



## Research and Development: Selected R & D Highlights

- **In summary**, 618 establishments in Ohio were engaged in R & D in engineering and the physical and life sciences (NAICS 54171) during 2014 – a 27.7 percent increase from 2002, according to the U.S. Bureau of Labor Statistics (U.S. BLS). At least 77 percent are located in six larger metropolitan areas:
  - **Akron** (38, with 31 in Summit Co.),
  - **Cincinnati** (119, with 77 in Hamilton Co.)
  - **Cleveland-Elyria** (123, with 104 in Cuyahoga Co.)
  - **Columbus** (99, with 76 in Franklin Co.)
  - **Dayton** (79, with 42 in Greene Co. and 35 in Montgomery Co.)
  - **Toledo** (24, with 17 in Lucas Co.).\*
- Among these private sector R & D establishments, the [Battelle Memorial Institute](#) is notable as the world's largest such non-profit organization. It employs about 22,000 at 130 locations around the world, with at least 2,300 in Ohio at its Columbus headquarters (next to the Ohio State University) and four other major locations. Its R & D endeavors range from consumer and industrial products to energy and the environment, national security, and health – particularly pharmaceuticals and medical devices. It also manages or co-manages at least four federally funded research and development centers.
- Two [National Cancer Institute Cancer Research Centers](#) are located in Ohio: one at Case Western Reserve University (Cleveland), the other at Ohio State University.
- [GE-Aviation](#), headquartered in Evendale, produces jet engines for commercial and military aircraft. Its related Electrical Power Integrated Systems Center, a collaborative research project, is at the University of Dayton; its engine testing facility is located in Peebles.
- [NASA Glenn](#) and [Wright-Patterson Air Force Base Research Laboratory \(WPAFBRL\)](#) stand out among governmental R & D facilities in Ohio. **NASA Glenn** is adjacent to Cleveland Hopkins International Airport. Its primary mission has always been developing science and technology for use in aeronautics and space. Research focuses on microgravity, propulsion systems, material and structural durability, electrical power, communications and health, and is often done in conjunction with private companies. The center employs 1,624 civil servants, about 76 percent of which are scientists, engineers and technicians. Its Plum Brook Station subdivision near Sandusky conducts large-scale tests; the world's largest vacuum test chamber is located there.
- R & D activities at the **WPAFBRL**, located east of Dayton in Greene Co., are related to the testing, integration and/or modernization of the nation's aeronautical systems. Cyberspace systems and work on unmanned aerial vehicles are the most recent additions.
- **The State of Ohio** supports two programs facilitating a broad range of R & D. The [Third Frontier Project](#) began in 2002. The \$2.1 billion initiative links industry, academia and government agencies to facilitate the commercialization of innovative products and processes.
- The related **Edison Technology Centers** provide additional services to new and established organizations, often focusing on substantive areas. They link industry with academia and government in partnerships to strengthen industrial competitiveness through technological innovation. The six centers include:
  - [MAGNET](#) (Cleveland) and [TechSolve](#) (Cincinnati) – both specialize in productivity improvement in manufacturing processes, as well as delivering the federal-state Manufacturing Small Business Assistance programs. Individually, **MAGNET** concentrates on product design, while **TechSolve** focuses on machining technologies.
  - The [Edison Welding Institute](#) (Columbus) – conducts research on material joining technology for industry and government.
  - [CIFT](#) (Toledo) – concentrates on food processing and packaging; research examples include blow molding and wrapping technologies.
  - [BioOhio](#) (Columbus) – facilitates pharmaceutical and medical device development.
  - [PolymerOhio](#) (Westerville) – is a networking group for industrial companies, academics and service providers concerned with polymeric advances.
- Two similar organizations focus on aerospace R & D in Ohio.
  - The [Ohio Aerospace Institute \(OAI\)](#) is a joint initiative of **NASA Glenn**, the **WPAFBRL**, the State of Ohio, ten universities in Ohio granting doctoral degrees in aerospace-related engineering disciplines, and many companies engaged in aerospace activities. **OAI** is a non-profit organization serving as a network and information exchange for education, training, research on a wide variety of subjects, and related technology development. It has about 80 employees.
  - Led by Ohio State and funded as a Wright Center of Innovation, the [Ohio Center for Advanced Propulsion and Power \(OCAPP\)](#) is an interdisciplinary research center bringing together private sector aerospace companies, two federal laboratories, and five existing university research programs. **OCAPP** research is providing the knowledge to create faster, quieter and more fuel efficient jet engines with reduced environmental impact for the next generation of propulsion systems.

