Cleveland State University
Maxine Goodman Levin College of Urban Affairs

Prepared for:
NORTECH

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

THE HIGH-TECH SECTOR IN NORTHEAST OHIO:

BASELINE REPORT

February 2007

Center for Economic Development

The Ohio Urban University Program

2121 Euclid Avenue Cleveland, Ohio 44115
http://urban.csuohio.edu

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This study uses several indicators to measure the strengths and weaknesses of the high-tech sector in Northeast Ohio (NEO) in comparison to the U.S. High-tech industries are analyzed in terms of employment, average wage, gross regional product (output), and productivity. High-tech occupations are analyzed in terms of employment. Research and development activity is analyzed by examining trends in industry R&D funding and academic R&D expenditures.

In this study, Northeast Ohio (NEO) is defined as a 21-county area. The region consists of six metropolitan areas (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.

This report utilizes 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. Hecker identifies 46 four-digit NAICS industries as high-tech and further divides the high-tech industries into three levels based on high-tech intensity. High-tech occupations include 71 scientific, engineering, and technician occupations.

HIGH-TECH INDUSTRIES IN NORTHEAST OHIO

Total high-tech employment in NEO declined from 184,554 in 2000 to 160,819 in 2005. The rate of job loss in NEO's high-tech industries (-12.1%) was higher than in the U.S. (-8.7%). The decline in NEO was a result of large losses during the recessionary years, 2000-2003, and continuing losses in the following expansionary years, 2003-2005. In the U.S., high-tech employment declined mostly in the first three years.

Level III, the least high-tech intensive industries, is the largest high-tech category in NEO, while level I is the largest category in the U.S. Between 2003 and 2005, both NEO and the U.S. experienced employment gains of 0.8% in level I high-tech industries.

The share of high-tech industries in the overall economy declined in both NEO and the U.S. However, the share in NEO (8%) was lower than the share nationally (9.4%). NEO's share of level I high-tech industries was lower than nationally, while NEO's share of level III high-tech industries was higher than in the U.S. This is consistent with NEO's competitive clusters and industry mix.

Although employment declined in each level between 2000 and 2005, some individual industries experienced job gains. Level I high-tech industries that added jobs in NEO include Pharmaceutical and Medicine Manufacturing and Scientific Research and Development

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

Services. Level II high-tech industries that added jobs are Electric Power Generation, Transmission, and Distribution and Management, Scientific, and Technical Consulting Services. Level III industries that added jobs are Management of Companies and Enterprises (headquarters) and Facilities Support Services.

High-tech jobs are more concentrated in NEO's two largest metro areas than in the region as a whole. The Cleveland-Elyria-Mentor MSA accounted for 60 percent of NEO's high-tech jobs, while it accounted for only 51 percent of all jobs, and the Akron MSA accounted for 21 percent of NEO's high-tech jobs and almost 16 percent of all jobs. Moreover, high-tech industries play a more significant role in the Akron area. In the Akron MSA, 10.8 percent of all jobs are in high-tech industries in comparison to 9.2 percent in the Cleveland MSA and 9.4 percent in the U.S.

Akron and Sandusky are the only metro areas that added high-tech employment in the recessionary years of 2000-2003 and the following two years, 2003-2005. In Akron, job gains occurred in both time periods in level III high-tech industries; employment increased in level II industries during the expansionary years (2003-2005). The Cleveland-Elyria-Mentor metro area gained employment in level I industries between 2003 and 2005.

The average wage for NEO's high-tech industries was $62,350 in 2005. This is 72 percent higher than the average wage of $36,160 for all industries. The highest average wage is paid by level III industries in both NEO and the U.S.

Gross regional product (GRP) measures value added output for each industry. In 2005, total output for all high-tech industries in NEO was $20.8 billion, accounting for 12.1 percent of the total economy. This is a higher share than the share of high-tech employment (8%). In the U.S. these shares are 15.4% and 9.4%, respectively.

Moreover, GRP in NEO's high-tech industries increased between 2000 and 2005, in contrast to declining high-tech employment. In addition, the rate of increase in NEO (7.5%) was similar to the U.S. (7.9%).

Productivity (measured as GRP per employee) in high-tech industries is higher than average productivity for all industries. In 2005, productivity in high-tech industries in NEO was 52% higher than overall productivity in the economy (it was 77% higher in the U.S.). Within the high-tech sector, level II industries have the highest productivity, followed by level III and level I. Productivity in the U.S. is higher in each of the high-tech industry levels.

HIGH-TECH OCCUPATIONS IN NORTHEAST OHIO

Approximately 58,000 workers in NEO's metropolitan areas are employed in high-tech occupations, accounting for 3.1 percent of all workers. In the U.S., high-tech occupations account for 4.5 percent. The share of workers in high-tech occupations lags the nation for all occupational clusters, although the largest differences are in Computer and Mathematical jobs and Life and Physical Science jobs.

The distribution of NEO's high-tech workers within the occupational clusters reflects the region's industry mix. Nearly 38 percent of NEO's high-tech workers are in Architecture and Engineering occupations, a higher proportion than found nationally. Most of these workers are in

engineering occupations, which would be expected in an area with a large manufacturing base. The share found in Life and Physical Science occupations is lower than the national share.

RESEARCH AND DEVELOPMENT

Estimates of industry R&D indicate that funding in Northeast Ohio increased nearly 60 percent between 1993 and 2003, while the remainder of the state saw a 35 percent increase in funding.

Northeast Ohio's colleges and universities reported nearly $300 million in research expenditures in FY 2004. The vast majority (78%) of that research was conducted at Case Western Reserve University. The federal government supports 76 percent of the research that is undertaken by the region's academic institutions.

Academic R&D expenditures in Northeast Ohio increased 24 percent between 2000 and 2004. However, colleges and universities in NEO underperformed their counterparts in other parts of Ohio. Colleges and universities across Ohio reported a 44 percent increase in research expenditures over the same time period.

REACTIONS AND RECOMMENDATIONS

A draft of this report was shared with a select number of stakeholders who were asked to participate in a focus group to provide additional insight regarding the analysis and help develop strategic interventions that build on the baseline of information. These stakeholders included executives of high-tech companies, economists, and representatives from non-profit economic development organizations. Focus group participants discussed issues related to the interpretation of the data, areas for future research, and concluded by identifying strategic interventions that might be introduced to advance the high-tech sector in Northeast Ohio. The discussion on strategic interventions centered around three main issues: workforce development, company growth and retention, and university-industry partnerships.

CONCLUDING REMARKS

The information provided in this report is intended to provide a baseline for monitoring changes in the high-tech sector in Northeast Ohio. Tracking a specific set of measures on an annual basis will provide policy makers with a method for assessing progress and directing resources.

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 be begin to "move the needle" for some of the measures included in this report.

INTRODUCTION

This report analyzes trends in the high-tech sector in Northeast Ohio. The report was prepared for NorTech by the Center for Economic Development at Cleveland State University's Levin College of Urban Affairs.

The study uses several indicators to gauge the strengths and weaknesses of the high-tech sector in comparison to the U.S. High-tech industries are analyzed in terms of employment, average wage, gross regional product (output), and productivity. High-tech occupations are analyzed in terms of employment. Research and development activity is analyzed by examining trends in industry R&D funding and academic R&D expenditures.

In this study, Northeast Ohio (NEO) is defined as a 21-county area. The region corresponds to NorTech's service area, which has recently increased to match the regional definition suggested by the Ohio's Third Frontier Project.[2] The 21 county region 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.[3] The eight non-metro counties include Ashland, Ashtabula, Columbiana, Crawford, Holmes, Huron, Tuscarawas, and Wayne. A list of all sub-regions and their counties is also included in Appendix A.

RELATIONSHIP TO THE DASHBOARD OF ECONOMIC INDICATORS

This report complements the large ongoing effort to enhance and update the Dashboard of Economic Indicators project funded by the Fund for Our Economic Future (also one of NorTech's funders). The Dashboard Indicators project tracks economic and social variables that are strong indicators of economic growth. Data for more than 40 variables are collected for about 150 metropolitan areas across the U.S. Variables are then grouped statistically into several factors that affect economic growth, which 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 corporate and academic research and development funding.

This project differs from the Dashboard project in terms of the geographic focus. While the Dashboard measures economic performance for metropolitan areas, 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. Additionally, 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 make up the high-tech sector.

[2] The Third Frontier Project, a State initiative to stimulate innovation and entrepreneurship, divided Ohio into six regions. It defined Northeast Ohio to include 21 counties.
[3] With the exception of the analysis of high tech occupations, this report excludes Mercer County.

METHODOLOGY

This report 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."[4]

Within the high-tech group, Hecker 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.

Trends are examined for the 2000 to 2005 time period, although changes in employment and gross regional product are also examined for the recessionary (2000-2003) and expansionary (2003-2005) periods that comprise this broader time frame.[5] Employment trends are also analyzed for the sub-regions that comprise NEO – the six metropolitan areas and the non-metro counties. The analyses rely on data from two sources: the Quarterly Census of Employment and Wages (ES202) and Moody's economy.com. Employment and wage data is extracted from the ES202 database, and output and productivity data is derived from economy.com.

This study also relies upon a definition of high-tech occupation presented by Hecker. The list includes 71 scientific, engineering, and technician occupations. 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 within the 71 high-tech occupations was obtained from the U.S. Department of Labor, Bureau of Labor Statistics.[6] 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 only – definitional changes in occupations and metropolitan areas preclude trend analysis. It is intended that 2005 will serve as a baseline year that future changes can be measured against.

The study also examines research and development activity in the region by looking at industry R&D funding and R&D expenditures of academic institutions. Data is 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

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

[5] During the five year period from 2000 to 2005, the U.S. experienced an eight-month recession that began in March 2001 and ended in 2001(National Bureau of Economic Research, Business Cycle Expansions and Contractions). Because Northeast Ohio felt the impact of the recession sooner and was slower to recover, this analysis assumes the recessionary period began in 2000 and extended through 2002, with the expansionary period beginning in 2003.

[6] 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/

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 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 2003 and the latest data available for academic R&D is 2004.

HIGH-TECH INDUSTRIES IN NORTHEAST OHIO

This report analyzes high-tech industries in Northeast Ohio in terms of employment, average wages, gross regional product, and productivity. For all measures, NEO is compared to the U.S.; both include small and large metropolitan areas as well as rural (non-metro) counties. The analyses are conducted for high-tech industries as a whole, and the three levels defined by Hecker.

