# Knowledge-Based Economic Development Strategies

## for the

## Youngstown-Warren, OH-PA

## Metropolitan Area

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# Purpose of this Report

What is unique about this moment in time?

There are many strategies that companies can employ to compete in the national and the growing international marketplace. Some facilities compete with low-cost products, some specialize in quick delivery, and others invest in high quality production. The continued expansion of globalization has brought increased pressure to manufacturing and other sectors of local economies. We are now living in a time when the development of innovative products and services is even more critical to the growth of local economies than in the past.

An increasing strategy of economic development practitioners is to build programs to strengthen the knowledge-generating capacity of regions and encourage the development of innovative products and services. This report is intended to contribute to the dialogue among leaders in the private and public sectors in the Youngstown-Warren region about the next steps needed to further orient the area towards a knowledge-based economy. If nothing else, the author hopes the information and suggestions contained in this report will be a starting point for additional collaboration and discussion about the future of the region.

# Executive Summary

A holistic approach to local economic development includes strategies such as assisting company expansion, encouraging workforce development, site preparation, infrastructure development, marketing and tourism, and developing innovative ideas and technologies that may become catalysts for future economic growth. In a global economy, where innovation has an ever-increasing role in the competitive advantage of regions, it is important for communities to build relationships with those who are producing knowledge and to enhance the existing research and technology infrastructure. Contained in this report is the identification and description of the individuals and institutions that may be responsible for the future knowledge-based economic growth in the Youngstown-Warren region.

This report contains the following information about the Youngstown-Warren Region:
- An occupational and wage snapshot of the region with information on how the local economy has changed in the past few years
- A profile of the local educational institutions including data on the number and types of degrees conferred
- The institutions and individuals producing the most publications in scientific journals over the last decade
- The companies that have produced the most patents over the past four decades
- The identification of certain prolific individuals who account for much the Youngstown-Warren area's research activity
- Recommendations for the local community and economic development organizations

The largest employment sector of the Youngstown-Warren regional economy remains manufacturing, which accounts for 19% of the region's total employment. This is followed by health care & social assistance (17%), and then retail trade (16%). Even though they are smaller in employment size, the sectors of information services and management of companies have grown by 20% during the three-year period from 1999 to 2002. Compared to the other metropolitan areas in the United States, the region has a much larger percentage of its workers in higher wage production jobs, but the number of these jobs is rapidly decreasing. Alternatively, the area has a much lower concentration of jobs in the computer, engineering, life sciences, and arts and entertainment fields.

As a percentage of the population, the Youngstown-Warren area has a smaller percentage of residents with associates, bachelors, and graduate degrees when compared to the neighboring communities of Akron, Cleveland, and Pittsburgh, as well as the United States as a whole. In 2002, the four most numerous associates degrees awarded in the region were in the fields of information technology, business & marketing, electrical engineering technology, and computer programming. The four most numerous bachelors awarded were in the fields of business, education, biological & biomedical sciences, followed by engineering. The four most numerous masters degrees awarded were in the fields of education, business administration, counseling, and engineering.

The publications originating from the Youngstown-Warren region are mainly concentrated in the fields of chemistry, medicine, and physics. These research fields may be future areas of opportunity. Publications from engineering researchers and companies make up a very small percentage of the total number of publications. The yearly number of patents issued in the Youngstown-Warren area decreased by 30% from the early 70s through the 90s. However, in the past five years, the annual number of patents is re-approaching the numbers from the 1970s. Manufacturing companies are the dominant source of these patents.

The following ideas to enhance the economic development of the Youngstown-Warren region are further elaborated upon in the report:

**UNIVERSITY GROWTH**
- Recruit innovative researchers to the region by investing university development funds or private donations to develop endowed chairs for "research, development, and entrepreneurship" at local universities. Discretionary funds, which can be used for research equipment and laboratory personnel, should be provided to each recipient of the endowment.
- Strengthen YSU graduate research programs, especially in engineering, and encourage additional collaboration between existing industry, research firms, and universities in the areas of applied technology.
- Incorporate space for business incubation in the design of future business and research buildings in the region's universities.

**ACCESS TO RESOURCES**
- Form multi-institutional relationships from the private and public sector to pool resources for technology transfer needs.
- Create incentive-based programs to motivate individuals at all ages to attain more education.

**SOCIAL NETWORKS**
- Develop a regional organization that can facilitate a dialogue between a diverse collection of researchers, local institutions, and all interested individuals, in order to develop collaborative efforts and assess the needs of local researchers.
- Collaborate with recently retired or laid-off employees to discuss future opportunities for new or existing local companies.
- Contact the super-creative individuals in this report and solicit their opinions on how to develop the research community in the region.

**MARKETING AND MEASUREMENT**
- Include some information on the knowledge-producing components of the Youngstown-Warren CMSA as a central component of the Regional Chamber's website.
- Continually monitor the innovational development, adaptation of information technology, and the needs of manufacturing firms in the area.
- Have local economic development organizations continually monitor the metrics used in this report, including information on patents, publications, degree conferment, and creative individuals in the area.

## Introduction

Innovation is now identified as a critical reason why regions of the world are able to develop a competitive advantage and grow economically. New knowledge-based methods to measure innovation are becoming an important component of regional economic development strategies. This report first details the economy and the labor market of the Youngstown-Warren region, and how it has changed during the past few years. Additionally, methods such as regional occupational analysis, scientific publications and patents analysis, and educational attainment and degree analysis will be used to create a picture of the knowledge-based components of the Youngstown-Warren region. Finally, key innovative individuals in the Youngstown-Warren area will be identified, and suggestions will be provided for the continued development of the knowledge-based economy of the area.

## The Youngstown-Warren MSA vs. The Youngstown-Warren CSMA

Two different geographical areas are often used to describe the Youngstown-Warren region. The MSA stands for Metropolitan Statistical Area. For the data used in this report, the U.S. Office of Management and Budget and the Department of Labor defines the Youngstown-Warren MSA to be Mahoning, Trumbull, and Columbiana Counties, all located in the state of Ohio.

The Youngstown-Warren CSMA (Consolidated MSA) is defined to include Mahoning, Trumbull, and Columbiana Counties in Ohio, as well as Mercer County in Pennsylvania. The additional county represents the growing social and economic integration among the different cities in both Ohio and Pennsylvania within the region. The Youngstown-Warren Regional Chamber uses the CMSA for some of its economic publications, and most of the bibliometric analysis in this report uses the larger CMSA to describe the region. The 2004 population of the Youngstown-Warren CSMA was 715,039 residents. It is important to recognize the differences between the MSA and the CMSA when interpreting data.

