2%	21.0%	-11.4%	10.5%	11.2%	15.1%	25.1%	34.5%
Total High-Tech		6.2%	3.4%	3.2%	-0.7%	1.5%	6.9%	5.5%	5.0%	10.3%
Total Employment, all industries		4.4%	4.8%	8.8%	2.6%	2.1%	6.0%	7.1%	7.0%	15.3%

Note: Industries with fewer than 50 employees in Northeast Ohio are not shown, however, employment in these industries is included in the totals.

Table B5. High-Tech Employment by Occupation, 2006

Occupation		Employment, 2006	Employment per 100,000 Employees		
		NEO MSAs	NEO MSAs	Midwest States	U.S.
High-Tech Management Occupations		5,120	269.3	341.2	357.3
11-3021	Computer and information systems managers	2,560	134.7	185.6	189.4
11-9041	Engineering managers	2,320	122.0	139.2	138.7
11-9121	Natural sciences managers	240	12.6	16.3	29.2
High-Tech Computer and Mathematical Occupations		28,540	1,501.3	1,884.8	2,176.2
15-1011	Computer and information scientists, research **	-	-	13.7	20.9
15-1021	Computer programmers	3,830	201.5	286.4	298.6
15-1031	Computer software engineers, applications	5,810	305.6	301.4	356.3
15-1032	Computer software engineers, systems software *	1,590	83.6	169.0	248.2
15-1041	Computer support specialists	5,540	291.4	326.0	388.0
15-1051	Computer systems analysts	4,050	213.0	306.8	336.7
15-1061	Database administrators *	1,160	61.0	77.3	82.8
15-1071	Network and computer systems administrators	3,660	192.5	209.6	218.3
15-1081	Network systems and data communications analysts	2,440	128.4	133.2	153.6
15-2011	Actuaries *	-	-	15.9	12.5
15-2021	Mathematicians	-	-	0.6	2.1
15-2031	Operations research analysts	330	17.4	31.9	42.4
15-2041	Statisticians	130	6.8	12.3	14.8
15-2091	Mathematical technicians	-	-	0.7	0.9
High-Tech Architecture and Engineering Occupations		22,420	1,179.4	1,430.6	1,494.8
17-2011	Aerospace engineers	500	26.3	20.9	65.4
17-2021	Agricultural engineers	-	-	2.3	2.3
17-2031	Biomedical engineers	140	7.4	7.9	10.6
17-2041	Chemical engineers	640	33.7	20.3	21.9
17-2051	Civil engineers	1,780	93.6	128.7	178.5
17-2061	Computer hardware engineers	290	15.3	28.1	56.2
17-2071	Electrical engineers *	1,090	57.3	104.7	111.4
17-2072	Electronics engineers, except computer *	880	46.3	72.7	99.5
17-2081	Environmental engineers	660	34.7	31.3	38.7
17-2111	Health and safety engineers, except mining safety **	210	11.0	11.3	18.6
17-2112	Industrial engineers *	4,110	216.2	247.7	149.6
17-2121	Marine engineers and naval architects **	-	-	-	5.9
17-2131	Materials engineers *	690	36.3	19.5	16.0
17-2141	Mechanical engineers	3,800	199.9	252.2	164.0
17-2151	Mining and geological engineers, incl. mining safety **	-	-	1.3	5.1
17-2161	Nuclear engineers **	-	-	3.7	11.2
17-2171	Petroleum engineers	-	-	1.6	11.4
17-3011	Architectural and civil drafters	1,010	53.1	59.8	80.8
17-3012	Electrical and electronics drafters *	260	13.7	20.4	24.5
17-3013	Mechanical drafters	1,310	68.9	84.1	55.0
17-3021	Aerospace engineering and operations technicians	90	4.7	2.6	6.2
17-3022	Civil engineering technicians	610	32.1	51.1	65.4
17-3023	Electrical and electronic engineering technicians	1,580	83.1	98.4	125.4
17-3024	Electro-mechanical technicians *	-	-	12.2	11.5
17-3025	Environmental engineering technicians *	400	21.0	13.2	15.5
17-3026	Industrial engineering technicians *	790	41.6	81.8	55.5
17-3027	Mechanical engineering technicians *	1,030	54.2	52.7	35.2
17-3031	Surveying and mapping technicians	550	28.9	-	53.5

Occupation	Employment, 2006	Employment per 100,000 Employees		
	NEO MSAs	NEO MSAs	Midwest States	U.S.
High-Tech Life and Physical Science Occupations	5,070	266.7	373.9	498.0
19-1011 Animal scientists	-	-	1.0	3.0
19-1012 Food scientists and technologists	-	-	10.5	6.6
19-1013 Soil and plant scientists	-	-	6.5	8.1
19-1021 Biochemists and biophysicists * **	-	-	7.3	14.1
19-1022 Microbiologists	-	-	12.6	11.9
19-1023 Zoologists and wildlife biologists **	-	-	3.9	13.6
19-1031 Conservation scientists	-	-	9.7	12.1
19-1032 Foresters	-	-	7.7	8.1
19-1041 Epidemiologists	-	-	1.0	3.1
19-1042 Medical scientists, except epidemiologists	180	9.5	31.6	59.0
19-2011 Astronomers	-	-	-	1.1
19-2012 Physicists **	60	3.2	6.9	11.6
19-2021 Atmospheric and space scientists	-	-	4.7	6.2
19-2031 Chemists	1,450	76.3	62.6	60.7
19-2032 Materials scientists **	320	16.8	11.3	7.1
19-2041 Environmental scientists and specialists, including health	900	47.3	39.3	58.6
19-2042 Geoscientists, except hydrologists and geographers	40	2.1	8.5	21.9
19-2043 Hydrologists	-	-	2.4	5.8
19-4011 Agricultural and food science technicians	40	2.1	14.1	14.5
19-4021 Biological technicians	860	45.2	41.4	54.0
19-4031 Chemical technicians	1,220	64.2	47.4	45.2
19-4041 Geological and petroleum technicians **	-	-	0.6	8.5
19-4051 Nuclear technicians	-	-	2.7	4.8
19-4091 Environmental science and protection techs, incl. health *	-	-	25.3	26.2
19-4092 Forensic science technicians	-	-	6.3	9.3
19-4093 Forest and conservation technicians	-	-	8.6	23.1
				-
Total High-Tech	61,150	3,216.8	4,030.5	4,526.4
Total All Occupations	1,900,970			

* Estimates have not been released for one or more Northeast Ohio metropolitan areas.

** Estimates have not been released for one or more Midwest States.