EMPLOYMENT

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

Total high-tech employment in NEO declined from 184,554 in 2000 to 160,819 in 2005. The loss of nearly 24,000 jobs, or 12.9 percent, was a result of large losses during the recessionary years, 2000-2003, and continuing losses in the following two years, 2003-2005 (Table 1). National trends were similar; total high-tech employment in the U.S. declined by 8.7 percent between 2000 and 2005, and most of the decline (-8.6%) occurred in the first three years. However, the rate of decline of employment in NEO's high-tech industries (-12.1%) was higher than in the U.S. (-8.7%).

Table 1: Employment in High-Tech Industries in NEO, 2000 to 2005

Industry	Employment Totals			Employment Change		
	2000	2003	2005	2000-2003	2003-2005	2000-2005
Level 1 High-Tech Industries	57,666	47,534	47,891	-10,132	357	-9,775
Level 2 High-Tech Industries	42,703	38,444	36,624	-4,259	-1,820	-6,079
Level 3 High-Tech Industries	84,185	78,183	76,303	-6,002	-1,880	-7,882
Total High-Tech	184,554	164,161	160,819	-20,393	-3,342	-23,735
Total Employment, all industries	2,120,866	2,013,699	2,009,727	-107,167	-3,972	-111,139

Source: Quarterly Census of Employment and Wages (ES202)

Analyzing high-tech employment by technology level reveals that the largest high-tech category in NEO is level III, while level I is the largest high-tech category in the U.S. Level II is the smallest category in both.

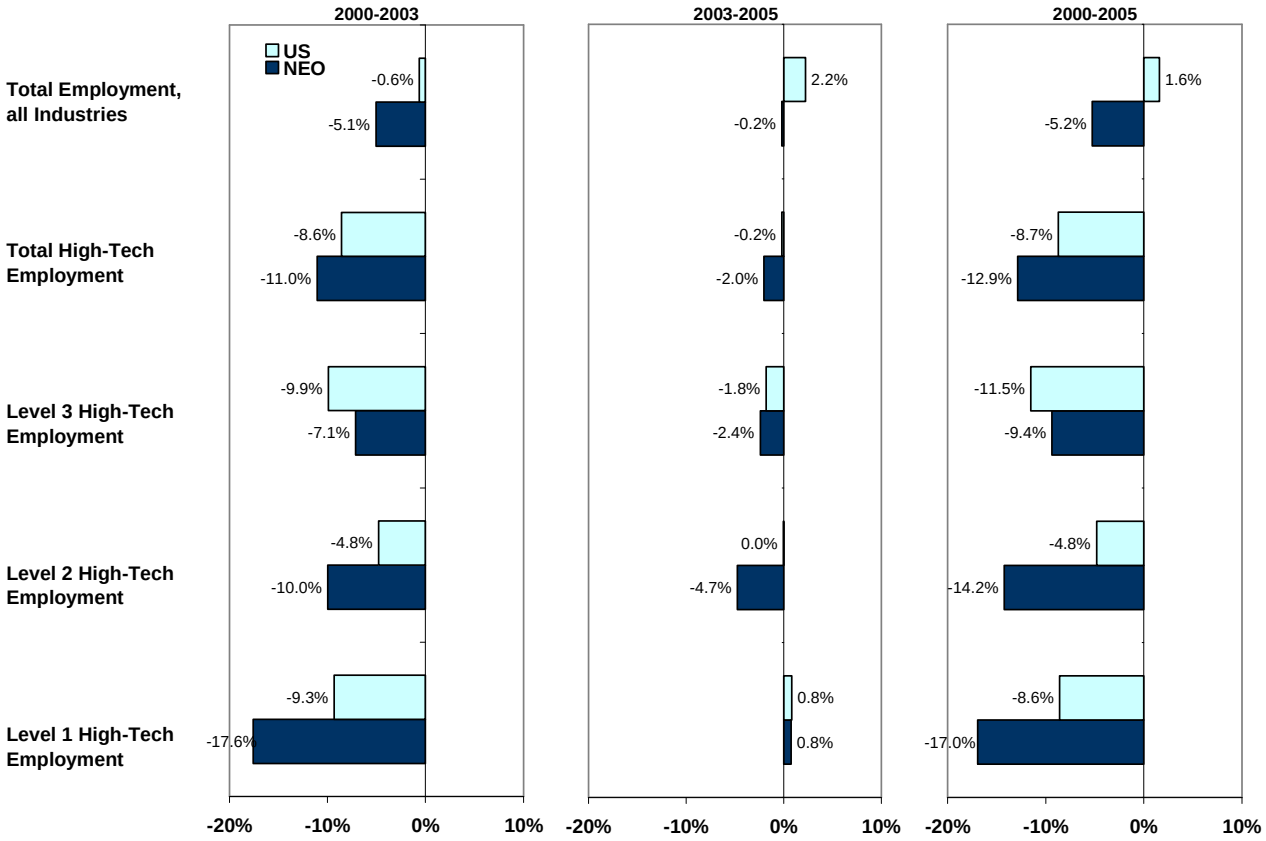
Table 2 and Figure 1 show the rates of change by technology level and time period for NEO and the U.S. Only level I industries showed employment increases between 2003 and 2005; both NEO and the U.S. experienced a 0.8 percent growth (NEO added 357 jobs).

Table 2: Employment Changes in High-Tech Industries in NEO and U.S., 2000 to 2005

Industry	% Employment Change (2000-2003)		% Employment Change (2003-2005)		% Employment Change (2000-2005)	
	NEO	U.S.	NEO	U.S.	NEO	U.S.
Level 1 High-Tech Industries	-17.6%	-9.3%	0.8%	0.8%	-17.0%	-8.6%
Level 2 High-Tech Industries	-10.0%	-4.8%	-4.7%	0.0%	-14.2%	-4.8%
Level 3 High-Tech Industries	-7.1%	-9.9%	-2.4%	-1.8%	-9.4%	-11.5%
Total High-Tech	-11.0%	-8.6%	-2.0%	-0.2%	-12.9%	-8.7%
Total Employment, all industries	-5.1%	-0.6%	-0.2%	2.2%	-5.2%	1.6%

Source: Quarterly Census of Employment and Wages (ES202)

Figure 1: Employment Percent Change in NEO and US 2000-2003, 2003-2005 and 2000-2005



Source: Quarterly Census of Employment and Wages (ES202)
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

During the recessionary years, 2000-2003, NEO lost high-tech jobs in levels I and II at much faster rates than the U.S. However, NEO's level III high-tech jobs declined at a slower pace (-7.1%) than in the U.S. (-9.9%). During the expansionary years, 2003-2005, both NEO and the U.S. gained level I jobs, but NEO lost level II jobs (-4.7%) while they remained stable in the U.S. Level III employment declined in both NEO and the U.S. (by -2.4% and -1.8% respectively).

Employment in high-tech industries not only declined in both NEO and the U.S., but the share of high-tech industries in the overall economy declined as well. In NEO, the share of employment in high-tech industries declined from 8.7 percent in 2000 to 8.0 percent in 2005; the respective shares in the U.S. fell from 10.5 percent to 9.4 percent (Table 3).

The high-tech sector is a smaller sector in NEO than nationally. The table shows that in 2005, eight percent of all jobs in NEO are found in high-tech industries; in the U.S., 9.4 percent of all employment is in high-tech industries. The difference is more pronounced in level I high-tech industries, the most high-tech intensive industries. In NEO, level I jobs account for 2.4 percent of all jobs compared to 4.4 percent in the U.S. In contrast, NEO's share of level III high-tech jobs (3.8%) is higher than in the U.S. (2.9%). This is consistent with the NEO's competitive clusters and industry mix.

Table 3: Share of High-Tech Employment in NEO and U.S., 2000 to 2005

Industry	% Share of Total Employment, 2000		% Share of Total Employment, 2003		% Share of Total Employment, 2005	
	NEO	U.S.	NEO	U.S.	NEO	U.S.
Level 1 High-Tech Industries	2.7%	4.9%	2.4%	4.4%	2.4%	4.4%
Level 2 High-Tech Industries	2.0%	2.2%	1.9%	2.1%	1.8%	2.0%
Level 3 High-Tech Industries	4.0%	3.4%	3.9%	3.0%	3.8%	2.9%
Total High-Tech	8.7%	10.5%	8.2%	9.6%	8.0%	9.4%
Total Employment, all industries	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Quarterly Census of Employment and Wages (ES202)

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 (Appendix B) provides the list of industries in each level and compares employment trends in NEO and the U.S. between 2000 and 2005. Although employment in high-tech industries declined in both NEO and the U.S., there was growth in some industries. Two level I high-tech industries added jobs throughout the period: Pharmaceutical and Medicine Manufacturing gained 47 percent (more than 400 jobs) in comparison to a six percent increase in the U.S.; and Scientific Research and Development Services added 34.3 percent (nearly 700 jobs), significantly more than the national gain (10.9%). These two industries added jobs during the recessionary years and the expansionary period. Between 2003 and 2005 two additional level I high-tech industries added jobs. Communications Equipment Manufacturing added 10.4 percent (more than 100 jobs) in contrast to a national decline (-9.7%). Computer Systems Design and Related Services added 9.4 percent (nearly 1,000 jobs), higher than the national gain of 5.6 percent.

Level II jobs declined in both NEO and the U.S., but two industries added jobs in NEO throughout the 2000-2005 period. Electric Power Generation, Transmission, and Distribution increased employment by 5.8 percent in comparison to a national decline of 6.5 percent. Another NEO industry experienced a small job gain – Management, Scientific, and Technical Consulting Services (1.8%); in contrast the U.S. experienced a much larger gain (19.6%).