# Research and Development: R & D Funds



## Performance Overview

- \$10.36 billion<sup>1</sup> was spent on research and development (R & D) activities in Ohio during 2011 according to the latest data from the National Science Foundation (NSF). Ohio ranked 10<sup>th</sup>.<sup>2</sup>
- Nearly 68 percent of the R & D activity was done by for-profit businesses. Higher education institutions were the next largest performers with 21.5 percent of funds spent.
- The Federal government performed \$960 million-worth of R & D, ranking Ohio 6<sup>th</sup>.<sup>3</sup> NASA Glenn and the Wright-Patterson Air Force Base Research Laboratory are notable for their efforts in aerospace. Expenditures by the State of Ohio for its own purposes were \$3 million, ranking the state 26<sup>th</sup> according to the NSF.

## Funding Overview

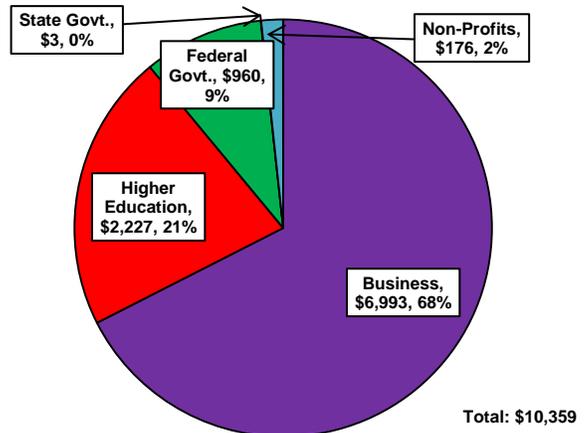
- For-profit businesses were the sources of most R & D funds, spending over \$5.5 billion in Ohio during 2011, and followed by the Federal government with over \$3.5 billion. The two sectors combined for nearly 88 percent of all funding.
- Higher education institutions spent \$395 million in R & D – 4.0 percent of total expenditures. Expenditures by the state, local governments and nonprofits combined for 2.5 percent of the total. Spending from all other sources – public or private, foreign or domestic – amounted to 6.1 percent of the total.

## The Roles of Businesses

- \$5.4 billion of the \$7.1-plus billion (i.e., 75.6 percent) either received or spent by businesses for R & D were generated in the business sector for its own purposes.<sup>4</sup>
- Ohio businesses also supplied \$1.59 billion in R & D services to the Federal government and other organizations.
- Businesses turned to higher education institutions for 2.1 percent of the R & D services they sought.

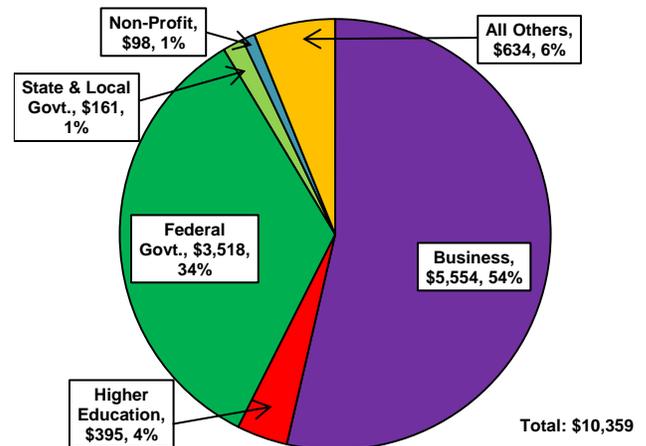
Notes: 1 – This includes very small percentages for social science as well as non-science research; 2 – Some R & D is performed in U.S. territories, and some expenditures cannot be allocated to the states; consequently ranks consider only the states and the District of Columbia; 3 – This excludes the special sub-category of Federally Funded Research and Development Centers; the 37 FFRDCs do R & D for the Federal government, but are administered by non-governmental agencies; none is in Ohio; 4 – This is the only category in which new data has been published. In 2013, \$5.58 billion of the \$8.11 billion (i.e., 68.8 percent) either received or spent by businesses for R & D were generated in the business sector for its own purposes.