## Economic Snapshot and Employment Data

The next few paragraphs present a snapshot of the economy of the Youngstown-Warren MSA. The North American Industry Classification System (NAICS) is utilized by the U.S. Census Bureau to classify all types of economic activity into specific sectors. NAICS has been used since the late 1990s, and it has replaced the SIC (Standard Industrial Classification) system developed in the 1930s. As an example of this classification, if a company named "Mahoning Tool and Die" employed 50 people in the Youngstown-Warren MSA, then because the company's primary product is a manufactured good, these 50 employees would be included in the manufacturing sector (labeled #31). Table 1 divides the region's employees into various NAICS classifications from 2002 employment data. The table includes other information such as the sector's percentage of jobs compared to the whole region, the percent change since 1999, and location quotients for each sector.

The location quotient (LQ) of each NAICS classification is a ratio of the Youngstown-Warren MSA's percentage of employment in a certain industry divided by the percentage of employment in that same industry for the United States. If the value of the location quotient is greater than one, then it could be considered that the Youngstown-Warren MSA has a comparative advantage in that industry, and that many of its products or services in that sector are exported outside of the region. For the Youngstown-Warren MSA, the industry sectors of manufacturing, transportation & warehousing, health care & social assistance, and accommodation & food services have location quotients greater than one, and are considered industries that are larger in the region compared to the nation.

**Table 1.** Employment Statistics by NAICS codes, 2002

| NAICS Industry Classification | Youngstown-Warren MSA - 2002 | | | |
|---|---|---|---|---|
| | Number of employees 2002 | Percentage of total jobs | LQ compared to U.S. | Percent change since 1999 |
| Total Employment | 193,336 | 100% | - | - 7.3 % |
| 21 – Mining | 337 | 0.2% | 0.42 | - 28.5% |
| 23 – Construction | 8,864 | 4.6% | 0.82 | - 8.6% |
| 31 – Manufacturing | 36,309 | 18.8% | **1.47** | - 28.6% |
| 42 – Wholesale Trade | 8,317 | 4.3% | 0.83 | - 2.9% |
| 44 – Retail Trade | 30,223 | 15.6 % | **1.19** | - 3.8% |
| 48 – Transportation & Warehousing | 5,475 | 2.8% | 0.89 | - 0.1% |
| 51 – Information | 4,615 | 2.4% | 0.76 | + 19.7% |
| 52 – Finance & Insurance | 6,770 | 3.5% | 0.61 | - 5.8% |
| 53 – Real Estate | 2,574 | 1.3% | 0.74 | - 2.8% |
| 54 – Professional & Scientific Services | 5,863 | 3.0% | 0.48 | - 2.7% |
| 55 – Management of Companies | 2,925 | 1.5% | 0.58 | + 35.5% |
| 56 – Administrative Support | 10,623 | 5.5% | 0.74 | - 19.8% |
| 61 – Educational Services | 1,643 | 0.8% | 0.35 | + 12.7% |
| 62 – Healthcare & Social Assistance | 33,409 | 17.3% | **1.30** | + 5.0% |
| 71 – Arts & Entertainment | 2,069 | 1.1% | 0.68 | + 18.6 % |
| 72 – Accommodation & Food Services | 19,273 | 10.0% | **1.12** | + 6.8% |

Source: OES values: U.S. Census Bureau, Metro Business Patterns, 1999 & 2002,
http://censtats.census.gov/cbpnaic/cbpnaic.shtml

Figure 1 on the next page is a graphical representation of the economy for the Youngstown-Warren MSA. The horizontal axis is the percent change of employment from 1999 to 2002. The vertical axis is the industry's location quotient compared to the United States. The size of the bubble represents the number of employees in each industry. It is interesting to note the industry segments with the largest number of employees are also the industry segments with the highest location quotients. Manufacturing, for example, is the largest sector; it has the highest location quotient, and it has had the largest decrease in employment from 1999 to 2002. Sectors that have growth rates larger than 10% are Information, Educational Services, Arts & Entertainment, and Management of Companies. These high-growth sectors may be opportunity areas for investment.