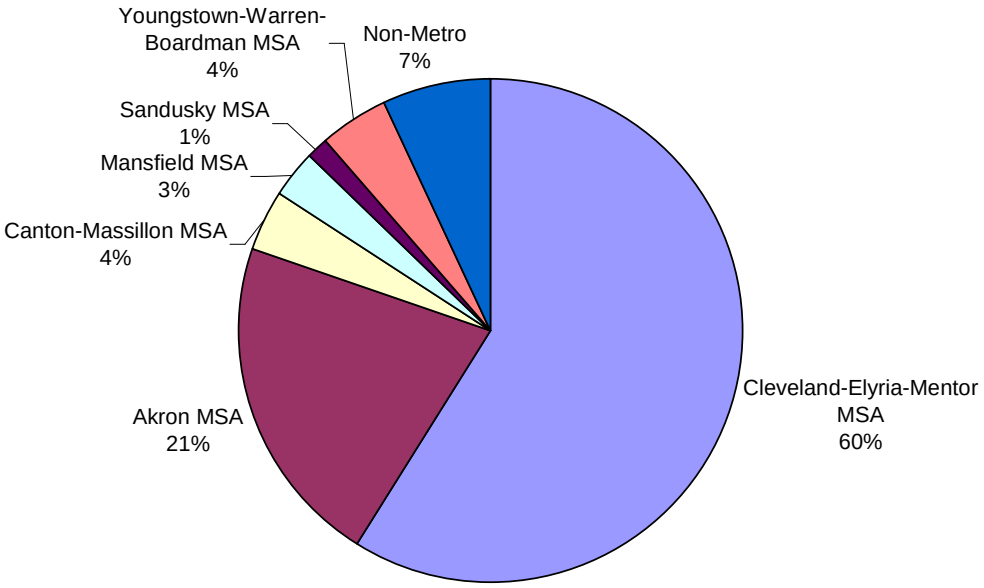
Two level III industries that experienced a job growth in NEO are: Management of Companies and Enterprises — company headquarters (8.8% in NEO versus -2.5% in the U.S.) and Facilities Support Services (33.1% in NEO versus 19.5% nationally). Two additional level III industries added jobs during the expansionary year: Engine, Turbine, and Power Transmission Equipment Manufacturing and Wireless Telecommunications Carriers (except Satellite).

High-tech Employment in NEO's Sub-Regions

NEO is not a unified economic region and thus, an analysis of the high-tech industries in the individual sub-regions is needed. The Cleveland-Elyria-Mentor metropolitan area is by far the largest economy in Northeast Ohio. It accounts for one-half (51%) of all jobs, and 60 percent of all high-tech employment (Figure 2). Thus, high-tech jobs are more concentrated in the Cleveland area in comparison to the larger regional economy.

The second largest high-tech region 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 the total NEO jobs, thus high-tech jobs are also concentrated in the Akron area in comparison to the regional economy.

Figure 2: Total High Tech Employment by MSA, 2005



Source: Quarterly Census of Employment and Wages (ES202)
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

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, 10.8 percent of all jobs are in high-tech industries (Table 5). This compares to 9.2 percent in the Cleveland-Elyria-Mentor MSA and to a national average of 9.4 percent. Thus, the share of the high-tech sector in the Cleveland metro area is similar to the national average, while it is much higher in the Akron area. 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 one-half of the regional share.

Table 5: Share of High-Tech Employment Metropolitan Regions of NEO, 2005

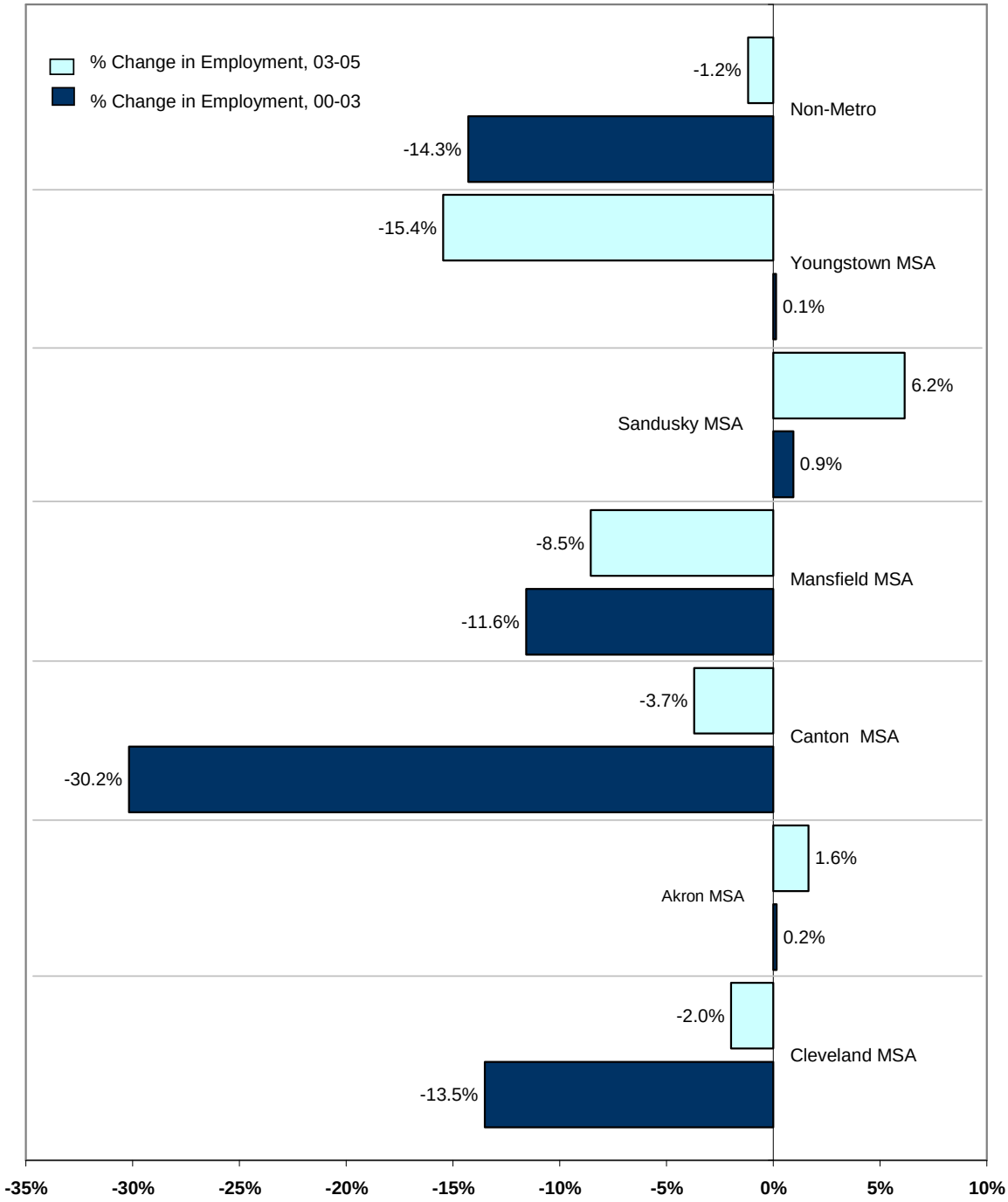
Industry	High-Tech Industries			
	Level 1	Level 2	Level 3	Total High-Tech
Cleveland MSA	3.0%	1.9%	4.3%	9.2%
Akron MSA	2.6%	2.5%	5.7%	10.8%
Canton-Massillon MSA	1.0%	1.2%	1.5%	3.7%
Mansfield MSA	3.4%	1.6%	3.7%	8.7%
Sandusky MSA	0.7%	2.9%	3.2%	6.7%
Youngstown MSA	0.9%	0.9%	2.0%	3.8%
Non-Metro Counties	1.3%	1.4%	2.3%	5.1%
NEO	2.4%	1.8%	3.8%	8.0%
U.S.	4.4%	2.0%	2.9%	9.4%

Source: Quarterly Census of Employment and Wages (ES202)

Among the smaller metropolitan areas, Sandusky has the largest share of high-tech employment at 8.7 percent. However, Sandusky MSA has only 35,775 employees, of which 2,400 are employed in high-tech industries.

Figure 3 shows rates of change in high-tech employment in each of NEO's sub regions in two time periods, 2000-2003 and 2003-2005. Akron and Sandusky are the only MSAs that added high-tech employment in both periods, but especially in the later two years. In all other areas, the rate of job loss was smaller in the 2003-2005 period.

Figure 3: Total High-Tech Employment by MSA: Percent Change, 2000-2003 and 2003-2005

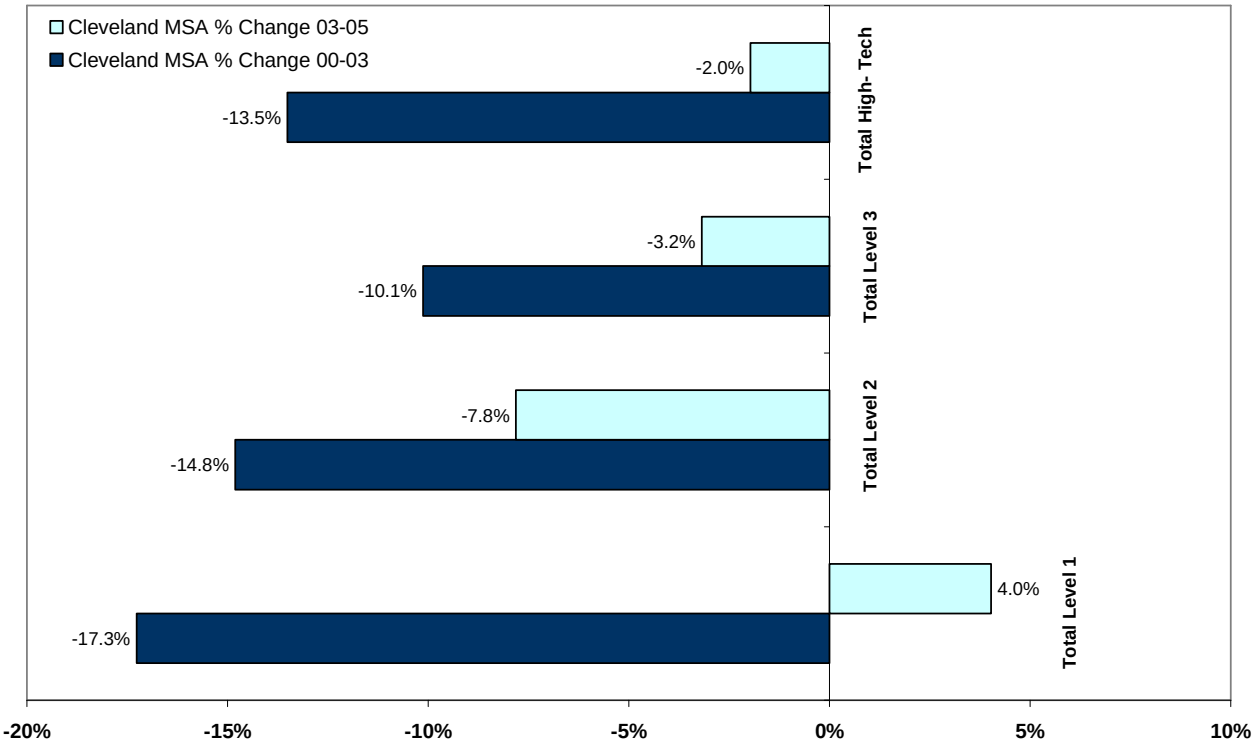


Source: Quarterly Census of Employment and Wages (ES202)
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

Figures 4 and 5 analyze employment changes in the two largest metropolitan areas, Cleveland and Akron MSAs by technology level. Figure 4 reveals that the Cleveland-Elyria-Mentor MSA experienced job growth in level I high-tech industries between 2003 and 2005. These gains occurred in six industries. Four industries added more than 100 jobs each: Pharmaceutical and Medicine Manufacturing, Communication Equipment Manufacturing, Computer System Design,

and Scientific Research and Development Services. The Pharmaceutical and Medicine Manufacturing and the Scientific Research and Development Services industries also added jobs in the recessionary years. Job losses occurred in both time periods in level II and level III high-tech industries. Only one level III industry added jobs during the whole period: Facilities support Services, which could indicate increased outsourcing of some services by local companies.