## Performance by Sector (in millions, except percentages)



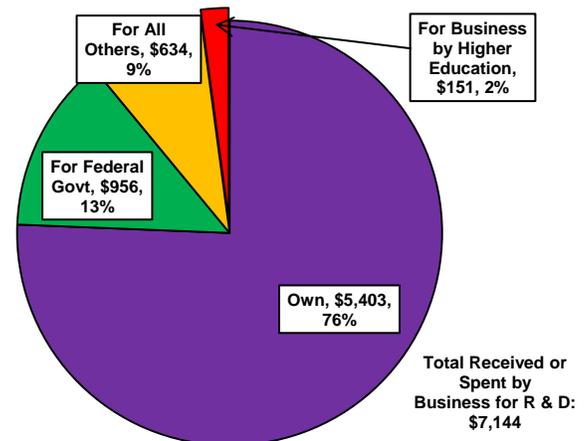
Source: National Science Foundation

## Funding by Sector (in millions, except percentages)



Source: National Science Foundation

## R & D by and for Businesses (in millions, except percentages)



Source: National Science Foundation, 2011 data

# Research and Development: Higher Education



## Research and Development

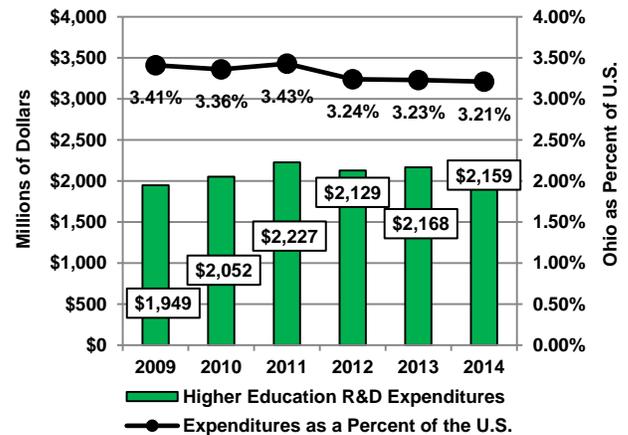
- Almost \$2 billion was spent by the 19 institutions in fiscal 2014 on R & D in natural sciences and math, computer and engineering fields. 64.7 percent was spent in the life sciences, followed by 23.7 percent for engineering; physical sciences spent 6.2 of the remaining 11.6 percent.
- 19 public and private higher education institutions in Ohio have engaged in research or development (R & D) in recent years according to the National Science Foundation, with aggregate expenditures steadily rising from less than \$1.9 billion to more than \$2.1 billion.\*
- The Ohio institutions' collective share of all national academic R & D during this time has decreased slightly from around 3.43 percent to 3.21, ranking Ohio 11<sup>th</sup> among the states.
- Such substantial spending in life sciences and engineering ranked Ohio's institutions 9<sup>th</sup> and 8<sup>th</sup> in the U.S., with 3.38 and 4.29 percent of the respective national totals.
- Within the life sciences, Ohio's seven medical schools spent almost \$1.06 billion on R & D in fiscal 2014 – 4.6 percent of the national total, ranking the state 8<sup>th</sup>.
- Ohio State, Case Western Reserve and the University of Cincinnati were the three institutions each spending over \$400 million in fiscal 2014 on R & D in the natural sciences and math, computer and engineering fields. Their combined spending of \$1.66 billion amounted to 76.8 percent of the higher education total in Ohio.
- 66.4 percent of the \$2.16 billion\* spent by Ohio's higher education institutions on R & D in fiscal 2014 came from governmental sources, with the Federal government supplying 60.1 percent of the funds. 18.8 percent of funds were supplied by the institutions themselves, with businesses providing over eight percent. Non-profits and others provided the remainder.