**Figure 1**. Snapshot of Youngstown-Warren MSA Economy by NAICS Classification
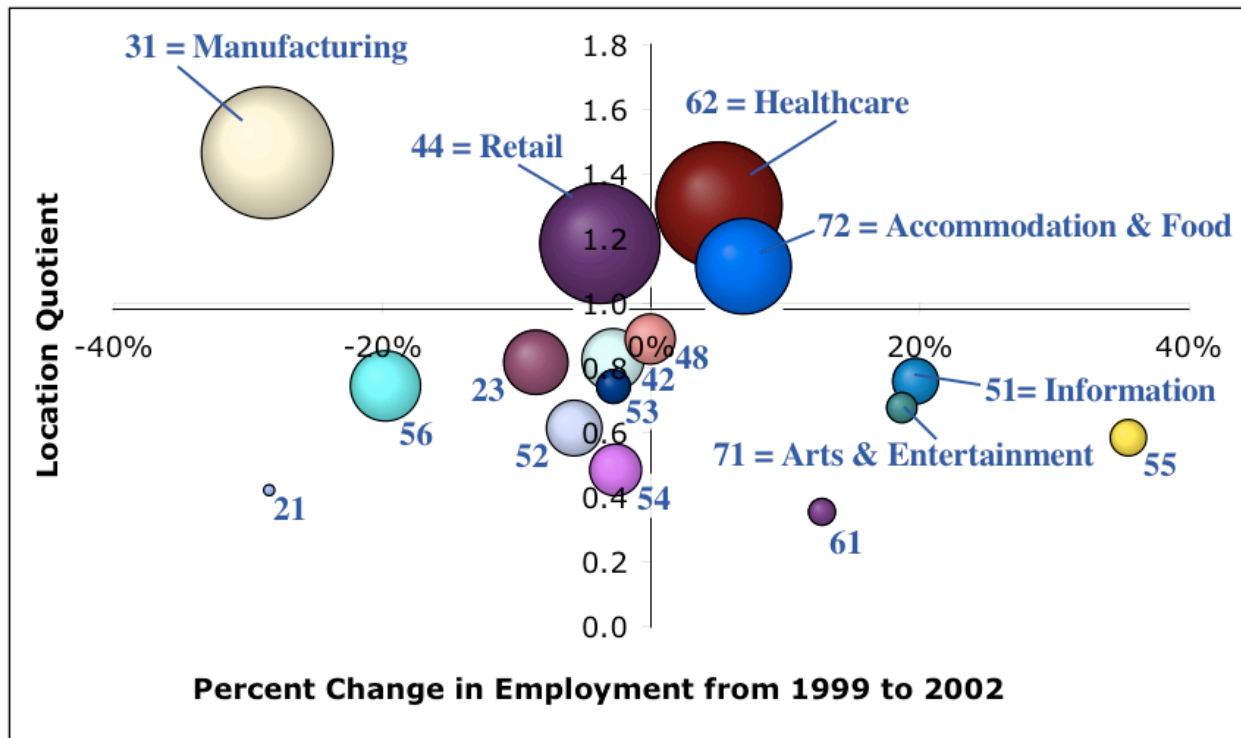


Source: OES values: U.S. Census Bureau, Metro Business Patterns, 1999 & 2002,
2 digit numbers in this figure refer to the NAICS classifications in Table 1
http://censtats.census.gov/cbpnaic/cbpnaic.shtml

Another method to analyze the employment of an area is to use occupational data provided by the Federal Department of Labor. The Standard Occupational Classification (SOC) groups all workers into separate employment classifications, regardless of the place of employment. For example, if a company named "Mahoning Tool and Die" employed 50 people in the Youngstown-Warren MSA (30 were machinists, 10 were engineers, 5 were managers, and 5 were office assistants), then the data would show 30 people in Production Occupations, 10 people in Engineering, 5 people in Management Occupations, and 5 people in Office & Administrative Support. Simply put, the OES data breaks down employment by occupation for the entire MSA.

Table 2 summarizes the 2003 Youngstown-Warren MSA data from the Department of Labor. All twenty-one OES classification groups are further divided by the employment classes used by Richard Florida in his book, "The Rise of the Creative Class." Dr. Florida's methodology divides all employment into what he labels the Service Class, the Working Class, the Creative Professionals, and the Super-Creative Core. He believes that employees from the Creative Professionals and the Super-Creative Core are the engines that will produce innovation, leading to future economic development. Furthermore, regions that have large number of employees in these certain occupational clusters will have a greater competitive advantage in the future. Table 2 includes data for each of the twenty-one groups including the number of employees in 2003, the percent change from 2000, the occupational location quotient, the average hourly wage, and how the average wage compares to other wages across the entire MSA.

**Table 2.** Employment Statistics by OES Occupational Employment Clusters, November 2003

| Occupational Employment Classification | Youngstown-Warren MSA – November 2003 | | | | |
|---|---|---|---|---|---|
| | Number of Employees | % Change from 2000 | LQ | Average Hourly Wage | Wage Level |
| **Service Class** | | | | | |
| 21 – Community and Social Services | 2,280 | - 4.6% | 0.81 | $16.71 | Mid |
| 31 – Health Care Support | 8,460 | + 9.6% | **1.54** | $10.15 | Low |
| 33 – Protective Services | 4,930 | - 15.7% | 0.93 | $14.44 | Mid |
| 35 – Food Preparation and Serving | 21,930 | + 2.1% | **1.23** | $7.37 | Low |
| 37 – Building and Grounds Maintenance | 7,330 | + 2.9% | 0.98 | $9.59 | Low |
| 39 – Personal Care and Service | 4,440 | + 11.3% | 0.82 | $8.31 | Low |
| 41 – Sales and Related Occupations | 22,130 | - 15.0% | 0.92 | $12.98 | Mid |
| 43 – Office and Administrative Support | 33,560 | - 4.4% | 0.82 | $11.98 | Low |
| **Working Class** | | | | | |
| 47 – Construction and Extraction | 8,870 | - 10.5% | 0.85 | $19.33 | High |
| 49 – Installation, Maintenance, and Repair | 9,760 | - 6.5% | **1.10** | $17.62 | Mid |
| 51 – Production Occupations | 28,360 | - 23.2% | **1.73** | $16.64 | Mid |
| 53 – Transportation and Material Moving | 20,780 | + 3.6% | **1.32** | $13.26 | Mid |
| **Creative Professionals** | | | | | |
| 11 – Management Occupations | 8,000 | - 36.3% | 0.69 | $36.53 | High |
| 13 – Business and Financial Operations | 6,070 | + 3.1% | 0.63 | $21.41 | High |
| 23 – Legal Occupations | 1,120 | + 3.7% | 0.61 | $27.47 | High |
| 29 – Healthcare Practitioners | 15,510 | + 16.4% | **1.41** | $24.86 | High |
| **Super-Creative Core** | | | | | |
| 15 – Computer and Math | 2,390 | + 27.1% | 0.43 | $25.74 | High |
| 17 – Architecture and Engineering | 2,170 | - 28.1% | 0.50 | $25.24 | High |
| 19 – Life, Physical, and Social Sciences | 560 | n. a. | 0.28 | $23.66 | High |
| 25 – Education, Training, and Library | 13,090 | + 2.3% | **1.02** | $19.22 | High |
| 27 – Arts and Entertainment | 1,990 | - 13.1% | 0.75 | $14.62 | Mid |

Sources: OES values: U.S. Department of Labor, http://www.bls.gov/oes/current/oessrcma.htm
2003 median wage values: U.S. Department of Labor, http://www.bls.gov/ro5
*note: wage level intervals were calculated by ordering each occupation by average hourly wage and separating the top third, middle third, and bottom third into distinct intervals. For example, one-third of the occupations in the MSA have average hourly wages between $12.85 and $19.00, or the Mid Level.*

The Youngstown-Warren MSA has a larger percentage of employees when compared to the nation in the fields of Health Care, Food Preparation, Maintenance & Repair, Transportation, and Production Operations, which on average, are paid less than or around the average wage for the region. The only two occupational clusters from the Creative Professional or the Super-Creative Core with a location quotient greater than one are Healthcare Practitioners and by a small margin, Education and Library Occupations. All other occupational clusters have location quotients less than one, and most occupations in the Super-Creative Core have very low representation in the region, when compared to the United States as a whole.

This table also shows that many middle and high wage jobs in the areas of Production Occupations and Engineering have decreased since 2000. However, there is growth in some higher-wage jobs within the MSA, especially in the Healthcare and Computer Occupations.