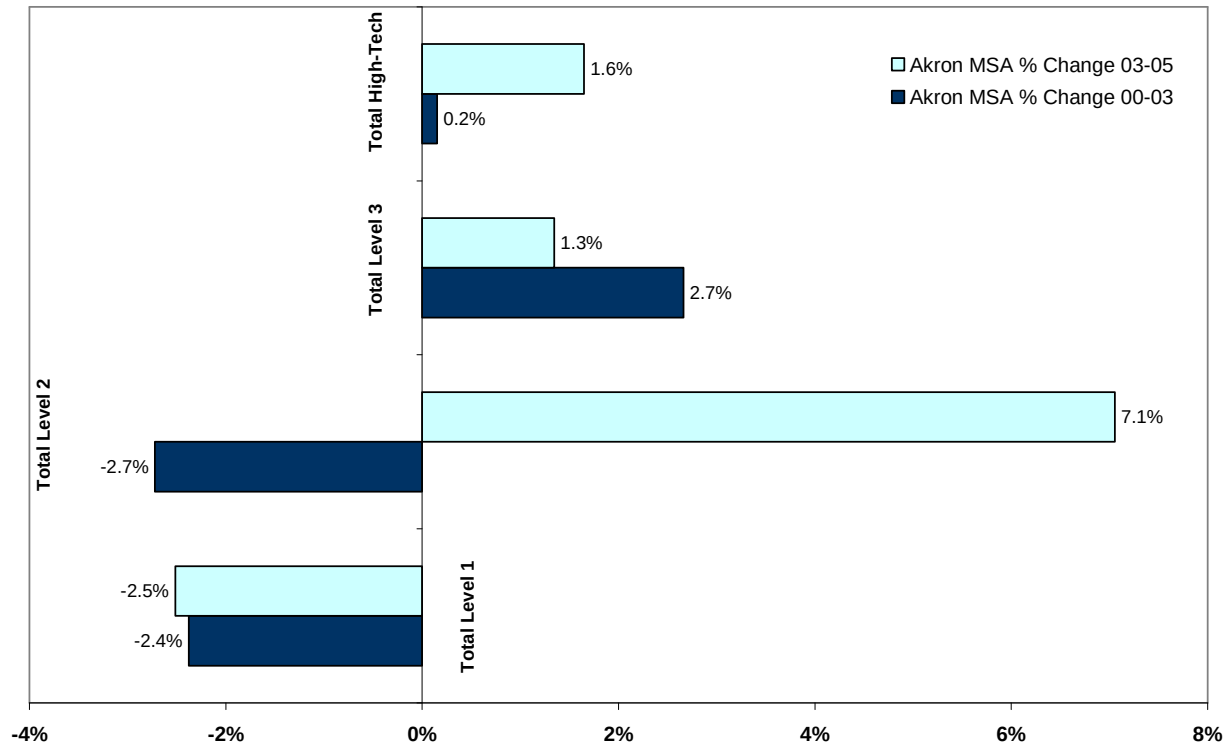
Figure 4: Total High-Tech Employment in Cleveland MSA, Percent Change : 2000-2003 and 2003-2005



Source: Quarterly Census of Employment and Wages (ES202)
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

As shown in Figure 5, level III industries in the Akron MSA added jobs in both the 2000-2003 and 2003-2005 periods. A large level III industry that added jobs is Management of Companies. Level II industries gained employment in the later two years. A large level II industry in Akron that added jobs is Electric Power Generation, Transmission, and Distribution. Although level I industries as a group lost jobs through the whole period, three small industries added jobs: Scientific Research and Development Services, Computer and Peripheral Equipment Manufacturing, and Communications Equipment Manufacturing.

Figure 5: Total High-Tech Employment in Akron MSA, Percent Change: 2000-2003 and 2003-2005



Source: Quarterly Census of Employment and Wages (ES202)
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

AVERAGE WAGES IN HIGH-TECH INDUSTRIES

The average wage for NEO's high-tech industries was $62,350 in 2005. This is 72 percent higher than the average wage of $36,160 for all industries (Table 6). The highest average wage is paid by level III industries in both NEO and the U.S., indicating that, 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 ($101,700) and Facilities Support Services ($80,400).

Table 6: Average Wages in High-Tech Industries in NEO and U.S

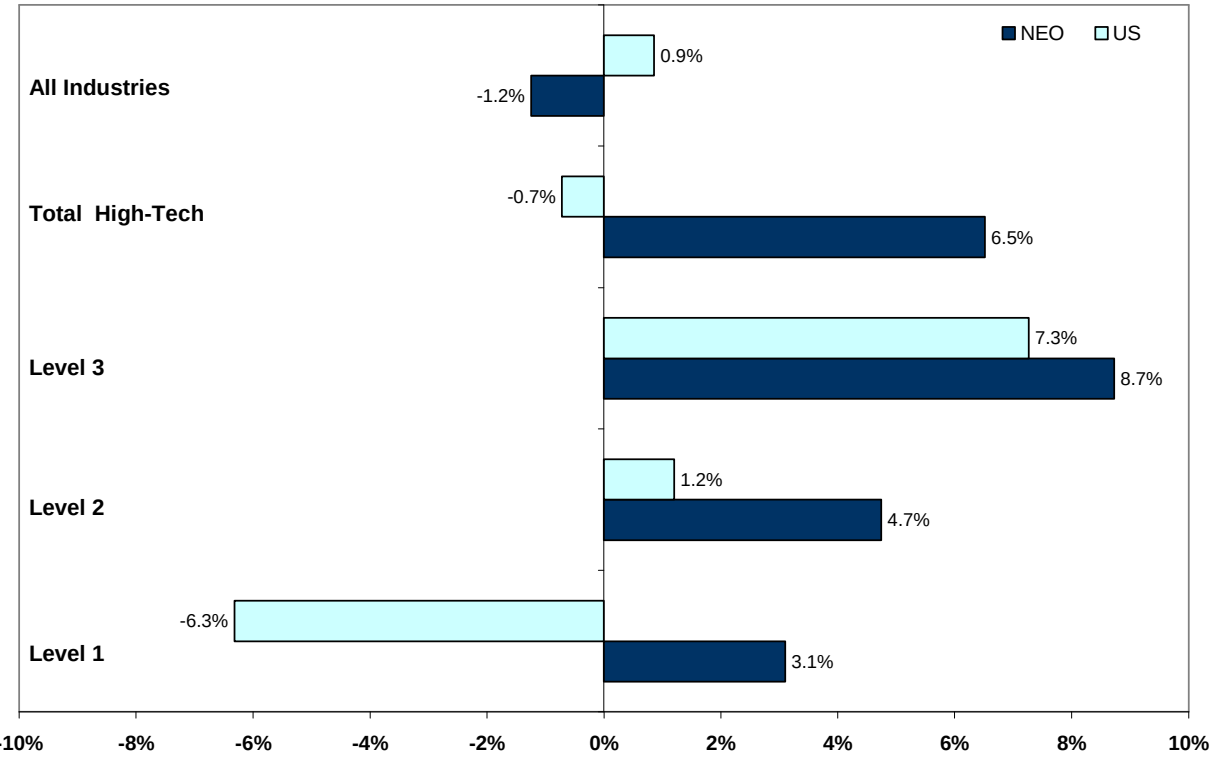
Industry	2005		Percent Change (2000-2005)	
	NEO	U.S.	NEO	U.S.
Level 1 High-Tech Industries	53,917	75,700	3.1%	-6.3%
Level 2 High-Tech Industries	63,474	75,278	4.7%	1.2%
Level 3 High-Tech Industries	67,105	78,247	8.7%	7.3%
Total High-Tech	**62,351**	**76,399**	**6.5%**	**-0.7%**
Total in all industries	**36,164**	**40,305**	**-1.2%**	**0.9%**

Source: Quarterly Census of Employment and Wages (ES202)

NEO's highest paying level I industries in 2005 are Scientific Research and Development Services ($78,800) and Pharmaceutical and Medicine Manufacturing ($69,900). The highest paying level II industries are Manufacturing and Reproducing, Magnetic and Optical Media ($98,500); Electric Power Generation, Transmission, and Distribution ($83,800); and Basic Chemical Manufacturing ($82,500).

In the U.S., the average wage in level I industries declined between 2000 and 2005, while in NEO the average wage increased in each of the three levels (Figure 6). For all high-tech industries, the average wage declined slightly nationally (-0.7%), while it increased in NEO (6.5%). However, the average wage for high-tech industries and all industries are still higher in the U.S. throughout the study period.

Figure 6: Percent Change in Average Wages in High Tech Industries in NEO and US, 2000-2005



Source: Quarterly Census of Employment and Wages (ES202)
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

GROSS REGIONAL PRODUCT GENERATED BY HIGH-TECH INDUSTRIES

Gross regional product (GRP) measures value added output for each industry. In 2005, total output for all high-tech industries in NEO was $20.8 billion, accounting for 12.1 percent of the total economy. This is a much higher share than the share of high-tech employment (8%). In the U.S. these shares are 15.4% and 9.4%, respectively.