## Training

- 12 public and three private universities granted 6,318 PhDs in more than 30 specific fields of engineering, health, math and natural sciences in fiscal years 2009 through 2014 according to the Ohio Dept. of Higher Education. Ohio State, Case Western Reserve and the University of Cincinnati accounted for 57.6 percent of the total.
- 121 public and private different higher education institutions in Ohio offer various degrees and certificates in 40 specific fields associated with high-tech occupations.

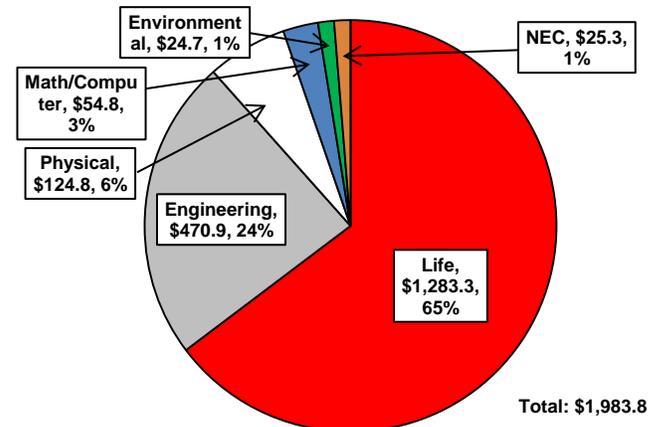
Note: \* – The figures include small percentages for social science as well as non-science research; no adjustment has been made for inflation.

## The Trend in Ohio



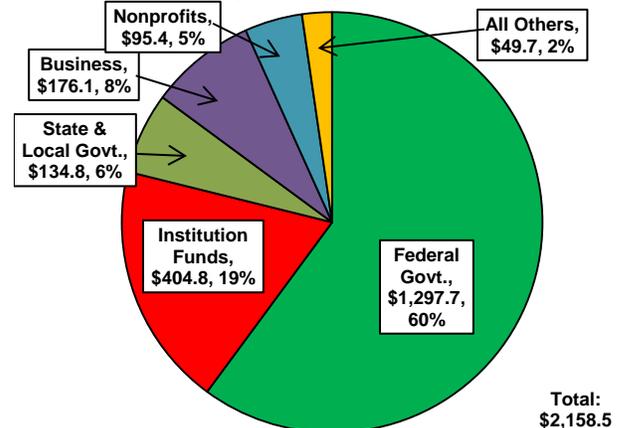
Source: National Science Foundation

## Where the Money Was Spent in FY 2014 (in millions, except percentages)



Source: National Science Foundation

## Funding Sources in FY2014 (in millions, except percentages)\*



Source: National Science Foundation

# Research and Development: Industry Trends and Projections



## Recent Employment Trends

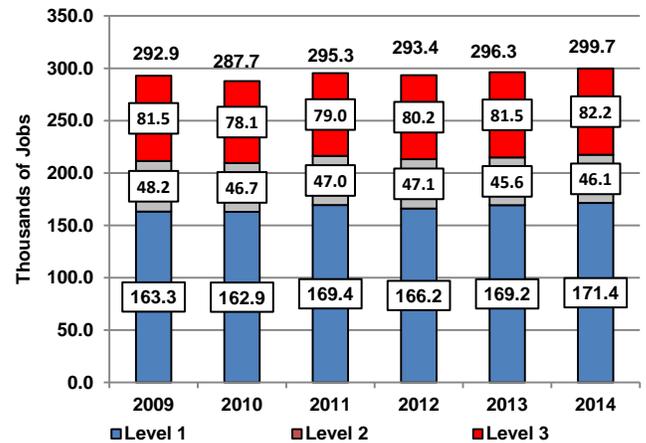
- 299,655 people worked in Ohio's high-tech industries in 2014 according to the U.S. Bureau of Labor Statistics (U.S. BLS). This is net increase from the early-expansion low of 287,700.
- Level 1 industries – wherein high-tech occupations comprise at least 25 percent of all industry employment – continued to recover from their 2010 dip to 162,900 jobs. Level 2 and 3 industries (in which the portions of high-tech jobs range from 14.8-24.7 and 9.8-14.7 percent, respectively) have followed similar patterns. While Level 3 industries have steadily added approximately 1,000 jobs annually since 2010, Level 2 industries have fluctuated around 46,000 jobs, which is below their 2009 marks. (See page 8 for the list of industries in and the definitions of each level.)
- High-tech industries may also be grouped into *goods-producers* – largely machinery, chemical, and semiconductor-based industries, with a few other manufacturers, and *service-providers* – mostly selected professional, scientific, technical and telecommunication/internet activities. The second chart shows both groups maintaining a trend toward recovery, but fluctuating year to year.
- Computer systems design (NAICS 5415), engineering (54133) and research and development in the physical, engineering and life sciences (54171) – all Level 1 services – have been the largest stable-to-growing groups.