Table 3 provides additional information about employment by occupation in the Youngstown-Warren MSA. Every type of occupation in the region has been placed into one of three categories, based upon the average hourly wage. Then for each wage bracket (high, medium, and low) the ten occupations with the highest location quotient are listed, along with the number of employees and the average hourly wage. For example, in the Youngstown-Warren MSA, there is an extremely high concentration of molders and casters in the region (10 times the percentage of jobs when compared to the rest of the country), and in this classification there are 270 employees who make an average of $12.30 an hour.

Analysis of Table 3 shows that large concentrations of highly skilled production jobs exist at the highest wage levels. But looking closely at these ten occupations with the largest occupational concentrations in the highest wage levels, only one (materials engineers) can be classified as "super-creative" using Florida's typology. Similarly, working class and service class occupations constitute a majority of the jobs in the lower and middle level wage brackets.

**Table 3.** Occupations with High Location Quotients for Different Wage Groups, 2003

| Occupational Employment Classification | | Youngstown-Warren MSA – November 2003 | | |
|---|---|---|---|---|
| | | LQ | Number of Employees in 2003 | Average Hourly Wage |
| **Lower Third ($12.85 per hour and less)** | | | | |
| 51-9195 | Molders & Casters, no metal and plastic | 10.53 | 270 | $12.30 |
| 42-4121 | Library Assistants, Clerical | 5.90 | 890 | $7.90 |
| 39-4021 | Funeral Attendants | 5.74 | 160 | $9.00 |
| 51-9083 | Ophthalmic Laboratory Technicians | 5.15 | 90 | $8.98 |
| 51-4194 | Tool Grinders and Sharpeners | 4.03 | 80 | $11.87 |
| 51-4032 | Drilling & Boring Machine Setters and Operators | 3.48 | 190 | $10.83 |
| 51-9123 | Painters | 3.43 | 110 | $9.51 |
| 49-3052 | Motorcycle Mechanics | 3.00 | 50 | $10.28 |
| 29-2041 | Emergency Medical Paramedics | 2.88 | 680 | $11.03 |
| 37-3012 | Pesticide Handlers | 2.68 | 60 | $12.06 |
| **Middle Third ($12.85 per hour to $19.00 per hour)** | | | | |
| 51-4062 | Patternmakers, metal and plastic | 14.43 | 50 | $15.74 |
| 51-4023 | Rolling Machine Setters and Operators | 14.27 | 690 | $18.33 |
| 51-9051 | Furnace and Oven Operators | 10.75 | 210 | $14.52 |
| 51-4071 | Foundry Mold and Coremakers | 10.39 | 110 | $13.16 |
| 51-4022 | Forging Machine Setters and Operators | 9.14 | 350 | $17.19 |
| 31-2011 | Occupational Therapist Assistants | 6.38 | 170 | $17.47 |
| 53-7081 | Refuse & Recyclable Material Collectors | 4.89 | 300 | $14.61 |
| 49-2092 | Electric Motor and Power Tool Repair | 4.42 | 90 | $15.81 |
| 25-4031 | Library Technicians | 4.13 | 640 | $15.08 |
| 53-7021 | Crane and Tower Operators | 4.00 | 230 | $15.06 |

| | Higher Third (more than $19.00 per hour) | | | |
|---|---|---|---|---|
| 51-9041 | Extruding and Compacting Machine Setters and Operators | 6.26 | 500 | $19.53 |
| 51-4111 | Tool and Die Makers | 5.35 | 840 | $25.54 |
| 49-9043 | Maintenance Workers Machinery | 4.47 | 500 | $21.64 |
| 11-9131 | Postmasters | 4.23 | 60 | $25.50 |
| 11-9061 | Funeral Directors | 3.75 | 90 | $26.30 |
| 29-2033 | Nuclear Medicine Technologists | 3.73 | 80 | $26.14 |
| 33-1011 | Managers of Correctional Officers | 3.17 | 70 | $24.60 |
| 17-2131 | Materials Engineers | 3.05 | 80 | $26.66 |
| 47-2221 | Structural Iron and Steel Workers | 3.05 | 270 | $23.28 |
| 29-2021 | Dental Hygienists | 2.69 | 560 | $19.70 |

Sources: OES values: U.S. Department of Labor, http://www.bls.gov/oes/current/oessrcma.htm

## Educational Assets and Degree Production

A critical component to the future economic development of a community is the education and workforce skills of its citizens. Every year, the U.S. Bureau of the Census reports in its American Community Survey the levels of educational attainment (for those 25 years of age and older) for the population of every Metropolitan Statistical Area in the nation. Table 4 compares these statistics for the Youngstown-Warren MSA, the Cleveland MSA, the Akron MSA, the Pittsburgh MSA, and the entire United States.

**Table 4.** Highest Level of Educational Attainment as Percentage of Population, 2003
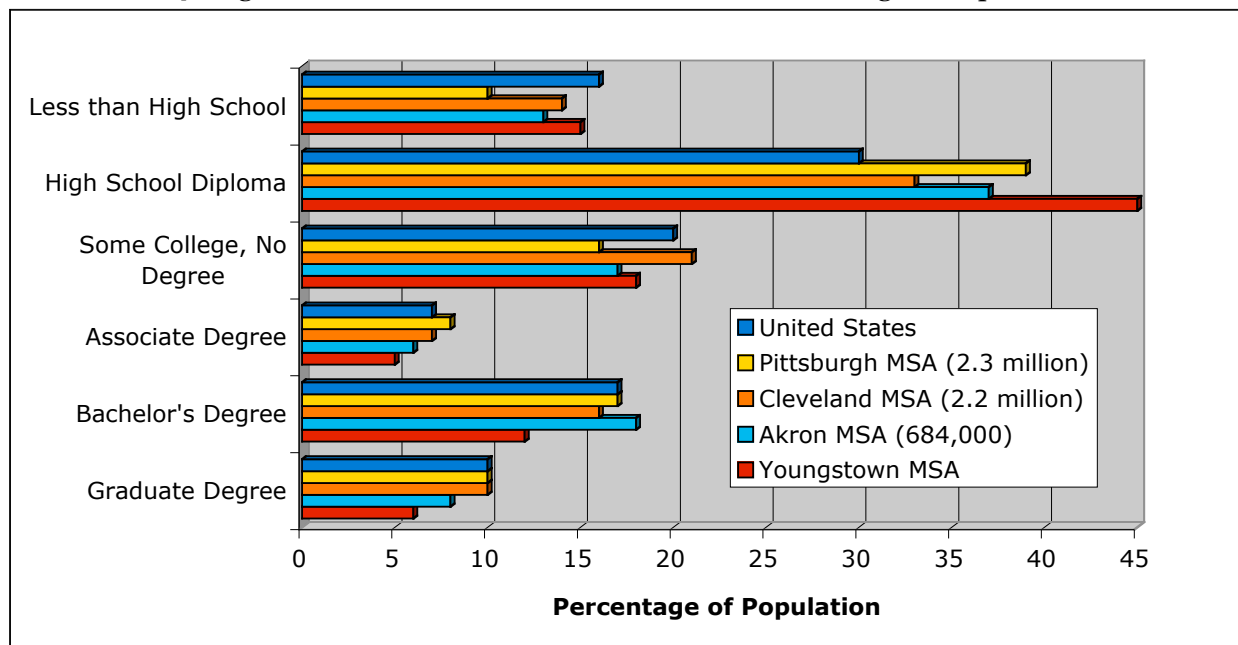