Within the high-tech sector in NEO, level III accounted for 47 percent of all high-tech output, followed by level II (29%) and level I (24%). In the U.S., the output of high-tech industries is more evenly distributed among the three levels (level I: 37%, level III: 32% and level II: 31%). GRP of NEO's high-tech industries not only accounted for a higher share of the economy than their employment share, but high-tech GRP increased in NEO between 2000 and 2005, while high-tech employment declined. The growing GRP was a result of gains in both the recessionary and expansionary years (Table 7).

In addition, the rate of increase in NEO (7.5%) was similar to the U.S. (7.9%). Level I output declined in the earlier years between 2000 and 2003, however, level II and III outputs grew throughout the whole period.

Table 7: Output in High-Tech Industries in NEO and U.S., 2000 to 2005

Industry	% Change in Output (2000-2003)		% Change in Output (2003-2005)		% Change in Output (2000-2005)	
	NEO	U.S.	NEO	U.S.	NEO	U.S.
Level 1 High-Tech Industries	-7.2%	-6.7%	2.1%	7.7%	-5.3%	0.4%
Level 2 High-Tech Industries	9.6%	4.6%	-0.2%	12.8%	9.4%	18.0%
Level 3 High-Tech Industries	3.2%	-0.9%	10.3%	9.5%	13.8%	8.5%
Total High-Tech	2.3%	-1.7%	5.1%	9.8%	7.5%	7.9%
Total Employment in all industries	1.1%	6.2%	4.5%	7.4%	5.7%	14.1%

Source: Moody's Economy.com

Focusing on the performance of NEO in comparison to the U.S. reveals that high-tech output grew faster in NEO in only level III industries during 2000-2005 period. Level I output declined in NEO while it remained stable in the U.S. because national output grew at a much faster rate in the last two years.

Table 8 shows the share of high-tech employment in the total economy for both NEO and the U.S. The output share of all high-tech industries in NEO increased slightly between 2000 and 2005, while it declined nationally. The gain in NEO was a result of increased output in both level II and III high-tech industries.

Table 8: High-Tech Share of Total Output, NEO and U.S.

Industry	2000		2003		2005	
	NEO	U.S.	NEO	U.S.	NEO	U.S.
Level 1 High-Tech Industries	3.2%	6.5%	2.9%	5.7%	2.9%	5.7%
Level 2 High-Tech Industries	3.4%	4.6%	3.7%	4.5%	3.6%	4.7%
Level 3 High-Tech Industries	5.3%	5.2%	5.4%	4.8%	5.7%	4.9%
Total High-Tech	11.9%	16.2%	12.1%	15.0%	12.1%	15.4%
Total Employment in all industries	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Moody's Economy.com

Analyzing output trends in NEO's largest two sub-regions shows that output growth follows different patterns in the Cleveland-Elyria-Mentor and Akron metropolitan areas. In the Akron area, output in all high-tech industry levels grew in both the 2000-2003 and 2003-2005 time periods. In contrast, in the Cleveland metropolitan area output declined in each industry level between 2000 and 2003 and increased in levels I and III in the following two years. Level II output continued to decline.

PRODUCTIVITY IN HIGH-TECH INDUSTRIES

GRP per employee is used to estimate productivity. Not surprisingly, productivity in high-tech industries is higher than average productivity for all industries. In 2005, productivity in high-tech industries in NEO was 52% higher than overall productivity in the economy (it was 77% higher in the U.S.). Within the high-tech sector, level II industries have the highest productivity, followed by level III and level I (Table 9).

Table 9: Productivity in High-Tech Industries in NEO and U.S.

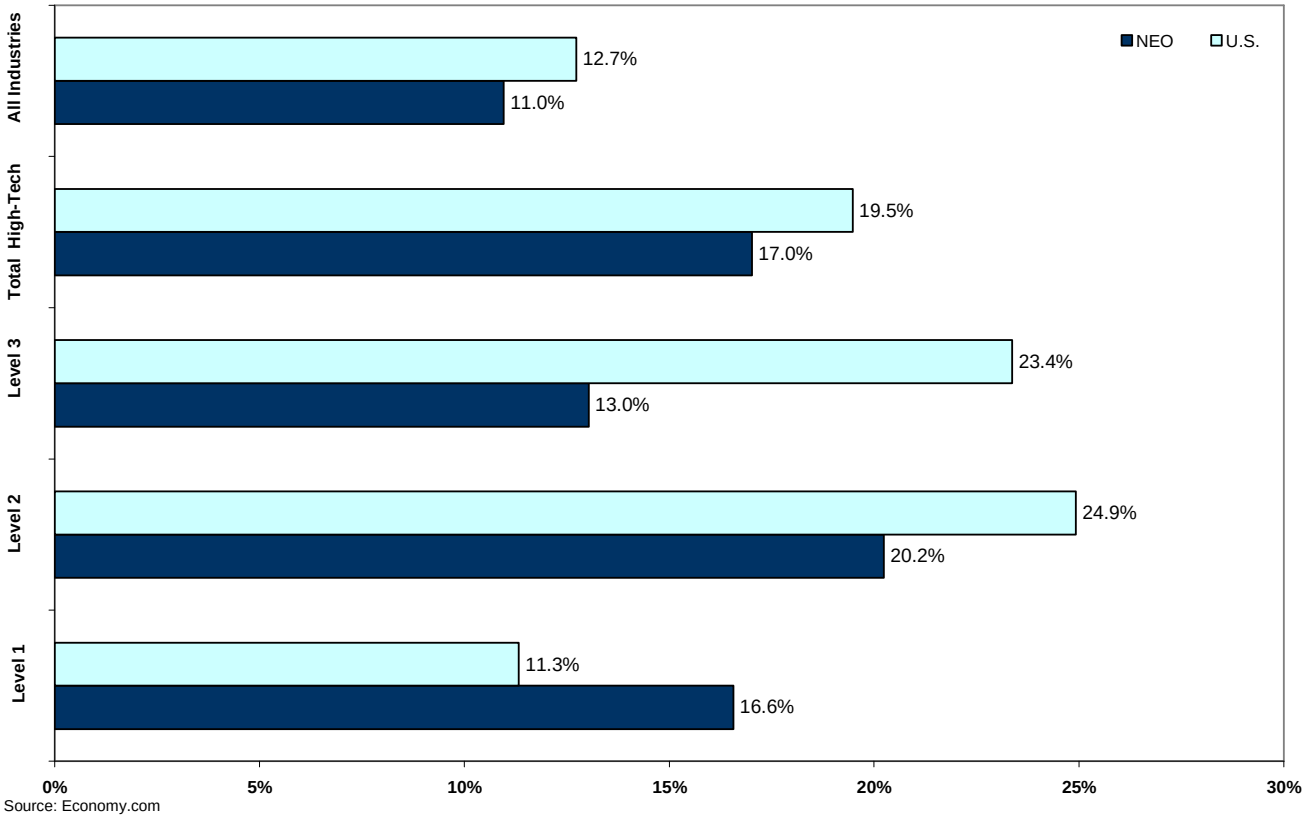
Industry	2005 (in thousands)		Percent Change (2000-2005)	
	NEO	U.S.	NEO	U.S.
Level 1 High-Tech Industries	$92.6	$124.7	16.6%	11.3%
Level 2 High-Tech Industries	$160.7	$228.3	20.2%	24.9%
Level 3 High-Tech Industries	$120.0	$162.9	13.0%	23.4%
Total High-Tech	**$120.6**	**$158.8**	**17.0%**	**19.5%**
Total in all industries	**$79.5**	**$89.6**	**11.0%**	**12.7%**

Source: Moody's Economy.com

These observations are consistent with U.S. trends, but productivity is higher in the U.S. in each high-tech industry level. Productivity in NEO grew by 17 percent during 2000-2005, compared to 19.5 percent in the U.S. The table also demonstrates that, as expected, high-tech productivity in both NEO and the U.S. grew at a faster rate than overall productivity.

Productivity grew in each level of high-tech industries during 2000-2005 (Figure 7). Level II industries not only had the highest productivity levels, but they also grew at the highest rates in both NEO and the nation. NEO's productivity grew faster than the U.S. in level I high-tech industries.

Figure 7: Percent Productivity Change in High Tech Industries in NEO and US, 2000-2005



Source: Economy.com
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

HIGH-TECH OCCUPATIONS IN NORTHEAST OHIO

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 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

Approximately 58,000 workers in NEO's metropolitan areas are employed in high-tech occupations (Table 10). This represents 3.1 percent of all workers, compared to 4.5 percent nationally. The share of workers in high-tech occupations lags the nation for all occupational clusters, although the largest differences are in Computer and Mathematical jobs and Life and Physical Science jobs.

Table 10. Employment in High-Tech Occupations by Occupational Cluster, 2005

High-Tech Occupations	Employment		Share of High-Tech Employment		Employment per 100,000 Employees		Share of Total Employment	
	NEO MSAs	U.S.	NEO MSAs	U.S.	NEO MSAs	U.S.	NEO MSAs	U.S.
Management	5,220	487,140	8.9%	8.3%	274.3	373.8	0.3%	0.4%
Computer and Mathematical	27,270	2,828,700	46.7%	48.0%	1,433.2	2,170.8	1.4%	2.2%
Architecture and Engineering	21,870	1,947,900	37.5%	33.1%	1,149.4	1,494.8	1.1%	1.5%
Life and Physical Science	4,010	625,850	6.9%	10.6%	210.7	480.3	0.2%	0.5%
Total High-Tech	58,370	5,889,590	100.0%	100.0%	3,067.6	4,519.8	3.1%	4.5%

Source: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics: http://www.bls.gov/oes

The distribution of NEO's high-tech workers within the occupational clusters reflects the region's industry mix. Nearly 38 percent of NEO's high-tech workers are in Architecture and Engineering occupations, a higher proportion than found nationally. Most of these workers are in engineering occupations, which would be expected in a area with a large manufacturing base. The share found in Life and Physical Science occupations is lower than the national share. This is also not surprising - although NEO is home to several strong medical research institutions and has a growing biotech industry, it has not caught up with other parts of the country.

Employment by detailed occupation can be found in Appendix B, Table B2. 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). These findings reflect NEO's manufacturing strengths.