## Projected Employment for Selected Industries\*

- Total employment in high-tech industries may rise 5 percent from 252,790 in 2012 to 265,420 by 2022 – a prediction from the Ohio Dept. of Job and Family Services' Labor Market Information division (ODJFS/LMI).\* By comparison, the total number of jobs in Ohio is forecast to rise 8.3 percent from 5,502,100 to 5,957,100 during the same time.
- Summary employment in Level 1 industries may rise 13.5 percent from 151,520 to 171,950.
- Summary employment in high-tech services may rise 12.6 percent from 147,120 to 165,700.
- More specifically, high-tech industry employment may be principally driven by the projected addition of 13,600-plus jobs in computer systems design and related services (5415 – 26.1 percent growth) and secondarily by 6,600 more jobs in architectural, engineering and related services (5413 – 16.9 percent growth). Both are Level 1.

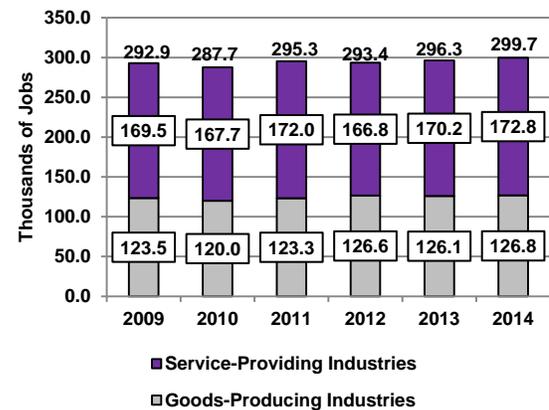
Note: \* – ODJFS/LMI does not make projections for very small industries, obviating comparisons to the U.S. BLS.