Source: U.S. Bureau of the Census, American Community Survey 2003

This data reveals that 85% of the Youngstown-Warren MSA's population have finished high school or received a general education diploma (GED), which is slightly higher than the

national percentage of 84%. Compared to other regions in close proximity, this percentage is lower than Cleveland (86%), Akron (87%), and Pittsburgh (90%). Additionally, the Youngstown-Warren MSA lags behind the U.S. average when it comes to percentages of its population with undergraduate and graduate degrees. About 18% of the Youngstown-Warren population has attained at least a bachelor's degree, compared to a national figure of 27%. The Akron, Cleveland, and Pittsburgh MSAs all have at least 26% of their residents with bachelor's degrees – on par with the national average. Furthermore, only 6% of Youngstown-Warren MSA residents have a graduate degree, compared to the nation with 10%. In Cleveland and Pittsburgh this percentage is also around 10%, and in Akron 8% of the population has a graduate degree. Possible explanations for these differences include the following: the differing ages of the population base in each of the metropolitan areas, the number of graduate programs provided at local universities, and the possibility of the relocation of residents looking for employment in occupations that require higher levels of education.

Table 5 shows the ten degree-granting institutions in the Youngstown-Warren (OH-PA) CMSA in 2002 and the number of degrees awarded at each. Youngstown State University awards all of the Masters Degrees in the region, and the Northeastern Ohio Universities College of Medicine (NEOUCOM) awards a great majority of the doctoral degrees, even though 2/3 of the students enrolled in this program are not directly affiliated with the Youngstown area because the NEOUCOM student body includes students from the University of Akron and Kent State University (both outside the Youngstown-Warren CMSA). Beginning in 2007, NEOUCOM will commence enrollment in their new doctor of pharmacy program, increasing the local annual production of PhDs.

**Table 5.** Degree Granting Institutions in the Youngstown-Warren CSMA

| Institution | Enrollment | Degrees Granted in 2002 | | | |
|---|---|---|---|---|---|
| | | Associate | Bachelor | Master | PhD/MD |
| **Totals** | | **469** | **2075** | **308** | **105** |
| Youngstown State University | 12,300 | 166 | 1387 | 308 | 4 |
| NEOUCOM (medical college partnered with Kent and Akron) | 315 | - | - | - | 101 |
| Grove City College | 2,300 | - | 486 | - | - |
| Thiel College | 1,245 | 2 | 151 | - | - |
| Penn State University Shenango Campus | 1,016 | 67 | 50 | - | - |
| Kent State University Trumbull Campus | 2,300 | 104 | - | - | - |
| Kent State University Salem Campus | 1,050 | 90 | 1 | - | - |
| Kent State University East Liverpool Campus | 600 | 40 | - | - | - |
| ITT Technical Institute | 400 | 179 | - | - | - |
| Ohio Valley College of Technology, East Liverpool | 160 | 73 | - | - | - |

Source: National Center for Education Statistics, http://nces.ed.gov/ipeds/
Hobson's College View, http://www.collegeview.com

Table 6 further breaks down the diplomas awarded within the Youngstown-Warren CMSA in 2002 by ranking the most numerous degrees within each type of degree. The most

numerous Associate Degrees awarded include the fields of information technology, business and marketing, engineering technicians, and computer programmers.  Similarly, the most Bachelor's Degrees were awarded in business and management, education, the biological and biomedical sciences, and engineering.  Out of the top fifteen graduate degree programs in 2002, only Engineering (18 conferred), Biology (11), and Chemistry (9) represent degrees from scientific and technical fields.

**Table 6.** Number of Degrees Granted by Field in the Youngstown-Warren CSMA in 2002

| Associate (721) | Bachelor (2075) | Masters (308) | Doctorate (105) |
|---|---|---|---|
| Information Technology (102) | Business & Management (509) | Education (127) | M.D. (101) |
| Business & Marketing (96) | Education (328) | Business Administration (59) | Education (4) |
| Electrical Engr. Technicians (87) | Biological/Biomedical Sciences (133) | Counseling (18) | - |
| Computer Programming (80) | Engineering (114) | Engineering (18) | - |
| Drafting & Design (30) | Psychology (95) | English & Literature (15) | - |
| Security Services (27) | Criminal Justice (78) | History (12) | - |
| Accounting (26) | Communication & Journalism (64) | Health Care Administration (12) | - |
| Radiation Therapy (24) | English & Literature (56) | Criminal Justice (11) | - |
| Dental Support (24) | Political Science (54) | Biology (11) | - |
| Mechanical Engr. Technicians (20) | Visual & Performing Arts (53) | Visual & Performing Arts (9) | - |
| Physical Therapist Assistant (17) | Chemistry (51) | Physical Therapy (9) | - |
| Nursing (16) | History (48) | Chemistry (9) | - |
| Legal Assistant (12) | Nursing (44) | Economics (7) | - |
| Medical Office Assistant (12) | Social Work (39) | Nursing (4) | - |
| Child Care & Support (10) | Computer Science (33) | Mathematics (3) | - |

Source: National Center for Education Statistics, http://nces.ed.gov/ipeds/

### Publications and Patents in the Youngstown-Warren CSMA

In an attempt to discover what institutions in the area are producing the most publications in scholarly journals, a list of all publications originating from the Youngstown-Warren CMSA over the last decade were collected by using the ISI Web of Science Database. Table 7 lists the top ten publishing institution in the region, along with the institution's primary research field.  For example, Youngstown State University is most prolific in chemistry and physics research whereas Penn State Shenango's publications are concentrated in ecology and zoology.  A number of local medical organizations make the list, including the regional medical health care providers as well as the Arthritis Center of Northeast Ohio located in Youngstown and the Libby Group and Warren Otologic Group, which specializes in conditions of the ear,

nose, and throat (otorhinolaryngology).  Two manufacturing companies, Delphi Packard Electric Systems and RMI Titanium, also make the list.