NEO's larger metropolitan areas have the largest share of employment in high-tech occupations (Table 11). Cleveland-Elyria-Mentor leads with 3.8 percent, followed by Akron with 3.6 percent. The smaller metro areas have relatively few workers in high-tech occupations.

Table 11. Employment in High-Tech Occupations in Northeast Ohio Metropolitan Areas, 2005

NEO Metropolitan Areas	High-Tech Employment	Share of Total Employment
Akron MSA	11,840	3.6%
Canton-Massillon MSA	2,370	1.3%
Cleveland – Elyria – Mentor MSA	39,630	3.8%
Mansfield MSA	860	1.5%
Sandusky MSA	420	1.1%
Youngstown – Warren – Boardman MSA	3,250	1.3%
Total NEO MSAs	58,370	3.1%
U.S.		4.5%

Source: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics

A closer look at the Akron and Cleveland-Elyria-Mentor metropolitan areas (Table 12) reveals that employment is distributed differently within the high-tech occupations. When compared to the nation, Akron has a larger share of high-tech employment in the Architecture and Engineering cluster and a lower share in the Computer and Mathematical cluster. Cleveland has a lower share in the Life and Physical Science cluster and slightly higher shares in the other three occupational clusters.

Table 12. Employment in High-Tech Occupations by Occupational Cluster, Cleveland and Akron Metropolitan Areas, 2005

High-Tech Occupations	Employment per 100,000 Employees		Share of Total Employment		Share of High-Tech Employment	
	MSA	U.S.	MSA	U.S.	MSA	U.S.
Akron MSA						
Management	297.2	373.8	0.3%	0.4%	8.3%	8.3%
Computer and Mathematical	1,540.7	2,170.8	1.5%	2.2%	42.9%	48.0%
Architecture and Engineering	1,367.8	1,494.8	1.4%	1.5%	38.1%	33.1%
Life and Physical Science	385.2	480.3	0.4%	0.5%	10.7%	10.6%
Total High-Tech	3,590.9	4,519.8	3.6%	4.5%	100.0%	100.0%
Cleveland - Elyria - Mentor MSA						
Management	339.8	373.8	0.3%	0.4%	9.1%	8.3%
Computer and Mathematical	1845.9	2,170.8	1.8%	2.2%	49.2%	48.0%
Architecture and Engineering	1341.3	1,494.8	1.3%	1.5%	35.8%	33.1%
Life and Physical Science	224.3	480.3	0.2%	0.5%	6.0%	10.6%
Total High-Tech	3751.4	4,519.8	3.8%	4.5%	100.0%	100.0%

Source: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics: http://www.bls.gov/oes

If we compare the Akron and Cleveland metro areas with each other, we see that 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 IN NORTHEAST OHIO

Research and development activity in Northeast Ohio is assessed in terms of industry R&D funding and academic R&D expenditures. Industry R&D is examined over a 10-year period from 1993 to 2003. Academic R&D expenditures are examined in terms of funding source and short-term trends (2000 to 2004).

INDUSTRY RESEARCH & DEVELOPMENT

Estimates of industry R&D indicate that funding in Northeast Ohio increased nearly 60 percent between 1993 and 2003, while the remainder of the state saw a 35 percent increase in funding.[7] Industry R&D funding in the Cleveland-Elyria-Mentor metro area reached nearly $800 million in 2003, a 29 percent increase over a 10-year period. Many of the smaller metro areas experienced large increases in industry R&D, although they still represent a relatively small share of total funding in the region. Northeast Ohio captures 20.4% of all industry R&D funding in Ohio; the Cleveland area captures 62.4% of Northeast Ohio funding.

Table 13. Estimated Industry R&D Funding by Sub-Region, 1993-2003

(Dollars in millions)

	1993	1995	1997	1998	1999	2000	2001	2002	2003	change 1993-2003
Metropolitan Areas										
Akron	27.4	43.9	78.0	108.5	174.4	157.6	161.0	127.0	124.5	354.9%
Canton-Massillon	14.5	15.6	42.3	53.4	104.8	135.8	143.1	133.1	84.6	482.4%
Cleveland-Elyria-Mentor	619.0	755.1	783.6	757.0	810.9	671.2	811.0	799.0	798.7	29.0%
Mansfield	36.2	40.9	55.1	59.4	69.6	69.8	78.0	68.0	63.3	75.2%
Sandusky	17.9	15.6	16.3	14.6	15.4	14.7	14.9	15.5	12.4	-30.7%
Youngstown-Warren*	6.8	8.0	10.6	11.6	17.4	20.4	19.4	16.9	15.5	129.5%
Non-Metro Counties	84.5	102.4	167.5	188.2	221.6	223.6	209.7	200.1	181.2	114.5%
NorTech Service Area	806.2	981.5	1153.3	1192.8	1414.1	1293.0	1437.2	1359.5	1280.3	58.8%
Remainder of Ohio	3687.8	3019.5	4454.7	4549.2	5116.9	4952.0	5256.8	4870.5	4979.7	35.0%
Ohio Total	4,494	4,001	5,608	5,742	6,531	6,245	6,694	6,230	6,260	39.3%

* Does not include Mercer County, PA

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Industrial Research and Development Funds for industrial R&D performance in the United States, by state: http://www.nsf.gov/statistics/nsf06322/pdf/tab35.pdf

ACADEMIC RESEARCH & DEVELOPMENT

Northeast Ohio's colleges and universities reported nearly $300 million in research expenditures in FY 2004. The vast majority (78%) of that research was conducted at Case Western Reserve University. The federal government supports 76 percent of the research that is undertaken by the region's academic institutions.

[7] Industry R&D funding at the regional level is estimated from state-level data. See methodology section for further detail.

Table 14. R&D Expenditures at NEO Colleges and Universities by Funding Source, FY 2004

(Dollars in thousands)

State, control, and institution	All R&D expenditures	Federal government		State and Local government	Industry	Institutional funds	All other sources
Ohio	1,318,420	847,844	64.3%	109,415	72,504	230,194	58,463
Northeast Ohio Institutions	297,460	226,400	76.1%	27,463	10,219	27,981	5,397
U. Akron	27,488	10,284	37.4%	992	3,475	9,323	3,414
Case Western Reserve U.	231,800	195,525	84.4%	22,097	5,340	8,838	0
Cleveland State U.	16,888	6,380	37.8%	2,831	384	5,896	1,397
John Carroll U.	478	197	41.2%	127	0	0	154
Kent State U.	12,712	9,093	71.5%	917	818	1,884	0
NEO Univ. C. of Medicine	5,601	2,964	52.9%	235	100	1,870	432
Oberlin C.	381	291	76.4%	17	36	37	0
C. Wooster	281e	281e	100.0%	0	0	0	0
Youngstown State U.	1,831	1,385	75.6%	247	66	133	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 2004. http://www.nsf.gov/statistics/nsf06323/pdf/tab24.pdf

Academic R&D expenditures in Northeast Ohio increased 24 percent between 2000 and 2004. Colleges and universities across Ohio reported a 44 percent increase in research expenditures over the same time period. The four largest institutions in NEO – Cleveland State, Kent State, U. Akron, and Case – all reported substantial increases.

Table 15. R&D Expenditures at NEO Colleges and Universities, FY 2000-2004

(Dollars in thousands)

Institution	2000	2001	2002	2003	2004	Change 2000-2004
Ohio	918,500	995,972	1,116,957	1,268,784	1,318,420	43.5%
Northeast Ohio Institutions	240,482	251,328	281,253	314,376	297,460	23.7%
Cleveland State U.	10,214	12,986	13,855	14,112	16,888	65.3%
Kent State U.	10,817	11,316	12,868	14,549	12,712	17.5%
NEO Univ. C. of Medicine	4,011	4,532	4,525	4,364	5,601	39.6%
U. Akron	19,495	22,266	28,080	27,953	27,488	41.0%
Youngstown State U.	532	849	1,259	1,398	1,831	244.2%
Case Western Reserve U.	193,057	198,253	219,042	250,674	231,800	20.1%
C. Wooster	593	286	362	413	281 e	-52.6%
John Carroll U.	1,072 e	515	823	442	478	-55.4%
Oberlin C.	691	325	439	471	381	-44.9%

e = estimated
SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Research and Development Expenditures at Universities and Colleges, FY 2000-2004.

Despite the gains, NEO institutions are not keeping pace with others in the state. If we were to show all colleges and universities in Ohio, we would see that the large statewide increase can be primarily attributed to The Ohio State University (OSU), which saw a 43% increase in R&D expenditures between 2000 and 2004. In 2004, OSU accounted for 39 percent of all academic R&D in Ohio. The University of Cincinnati has also experienced a large increase in expenditures – 61 percent between 2000 and 2004. By 2004, Cincinnati accounted for 21% of all academic R&D in the state. By comparison, Case accounted for 18 percent.

Comparable data on R&D expenditures is not available for some of Northeast Ohio's largest research institutions. It is important to note that the R&D expenditures of the Cleveland Clinic and NASA Glenn Research Center are not included in the figures shown above. The Cleveland Clinic reports annual research expenditures exceeding $150 million,[8] approximately 50 percent of the total for all academic institutions in the region. In 2005, the Clinic was awarded an estimated $83 million from the National Institutes of Health, placing it among the top 10 recipients in the country of NIH funding among research institutes or independent hospitals.[9] The Clinic also ranked 7th nationally for funds received from the American Heart Association in 2004.[10]

[8] Source: The Cleveland Clinic, http://cms.clevelandclinic.org/body.cfm?id=148&oTopID=148

[9] Source: The Cleveland Clinic Lerner Research Institute, Scientific Report 2006-07, http://www.lerner.ccf.org/news/documents/sr2006-07.pdf.
It should be noted that annual awards are not directly comparable to annual expenditures; award data often includes multi-year grants that will be expended over a number of years.

[10] Source: The Cleveland Clinic Lerner Research Institute, Scientific Report 2006-07, http://www.lerner.ccf.org/news/documents/sr2006-07.pdf.

REACTIONS AND RECOMMENDATIONS

A draft of this report was shared with a select number of stakeholders who were asked to participate in a focus group to provide additional insight regarding the analysis and help develop strategic interventions that build on the baseline of information. These stakeholders included executives of high-tech companies, economists, and representatives from non-profit economic development organizations.[11] They were asked about what positive and negative messages they found in the data, whether any of the findings were unexpected, and what additional information would be helpful to better understand the high-tech sector in Northeast Ohio. They were also asked how the region can build upon positive findings, address negative findings, and what NorTech can do to help the region move forward. A summary of the focus group discussion is provided below.