## Industry Employment by “High-Tech” Level



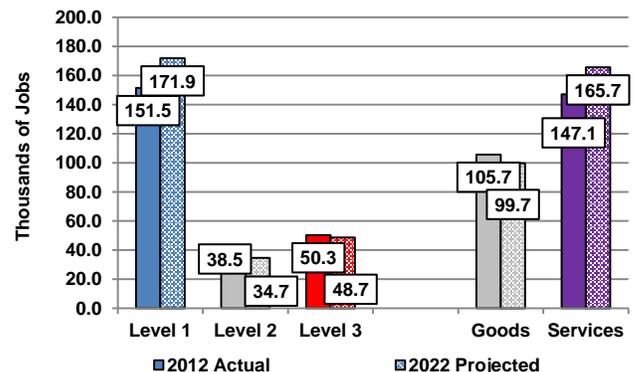
Source: U.S. Bureau of Labor Statistics

## “High-Tech” Industry Employment by Sector



Source: U.S. Bureau of Labor Statistics

## Projected “High-Tech” Employment for Selected Industries\*



Source: ODJFS/LMI

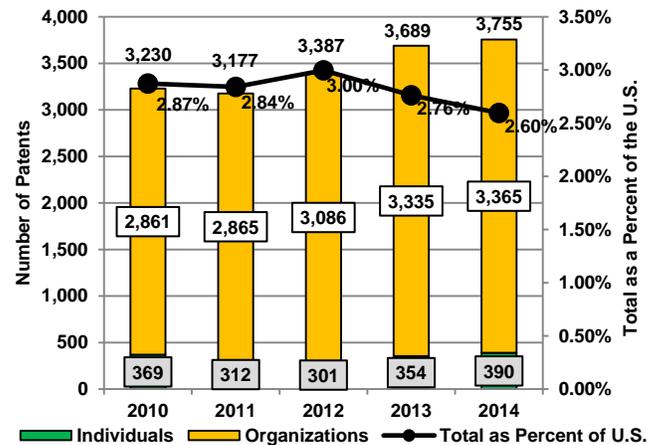
# Research and Development: Activities



## Patents

- 17,238 utility patents<sup>1</sup> were granted to individuals and organizations located in Ohio from 2010 through 2014, with 14,007 – 81.3 percent – granted during the recovery in the last four years.
- 90 percent of the patents went to organizations with operations here. Procter and Gamble, General Electric, Honda and Ethicon Endo-Surgery were the most active – each received more than 500 patents; 11 more private companies each had 100 to 499 patents in five years.
- 12 universities received 605 patents, led by Case Western Reserve with 145; four federal government agencies received 198 patents, led by the Air Force and NASA.
- Ohio ranked 12<sup>th</sup> among all U.S. states and territories in patents received with an average share of 1.76 percent during the five years.

## Patents by Ohio Residents

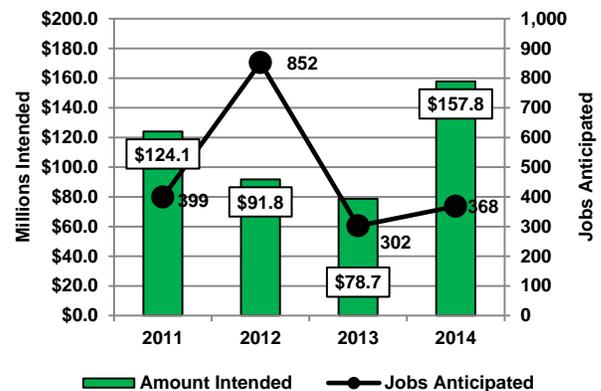


Source: U.S. Patent Office

## Research and Development Projects, SBIR Grants

- 39 companies announced 43 major research and development projects (R & D, NAICS 54171) from 2011 through 2014, intending to invest \$452.4 million; 1,921 new jobs were anticipated upon completion.<sup>2</sup> Timken and Nestle each invested more than \$50 million, and IBM planned 500 jobs.
- During the same time, 52 companies announced 55 additional projects in which R & D was secondary.
- 1,011 awards for Small Business Innovation Research totaling \$393,943,332.75 were made to Ohio companies in the 2010-2014 fiscal years according to the U.S. Small Business Administration. Both figures were 4.0 percent of U.S. totals, ranking Ohio 8<sup>th</sup> and 9<sup>th</sup>, respectively.

## Major R & D Projects in Ohio

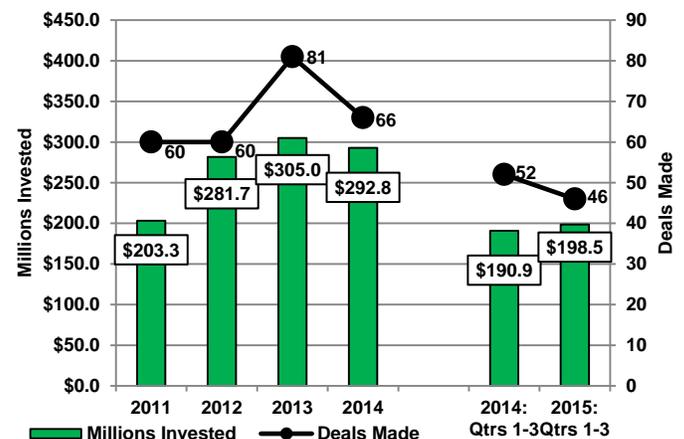


Source: Ohio Development Services Agency

## Venture Capital Deals

- Venture capital deals often are made for new or improved products, processes or services. 267 such deals were completed in Ohio from 2011 through 2014 with at least one billion dollars invested. These amounted to 1.67 and 0.80 percent of the corresponding national totals, respectively ranking the state 12<sup>th</sup> and 18<sup>th</sup>.<sup>3</sup>
- The number of deals has declined, but the amounts invested have grown over the past year. Investments continue apace with 46 deals worth \$198.5 million completed through the third quarter of 2015, compared to 52 deals and \$190.9 million through 2014's third quarter.