**Table 7.** Top Publishing Institutions from 1995 to 2004 in the Youngstown-Warren CSMA

| Institution | No. of Publications | Primary Research Fields |
|---|---|---|
| Youngstown State University | 655 | Chemistry, Physics |
| NEOUCOM | 226 | Medicine |
| St. Elizabeth's Medical Center | 128 | Medicine |
| Penn State University, Shenango Branch | 128 | Ecology, Zoology |
| Forum Health | 87 | Medicine |
| Arthritis Center of Northeast Ohio | 65 | Rheumatology, Anthropology |
| Delphi Packard Electric Systems | 24 | Automotive, Electrical Connections |
| Warren Otologic Group | 15 | Otorhinolaryngology |
| RMI Titanium | 13 | Materials Engineering |
| Lippy Ear, Nose & Throat Group | 8 | Otorhinolaryngology |

Source: ISI Web of Science Database of Publications, http://www.isinet.com/products/citation/wos/

All of these knowledge-producing institutions in the Youngstown-Warren CSMA are comprised of creative individuals who are listed as primary or secondary authors in these publications.  A list of these individuals and their fields of research are included in Table 8.  The most prolific author in the past decade has been Dr. Charles Bursey from Penn State Shenango with 109 publications.  The other prolific authors listed perform research in the fields of chemistry, physics, medicine, otorhinolaryngology, and cardiovascular research.  It is interesting to note the lack of engineering-related publications in the Youngstown-Warren CSMA.

**Table 8.** Most Prolific Publishing Individuals in Science, Technology, and Medicine from 1995 to 2004 in the Youngstown-Warren CSMA

| Author | No. of Publications | Institution | Fields of Research |
|---|---|---|---|
| Bursey, C. R. | 109 | Penn State U. Shenango | Biology, Wetlands Ecology |
| Rothschild, B. M. | 105 | NEOUCOM – Arthritis Center of Northeast Ohio | Rheumatology, Bone Disease, Anthropology |
| Del Bene, J. E. | 59 | Youngstown State Univ. | Chemistry |
| Hunter, A. D. | 50 | Youngstown State Univ. | Chemistry, Crystallography |
| Zeller, M. | 38 | Youngstown State Univ. | Chemistry |
| Carroll, J. J. | 36 | Youngstown State Univ. | Physics, Optics |
| Brodell, R. T. | 34 | NEOUCOM | Dermatology |
| Watanakunakorn, C. | 33 | St. Elizabeth's Medical | Infectious Disease |
| Rothschild, C. | 26 | Arthritis Center of Northeast Ohio | Rheumatology, Anthropology |
| Lippy, W. H. | 23 | Lippy Group | Otorhinolaryngology |
| Norris, P. | 22 | Youngstown State Univ. | Chemistry |

| Rizer, F. M. | 22 | Warren Otologic Group | Otorhinolaryngology |
|---|---|---|---|
| Schuring, A. G. | 20 | Warren Otologic Group | Otorhinolaryngology |
| Smiley, J. A. | 17 | Youngstown State Univ. | Chemistry |
| Dunham, C. M. | 16 | St. Elizabeth's Medical | Injury Trauma |
| Falconer, R. L. | 16 | Youngstown State Univ. | Chemistry |
| Porter, J. M. | 15 | St. Elizabeth's Medical | Injury Trauma |
| Burkey, J. M. | 14 | Warren Otologic Group | Otorhinolaryngology |
| Kasirajan K. | 13 | Forum Health | Cardiovascular Systems |
| Rubin, J. R. | 12 | Forum Health | Cardiovascular Systems |
| Wagner, T. R. | 12 | Youngstown State Univ. | Chemistry |

Source: ISI Web of Science Database of Publications, http://www.isinet.com/products/citation/wos/

One possible method to the measure economic development potential of a region is to analyze the various patents that originate from that metropolitan area. Patents are good metrics of innovation because they are new and nontrivial ideas, often created with commercial applications in mind. Each patent granted by the U.S. Patent and Trademark Office includes information about the location of the inventor as well as the location of the patent's assignee (the assignee is usually a company). Figure 2 below shows the annual number of patents since 1971 that were issued to either individuals or companies in the Youngstown-Warren CMSA. Even though some of the companies included in this data are located outside of the Youngstown-Warren CMSA, the employees who created those patents live within the area and are a component of the region's intellectual capital. This graph shows the most prolific time for patents in the area was the early 1970s and more recently, from 1997 to 2003.

**Figure 2**. Number of Patents Issued by Year in the Youngstown-Warren CMSA



Source: Community of Science Database of Patents, http://patents.cos.com
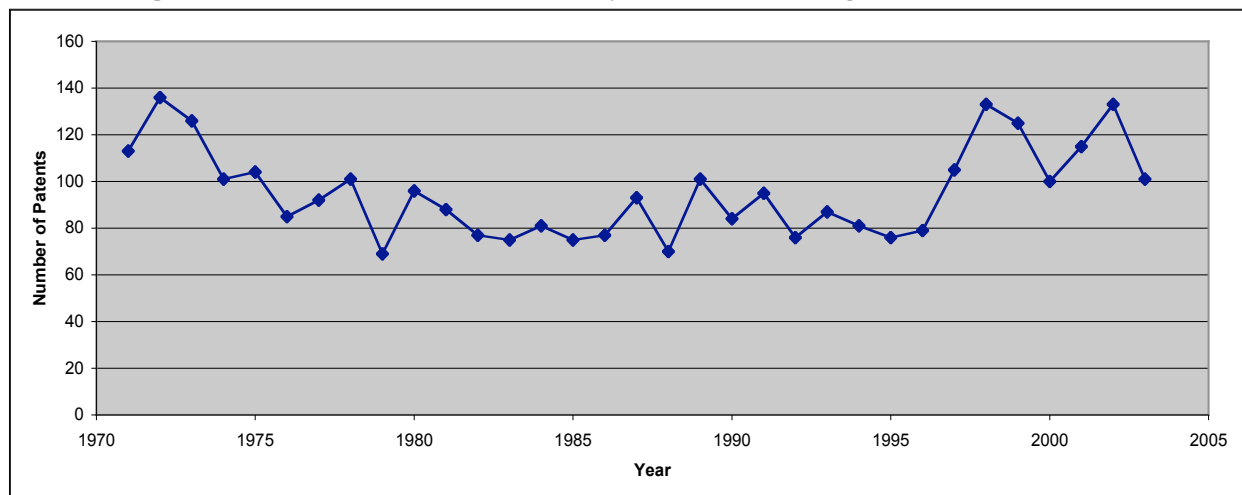
Table 9 charts the companies that produced the largest number of patents during each decade in the Youngstown-Warren CSMA. Patents from the 1970s and 1980s reflect the various metal fabrication facilities from the area. Patents from the 1990s to the present contain a large number of automobile component and electrical connectors patents, primarily from General Motors and Delphi Packard Electrical Systems. One interesting company to note is Infectech Inc. (now NanoLogix, Inc.) located in Sharon, Pennsylvania. This company seems to have the