INTERPRETATION OF THE FINDINGS

Participants noted the high average incomes found in high-tech industries and believe income is a better measure of economic performance than employment trends. It was suggested that an analysis that only focuses on employment trends provides a limited view of the impact of the high-tech sector because many analysts are most concerned about increasing incomes. A further argument against putting too much weight on employment is that high-tech industries often eliminate jobs intentionally – it is in their nature to use technology to reduce costs by cutting jobs that are routine. Job losses do not necessarily indicate a struggling industry. It was also noted that we shouldn't expect much employment growth in Northeast Ohio when population growth is flat. Additionally, the 5-year period analyzed in the report is a difficult period by which to judge the high-tech sector because the overall economy was struggling. It is believed that most of the industries included in the analysis will probably perform better in the future than they did in the past five years.

Other observations related to productivity gains in the high-tech sector. In some cases productivity gains in Northeast Ohio outpaced productivity gains nationally, even when employment did not keep pace (among level I industries, productivity gains in the region exceeded gains in the U.S by more than 5%, and while both experienced job losses, the rate of employment decline was much higher in the region – 17% versus 8.6%). Finally, it was pointed out that Northeast Ohio's strengths are in high-tech industries that are not highly information-based (the less high-tech intensive industries), but another participant noted that these industries are also those that pay the highest wages, both locally and nationally.

AREAS FOR FUTURE RESEARCH

The report also generated questions that were beyond the scope of work but might be of interest if additional research is conducted. A suggestion was made to look more closely at national trends and projections for the industries in which the region has strengths – if these industries are doing well nationally, it may suggest future growth in the region, but if these industries are declining nationally, it might signify trouble in the near future. Another comment related to what we might see in the data if industries were analyzed in terms of the region's high-tech clusters (although a concern was raised that looking at the data in terms of clusters

[11] A list of participants can be found in Appendix C. One person who could not attend the focus group submitted comments in writing. Those comments have been incorporated into the summary.

ignores the role of management in developing high-tech sectors and management is one of the critical ingredients along with technology and products).

A question was raised about why productivity gains in Northeast Ohio were greater than national gains (productivity gains were higher in level I industries). A number of possible explanations were mentioned, but the issue could be explored further. There were also multiple questions about what companies are classified as "Management of Companies" and why there has been growth in this industry.[12] There was a strong interest in determining the research expenditures of the Cleveland Clinic because reporting only the research expenditures of local universities underestimates the research capacity of the region (comparable data for the Clinic was not available when the report was issued). Finally, it was noted that the report highlights those industries that have experienced growth, but gives limited attention to those industries that are losing jobs, but at a slower pace than the same industries nationally (and why that might be occurring).

The discussion about directions for future research included a lengthy conversation about the most appropriate metrics and geographic unit of comparison. With respect to metrics, it was pointed out that there are two types of metrics – those that measure the high-tech sector in Northeast Ohio and those that measure the impact of NorTech. This report focused on the former and did not address the impact of NorTech activities. One participant suggested that if future work attempts to assess NorTech activities, it is important to consider where the region is on the continuum of developing the high-tech sector. NorTech's should be judged on its advocacy role – the high-tech sector in Northeast Ohio is not far enough along the continuum to expect large investment flows or high value added and large increases in employment. It is important to focus on the process rather than the outcomes.

There was a prolonged debate about the appropriate geographic unit of comparison for Northeast Ohio if future work is conducted. Because the definition of Northeast Ohio used for this analysis does not represent an economic region and includes both urban and rural areas, the region was compared to the U.S. as a whole. A number of alternatives were discussed including comparing Northeast Ohio to the entire Midwest region (incorporating urban and rural areas), selected metropolitan areas within the Midwest, selected metropolitan areas across the U.S., or a group of metropolitan areas that are aligned with the Dashboard of Economic Indicators.

RECOMMENDATIONS

This baseline analysis provides only a description of the high-tech sector in Northeast Ohio – it does not address what is needed to further develop high-tech industries. The focus group concluded with a discussion of strategic interventions that might be introduced to advance the high-tech sector in Northeast Ohio. The discussion centered around three main issues: workforce development, company growth and retention, and university-industry partnerships. In some cases, implementation of the strategies discussed would require changes to public policy while others would require action by various stakeholder groups.

[12] Specific company names cannot be revealed due to confidentiality restrictions.

Workforce Development

Focus group participants raised a number of concerns about the supply and demand of workers in high-tech industries. It was argued that it will be difficult to attract high-tech workers from outside the region until Northeast Ohio develops more depth in some high-tech industries because workers are concerned that if the job they relocate for does not work out, they will not have other opportunities. Regarding the local workforce, it was noted that the highest growth nationally is in those industries that are highly information-based and our workers may not be prepared. This may be of particular concern in the healthcare industry. Although Northeast Ohio has strength in this sector, future growth is expected to be in healthcare information industries. An IT industry representative said that it is a struggle to find qualified people in Northeast Ohio. Students may be steered away from IT employment because they are being told that those jobs are being outsourced to other countries. He expressed the need to create better linkages between high schools and colleges. Another person pointed out that K-12 schools need to do a better job of building students' skills in basic math and science and improve graduation rates. There was a concern as to whether students coming from the public urban school systems are prepared for jobs in the high-tech sector. At the post-secondary level, a question was raised about what types of graduates local universities are producing – do universities develop programs to support local industries or do they only focus on enrollment goals? It was suggested that they must find a way to do both. It was also argued that the region's educational institutions need to achieve higher rankings in key disciplines, increase R&D activity, and produce higher graduation and local retention rates. There was also discussion about the need to re-train incumbent workers as well as prepare the future workforce. It was suggested that the Northeast Ohio region has a solid infrastructure and good base of employment but there is a need to focus on "people issues."

University-Industry Relationships

A separate discussion focused on how to improve university-industry partnerships. It was noted that university investment in research is an important strength, particularly at Case, and there should be an effort to build on this. The link between R&D and commercialization needs to be improved and there need to be better programs that connect faculty and students with industry. An industry representative noted that companies are concerned about the timetable that university people follow. It was suggested that while more resources could be made available to foster university-industry partnerships, the main issue is that universities need to focus on the customer, not what the university gets from the relationship. Industrial liaison programs have been successful elsewhere but they can take a long time to develop. There was a suggestion to try to secure Third Frontier funding to enhance university-industry partnership programs.

Company Growth and Retention

A number of comments were related to the growth and retention of high-tech companies. With respect to growing new companies, it was pointed out that there is no one large public company in Northeast Ohio that is leading the charge and that there are not many flywheel companies (some local companies that have acted as flywheels are Steris, BP, TRW, Goodrich, and Rubbermaid).[13] Flywheels are often companies that are in the process of breaking up; this is true here and in other areas. Younger people who leave or are laid off from a big company are starting new companies. These individuals need both technical knowledge and management expertise – many of the workers in Northeast Ohio have not had the technical knowledge. To

[13] Flywheels are companies that spin-off other companies.

foster growth of high-tech companies, one person advocated for more venture capital funding (including public sector contributions), stronger entrepreneurial networks, more corporate R&D, continuation of the Third Frontier program, and reduced taxation on R&D.

One participant stated that it is important to focus on start-ups, but we should not ignore existing businesses that have the potential to grow in Northeast Ohio. Another person observed that we tend to lose jobs in large chunks and try to gain in small pieces – we should look more closely at where we are losing in chunks. A question was also raised about the impact of business activity moving overseas; what industries are more or less likely to move operations overseas? The importance of understanding the dynamics of the market was also raised. High-tech companies locate where the knowledge is – we want to keep those companies as they move up the product cycle. We need to find the intersections; we need to identify where we have a talent advantage and what is the binding constraint where geography matters. Another participant stressed the need to focus on retention and not try to copy what other regions are doing.

CONCLUDING REMARKS

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 be begin to "move the needle" for some of the measures included in this report.

The information provided in this report is intended to serve as a baseline for monitoring changes in the high-tech sector in Northeast Ohio. Tracking a specific set of measures on an annual basis will provide policy makers with a method for assessing progress and directing resources.

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. Percent Change in High-Tech Employment by Industry, NEO and U.S.