most patents of companies in the biomedical area as they hold a number of patents in microbiology and pathogen detection.

**Table 9.** Top Patenting Institutions by decade in the Youngstown-Warren CSMA

| Years | Institution | No. of Patents | Fields of Commercialization |
|---|---|---|---|
| 1971 to 1979 | Westinghouse Electric Corp. | 119 | Electrical Components |
| | General Motors | 67 | Automotive Components |
| | Youngstown Sheet & Tube Co. | 46 | Steel and Machinery |
| | Wean Industries, Inc | 29 | Metal Fabrication |
| | Ajax Magnethermic Corp. | 21 | Heating Devices |
| | GF Business Equipment, Inc | 16 | Furniture |
| | General American Transport Co. | 15 | Train Components |
| | The General Fireproofing Co. | 12 | Furniture |
| 1980 to 1989 | General Motors | 115 | Automotive Components |
| | Commercial Shearing Inc | 34 | Valves and Machinery |
| | NRM Corporation | 33 | Tire Components |
| | Westinghouse Electric Corp. | 26 | Electrical Components |
| | Alcan Aluminum Corp. | 21 | Aluminum Production |
| | Insul Company | 14 | Metal Production |
| | The Babcock & Wilcox Co. | 13 | Energy Production Components |
| | The Electric Power Research Inst. | 11 | Transformers and Conductors |
| 1990 to 1999 | General Motors | 170 | Automotive Components |
| | The Babcock & Wilcox Co. | 34 | Energy Production Components |
| | Winner Royalty Group | 29 | Security Devices |
| | Infectech, Inc | 27 | Microbiology Applications |
| | Spirex Corp. | 12 | Extruded Components |
| | Ajax Magnethermic Corp. | 11 | Heating Devices |
| | Packard Hughes Interconnect Co. | 9 | Electrical Connections |
| | Century Products Co. | 8 | Safety Belts and Seats |
| 2000 to 2004 | Delphi Technologies Inc | 82 | Electrical Connections |
| | General Motors | 19 | Automotive Components |
| | Keystone Ridge Designs | 12 | Furniture |
| | Alco Industries Inc | 9 | Pet Supplies |
| | Danieli Technology Inc | 8 | Chemical Processes |
| | McDermott Technologies | 8 | Energy Production Components |
| | Winner Royalty Group | 6 | Security Devices |
| | Gates Automation Inc | 6 | Bag Handling |

Source: Community of Science Database of Patents, http://patents.cos.com

**The Super-Creative Core of the Youngstown-Warren CSMA**
The publication and patent analysis has been used to discover the knowledge producing institutions and individuals within the region. Table 10 provides more specific information about the most prolific individuals in the CSMA. When creating future knowledge-based economic development strategies, it may be important to contact these individuals and ask them for advice or provide them with assistance when it comes to building research programs and developing an innovative workforce in the Youngstown-Warren CMSA.

**Table 10.** Important Knowledge-Producing Individuals in the Youngstown-Warren CSMA

| Name | Areas of Specialization | Important Information |
|---|---|---|
| Dr. Bruce Rothschild<br>brm@neoucom.edu | Rheumatology, Bone Disease, Anthropology, Arthritis of Fossils | • Director, Arthritis Center of Northeast Ohio (Youngstown)<br>• 105 publications within last decade<br>• Professor of Medicine (NEOUCOM)<br>• Professor of Bio. Engr. (U. of Akron) |
| Dr. Mitchell Felder<br>mfelder@infectech.com | Microbiology, Pathogen Identification | • CEO of Infectech, Inc. (Sharon)<br>• Renamed NanoLogix in March 2005<br>• www.nanologix.net states the company has 31 patents |
| Dr. Charles Bursey<br>cxb13@psu.edu | Wetlands and Marine Biology Research | • Professor of Biology (Penn State Shenango in Sharon)<br>• 109 publications within last decade |
| Dr. Allen Hunter<br>adhunter@cc.ysu.edu | Chemistry, Crystallography | • Director, YSU Structural & Chemical Instrumentation Center<br>• Professor of Chemistry, YSU<br>• 50 publications within last decade |
| Dr. Matthias Zeller<br>mzeller@cc.ysu.edu | Chemistry | • Chemistry Research Fellow, YSU<br>• 38 publications within last decade |
| Dr. James. J. Carroll<br>jjcarroll@cc.ysu.edu | Physics, Optics Photonuclear Reactions | • Director, Center for Photon-Induced Processes and X-Ray Effects Lab.<br>• Professor of Physics, YSU<br>• 36 publications within last decade |
| Dr. Robert Brodell<br>rtb@neoucom.edu | Medicine, Dermatology | • Head of Dermatology, NEOUCOM<br>• 34 publications within last decade |
| Dr. William H. Lippy | Ear Surgery Otorhinolaryngology | • Founder of Libby Otology Group<br>• Internationally recognized inner ear surgeon<br>• 23 publications within last decade |

**Review of Key Findings**
Here is a summary of the key findings discussed within the pages of this report that will be used as the basis for the recommendations:

- According to the U.S. Census Bureau, the largest employment sector of the Youngstown-Warren regional economy remains manufacturing, which accounts for 19% of the region's total employment. From 1999 to 2002 the number of employees in manufacturing has decreased by 29%. The sectors of information services and management of companies, which each account for 3% of the region's total employment, have grown by 20% during the same time period.