Industry	Employ-ment 2005	% Employment Change (2000-2003)		% Employment Change (2003-2005)		% Employment Change (2000-2005)	
	NEO	NEO	U.S.	NEO	U.S.	NEO	U.S.
Total Level 1	**47,891**	**-17.6%**	**-9.3%**	**0.8%**	**0.8%**	**-17.0%**	**-8.6%**
Pharmaceutical and Medicine mfg.	1,292	36.4%	7.6%	7.9%	-1.5%	47.1%	6.0%
Computer and peripheral equipment mfg.	493	-71.9%	-20.8%	-7.9%	-10.4%	-74.1%	-29.0%
Communications equipment mfg.	1,243	-54.8%	-33.2%	10.4%	-9.7%	-50.1%	-39.7%
Semiconductor and other electronic component mfg.	2,676	-28.5%	-26.0%	1.1%	-6.1%	-27.7%	-30.5%
Navigational, electromedical, and control instruments mfg.	5,973	-27.0%	-8.5%	-7.5%	-1.1%	-32.4%	-9.5%
Aerospace product and parts mfg.	3,432	-16.5%	-13.9%	-2.3%	-0.2%	-18.5%	-14.0%
Software publishers	625	6.6%	-5.2%	-12.2%	-2.6%	-6.4%	-7.6%
Internet publishing and broadcasting	264	-11.4%	-22.2%	-0.3%	0.3%	-11.6%	-22.0%
Internet service providers and web search portals	899	-17.5%	-21.7%	-10.9%	-7.7%	-26.5%	-27.7%
Data processing, hosting, and related services	1,957	5.4%	-11.0%	-6.8%	-6.3%	-1.7%	-16.7%
Architectural, engineering, and related services	15,140	-8.2%	0.9%	-2.7%	5.3%	-10.7%	6.2%
Computer systems design and related services	11,180	-18.2%	-10.5%	9.4%	5.6%	-10.5%	-5.4%
Scientific research-and-development services	2,698	7.0%	5.1%	25.5%	5.5%	34.3%	10.9%
Total Level 2	**36,624**	**-10.0%**	**-4.8%**	**-4.7%**	**0.0%**	**-14.2%**	**-4.8%**
Oil and gas extraction	398	-7.5%	-4.0%	-6.6%	3.1%	-13.6%	-0.9%
Electric power generation, transmission, and distribution	5,828	10.3%	-2.3%	-4.1%	-4.3%	5.8%	-6.5%
Basic chemical mfg.	4,353	-5.0%	-12.9%	-9.9%	-8.1%	-14.4%	-19.9%
Resin, synthetic rubber, artificial fibers and filaments mfg.	3,144	-30.1%	-17.6%	1.0%	-3.4%	-29.4%	-20.5%
Industrial machinery mfg.	3,617	-28.7%	-21.9%	-2.3%	-2.0%	-30.3%	-23.4%
Commercial and service industry machinery mfg.	2,055	-16.8%	-19.0%	-9.4%	-7.5%	-24.6%	-25.1%
Manufacturing and reproducing, magnetic and optical media	169	-48.5%	-22.5%	-3.4%	-11.2%	-50.2%	-31.2%
Professional and commercial equipment	8,887	-9.3%	-4.4%	-9.5%	-3.2%	-18.0%	-7.5%
Management, scientific, and technical consulting services	8,127	-0.1%	8.0%	1.9%	10.8%	1.8%	19.6%
Total Level 3	**76,303**	**-7.1%**	**-9.9%**	**-2.4%**	**-1.8%**	**-9.4%**	**-11.5%**
Petroleum and coal products mfg.	1,472	-26.7%	-6.7%	0.1%	-4.2%	-26.6%	-10.6%
Pesticide, fertilizer, and other agricultural chemical mfg.	593	1.5%	-12.9%	-19.3%	-4.6%	-18.1%	-16.9%
Paint, coating, and adhesive mfg.	5,247	-9.8%	-9.6%	0.0%	-4.4%	-9.7%	-13.6%
Other chemical product and preparation mfg.	3,072	-21.1%	-10.9%	-6.9%	-7.5%	-26.6%	-17.5%
Engine, turbine, and power transmission equipment mfg.	1,564	-20.8%	-16.6%	3.5%	-0.6%	-18.0%	-17.1%
Other general-purpose machinery mfg.	11,556	-23.2%	-21.5%	0.2%	-1.9%	-23.1%	-23.0%
Electrical equipment manufacturing	4,595	-30.2%	-21.7%	-1.0%	-7.6%	-30.9%	-27.6%
Other transportation equipment mfg.	169	-21.4%	-1.0%	-22.1%	-5.9%	-38.8%	-6.8%
Pipeline transportation of natural gas	165	-31.8%	-11.9%	0.0%	-11.2%	-31.8%	-21.7%
Other pipeline transportation	59	10.5%	1.3%	-1.7%	-1.8%	8.6%	-0.5%
Wired telecommunications carriers	6,167	-17.5%	-17.1%	-13.4%	-12.6%	-28.5%	-27.5%
Wireless telecommunications carriers (except satellite)	1,430	-28.1%	7.8%	12.5%	1.4%	-19.0%	9.3%
Telecommunications resellers	768	135.4%	-13.5%	-53.9%	-14.9%	8.4%	-26.5%
Monetary authorities, central bank	N/A	N/A	0.5%	N/A	-9.3%	N/A	-8.8%
Management of companies and enterprises	35,818	9.1%	-6.0%	-0.2%	3.7%	8.8%	-2.5%
Facilities support services	1,596	-1.9%	9.7%	35.6%	8.9%	33.1%	19.5%
Electronic and precision equipment repair and maintenance	1,163	6.3%	-6.1%	-16.6%	1.7%	-11.3%	-4.5%
Total High-Tech	**160,819**	**-11.0%**	**-8.6%**	**-2.0%**	**-0.2%**	**-12.9%**	**-8.7%**
Total Employment in all industries	**2,009,727**	**-5.1%**	**-0.6%**	**-0.2%**	**2.2%**	**-5.2%**	**1.6%**

Note: Industries with fewer than 50 employees in Northeast Ohio are not shown, however, employment in these industries is included in the totals.
Source: Quarterly Census of Employment and Wages (ES202)
Prepared by: Center for Economic Development, Levin College of Urban Affairs, Cleveland State University

Table B2. High-Tech Employment by Occupation, 2005

	Occupation	Employment, 2005	Employment per 100,000 employees	
		NEO MSAs	NEO MSAs	U.S.
	High Tech Management Occupations	**5,220**	**274.3**	**373.8**
11-3021	Computer and information systems managers	2,590	136.1	199.0
11-9041	Engineering managers	2,410	126.7	143.8
11-9121	Natural sciences managers	220	11.6	31.0
	High Tech Computer and Mathematical Occupations	**27,270**	**1433.2**	**2170.8**
15-1011	Computer and information scientists, research	30	1.6	19.9
15-1021	Computer programmers	4,690	246.5	298.6
15-1031	Computer software engineers, applications	4,380	230.2	349.9
15-1032	Computer software engineers, systems software	1,560	82.0	246.1
15-1041	Computer support specialists	5,300	278.5	383.6
15-1051	Computer systems analysts	4,250	223.4	377.7
15-1061	Database administrators	960	50.5	76.3
15-1071	Network and computer systems administrators	3,660	192.3	207.5
15-1081	Network systems and data communications analysts	1,890	99.3	142.1
15-2011	Actuaries	0	0.0	12.1
15-2021	Mathematicians	0	0.0	2.2
15-2031	Operations research analysts	410	21.5	40.3
15-2041	Statisticians	140	7.4	13.4
15-2091	Mathematical technicians	0	0.0	1.1
	High Tech Architecture and Engineering Occupations	**21,870**	**1149.4**	**1494.8**
17-2011	Aerospace engineers	460	24.2	62.2
17-2021	Agricultural engineers	0	0.0	2.4
17-2031	Biomedical engineers	140	7.4	8.9
17-2041	Chemical engineers	500	26.3	21.1
17-2051	Civil engineers	1,480	77.8	176.3
17-2061	Computer hardware engineers	240	12.6	60.3
17-2071	Electrical engineers	1,740	91.4	111.2
17-2072	Electronics engineers, except computer	810	42.6	99.8
17-2081	Environmental engineers	550	28.9	38.5
17-2111	Health and safety engineers, except mining safety engineers and inspectors	210	11.0	19.4
17-2112	Industrial engineers	3,780	198.7	147.1
17-2121	Marine engineers and naval architects	0	0.0	5.0
17-2131	Materials engineers	530	27.9	16.1
17-2141	Mechanical engineers	3,670	192.9	169.4
17-2151	Mining and geological engineers, including mining safety engineers	0	0.0	4.4
17-2161	Nuclear engineers	0	0.0	11.0
17-2171	Petroleum engineers	0	0.0	11.4
17-3011	Architectural and civil drafters	900	47.3	77.5
17-3012	Electrical and electronics drafters	340	17.9	23.2
17-3013	Mechanical drafters	1,200	63.1	57.3
17-3021	Aerospace engineering and operations technicians	60	3.2	7.6
17-3022	Civil engineering technicians	570	30.0	69.4
17-3023	Electrical and electronic engineering technicians	1,850	97.2	127.3
17-3024	Electro-mechanical technicians	60	3.2	11.6
17-3025	Environmental engineering technicians	370	19.4	15.3
17-3026	Industrial engineering technicians	890	46.8	56.3
17-3027	Mechanical engineering technicians	950	49.9	35.7
17-3031	Surveying and mapping technicians	570	30.0	49.0

Table B2. High-Tech Employment by Occupation, 2005 (continued)

Occupation		Employment, 2005	Employment per 100,000 employees	
		NEO MSAs	NEO MSAs	U.S.
	High Tech Life, Physical, and Social Science Occupations	**4,010**	**210.7**	**480.3**
19-1011	Animal scientists	0	0.0	2.3
19-1012	Food scientists and technologists	0	0.0	5.8
19-1013	Soil and plant scientists	0	0.0	7.8
19-1021	Biochemists and biophysicists	50	2.6	13.6
19-1022	Microbiologists	30	1.6	11.7
19-1023	Zoologists and wildlife biologists	0	0.0	12.6
19-1031	Conservation scientists	0	0.0	11.9
19-1032	Foresters	0	0.0	8.2
19-1041	Epidemiologists	0	0.0	2.8
19-1042	Medical scientists, except epidemiologists	150	7.9	56.5
19-2011	Astronomers	0	0.0	0.7
19-2012	Physicists	50	2.6	11.6
19-2021	Atmospheric and space scientists	40	2.1	5.4
19-2031	Chemists	1,470	77.3	58.7
19-2032	Materials scientists	180	9.5	6.0
19-2041	Environmental scientists and specialists, including health	580	30.5	55.3
19-2042	Geoscientists, except hydrologists and geographers	40	2.1	21.1
19-2043	Hydrologists	0	0.0	6.4
19-4011	Agricultural and food science technicians	40	2.1	14.8
19-4021	Biological technicians	60	3.2	51.5
19-4031	Chemical technicians	1,170	61.5	45.9
19-4041	Geological and petroleum technicians	0	0.0	8.5
19-4051	Nuclear technicians	0	0.0	4.6
19-4091	Environmental science and protection technicians, including health	150	7.9	24.9
19-4092	Forensic science technicians	0	0.0	8.5
19-4093	Forest and conservation technicians	0	0.0	23.0
	Total High-Tech Occupations	**58,370**	**3067.6**	**4519.8**
	Total All Occupations	1,902,800		

APPENDIX C

Focus Group Participants

January 24, 2007

Doug Wenger – Senior Vice President and Chief Information Officer, OMNOVA Solutions Inc.
Stan Miller – Executive Director, NAACP
Mark Schweitzer – Assistant Vice President, Economic Research Department, Federal Reserve Bank of Cleveland
Greg Brown – Executive Director & President, Center for Community Solutions
Ned Hill – Vice President for Economic Development, CSU
Bob Jaquay – Associate Director, The George Gund Foundation
Guhan Venkatu – Economic Analyst, Federal Reserve Bank of Cleveland
Jim Mazella – President & CEO, Five Star Technologies
John Erdmann – President & CEO, Hana Microdisplay Technologies

NorTech Staff:
- Chris Varley
- Chris Mather
- Paula Gomez Farrell
- Sonja Thomas
- Dorothy Baunach

Cleveland State University Staff:
- Ziona Austrian
- Jill Taylor
- Abigail Horn, facilitator