- Compared to the other metropolitan areas in the United States, the region has a much larger percentage of its workers in higher wage production jobs, but the number of these jobs is rapidly decreasing. Alternatively, the area has a much lower concentration of jobs in the computer, engineering, life sciences, and arts and entertainment fields.
- As a percentage of the population, the Youngstown-Warren area has a smaller percentage of residents with associates, bachelors, and graduate degrees when compared to the neighboring communities of Akron, Cleveland, and Pittsburgh, as well as the United States as a whole.
- In 2002, the four most numerous associates degrees awarded in the region were in the fields of information technology, business & marketing, electrical engineering technicians, and computer programming. The four most numerous bachelors awarded were in the fields of business, education, biological & biomedical sciences, followed by engineering. The four most numerous masters degrees awarded were in the fields of education, business administration, counseling, and engineering.
- The publications originating from the Youngstown-Warren region are mainly concentrated in the fields of chemistry, medicine, and physics. These research fields may be future areas of opportunity.
- Publications from engineering researchers and companies make up a very small percentage of the total number of publications.
- The yearly number of patents issued in the Youngstown-Warren area decreased by 30% from the early 70s through the 90s. However, in the past five years, the annual number of patents is re-approaching the numbers from the 1970s. Manufacturing companies are the dominant source of these patents.

## Considerations and Recommendations

Some important questions for the business, political, and economic development leaders of the Youngstown-Warren CMSA may include the following:

- *Does the region have adequate programs or strategies to create and develop innovative companies, individuals, and institutions?*
- *Does the educational system provide the existing research and development base with the workforce required for the future growth of their companies?*
- *If the local universities are developing individuals in fields that are not well represented in the CMSA, what can be done to attract companies that will hire recent graduates in technical areas?*
- *Do collaborations exist among knowledge-producing companies and knowledge-producing institutions and between existing universities in the region?*
- *Does a dialogue exist between creative individuals and private sector leaders to discuss future collaboration?*
- *Does a current technology transfer infrastructure exist where universities, other institutions, and private companies can all attain grant writing, investment, legal, and business assistance?*
- *Do noticeable linkages exist between the stated needs of the private sector and all levels of the workforce and educational development systems in the region?*

A few possible ideas to enhance the economic development of the Youngstown-Warren CSMA are listed for consideration:

## UNIVERSITY GROWTH

- Many of the universities in the region are primarily teaching institutions that have been developing additional research opportunities over the past decade. Perhaps as older faculty retire, a new emphasis can be placed on hiring faculty that have experience in entrepreneurship and technology transfer, in additional to teaching and scholarly research. Maybe **university development funds or private donations can be used to develop endowed chairs for "research, development, and entrepreneurship" at local universities**. One program that can be emulated for its ability to attract a highly skilled research workforce is the Georgia Research Alliance (www.gra.org). Their Eminent Scholars program provides not only the funds for each researcher's salary, but also provides money for laboratory equipment to be used at the discretion of each researcher. Individuals can be sought to complement academic departments that already have high levels of scholarship and graduate programs. At Youngstown State for example, new faculty can be sought who specialize in both chemistry, physics, or materials engineering research and have experience in technology transfer. If investing in this type of program creates start-up businesses, then graduates of local universities can be used as a source of skilled labor. Programs should be created to invest heavily in human capital to create pools of scientific entrepreneurs to exploit knowledge.

- **Strengthen YSU graduate research programs, especially in engineering** and encourage additional collaboration between existing industry, research firms, and universities in the areas of applied technology.

- Right now, the Williamson School of Business at Youngstown State is looking to build a new building by the end of the decade. Perhaps some of **the building design can include space for business incubation**. Having start-up companies on campus may add to the entrepreneurial atmosphere on campus, provide employment opportunities for students and graduates, and can even act as a steppingstone to the Youngstown Business Incubator located downtown.

## ACCESS TO RESOURCES

- **Develop a regional organization that can facilitate a dialogue between a diverse collection of researchers, local institutions, and all interested individuals**, in order to develop collaborative efforts and assess the needs of local researchers. Encourage connections within the research community.

- **Create incentive-based programs to motivate individuals within the region to attain more education.** Degree attainment and educational access is a key criterion that knowledge-based companies and other industries use to examine the workforce skills of a potential labor pool. Developing a stronger workforce by strengthening the education system is a long-term project that needs to be continually reinforced by local community leaders.

## SOCIAL NETWORKS

- Communicate with the individuals and institutions in this report to determine if any of their technologies are marketable. Perhaps **if individuals in the research and development community have needs, multi-institutional relationships from the private and public sector can pool resources**. For example, if one university does not have the resources to hire a lawyer who specializes in technology transfer, both the university and the city can provide funds for the hiring.

- Recent downsizing at innovation-producing establishments such as Delphi Electric may create a highly skilled labor force with extensive knowledge of certain fields and markets with no immediate employment. Perhaps some of the engineers who chose to remain in the region can be mobilized to form new ventures or be advisors for other firms. **Collaborate with recently retired or laid-off employees to discuss future opportunities for new or existing local companies**.

- **Contact the super-creative individuals in this report and solicit their opinions on how to develop the research community in the region.** These individuals may have specialized needs that local leaders can address.

## MARKETING AND MEASUREMENT

- **Include some information on the knowledge-producing components of the Youngstown-Warren CMSA as a central component of the Regional Chamber's website**. Perhaps doing so may provide some high-tech components to the marketing of the region or help to develop the entrepreneurial culture in the area.

- **Continually monitor the innovational development, adaptation of information technology, and the needs of manufacturing firms** in the area. Perhaps local and state entities can provide technology assistance for manufacturing processes and workforce development.

- **Request that local economic development organizations continually monitor the metrics used in this report**, including information on patents, publications, degree conferment, and creative individuals in the area.

## Conclusion

This report has shown to a varying degree the existing economy and workforce, the educational output, and the knowledge generation of the Youngstown-Warren region. By assessing the connections between these components, certain strengths and weaknesses can be discovered. Perhaps future collaboration and planning from this analysis will enable new economic opportunities to develop. It is the hope of the author that this report contributes to the dialogue between researchers, economic developers, community leaders, and public and private institutions to build dynamic partnerships to advance the knowledge-based economy of the Youngstown-Warren region.