## Venture Capital Investments in Ohio



Source: National Venture Capital Association

Notes: 1 – Utility patents are given for original inventions, as opposed to design patents or trademarks. 2 – A major project involves at least \$1 million, 50 new jobs, or an addition of 20,000 square feet; projects often extend for more than one year, and jobs may be phased-in or realized at completion. 3 – Not every deal discloses investment amounts. The small percentages are partially understood by noting that Califor-

nia, Massachusetts and New York combined for 60 and 72 percent of the deals and dollars, respectively.

# Research and Development: Work Force



## Occupations

- Innovations start with the people working on the frontiers of knowledge and developing new products and processes. 247,280 people were employed in Ohio in the innovative cluster of computer, math, engineering, life and physical science occupations in 2014.<sup>1</sup> These were 3.4 percent of all such workers in the U.S. and 4.7 percent of all employed persons in Ohio.
- 125,190 worked in computer fields as researchers, programmers, analysts, administrators, technicians or support personnel; 3,920 worked in math-related fields.
- 59,920 were engineers, while 25,920 did related drafting and technical work; 4,250 worked in architecture-related fields.
- 14,480 were life and physical scientists; 11,800 were related technicians.

## Ohio's Shares of the U.S. Jobs

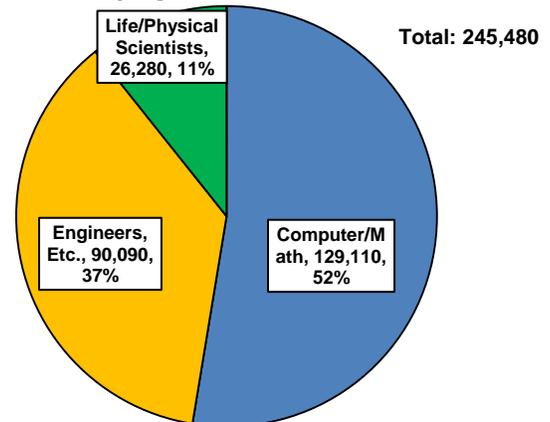
- 22 specific computer, math, engineering, life and physical science occupations are concentrated in Ohio, *i.e.*, Ohio's share of these particular jobs is greater than its summary proportion of 3.85 percent.
- Computer-related jobs concentrated here include systems analysts, software applications developer, and network support specialists.
- Actuaries represent the only mathematical occupation concentrated here, which reflects the concentration of the insurance industry in which they often work.
- Aerospace, industrial, material and mechanical engineers and most of the associated drafters and technicians are concentrated here as part of the notable presence of the aerospace, chemical and machinery industries in which they work as well as the overall concentration of manufacturing in the state.
- Food scientists and technicians, physicists, chemists, material scientists, hydrologists and biological and chemical technicians are concentrated here, again reflecting the concentration of the food processing and chemical industries in Ohio as well as the presence of research facilities.

## Researchers and Technicians as Entrepreneurs

- 3.6 and 4.2 percent of architectural/engineering and computer/math workers are self-employed, compared with 10.6 percent with those in life/physical sciences.

Notes: 1 – The U.S. BLS rounds numbers to the nearest 10;  
2 – BLS and Census figures differ due to different methodologies.

## "High-Tech" Employment



Source: U.S. Bureau of Labor Statistics

## Ohio's Shares of Selected "High-Tech" Occupations

Occupation	Percent of U.S. Jobs
Total	3.85%
Computer/math/architecture/engineering/ life/physical sciences subtotal-----	3.65%
Computer and math	3.37%
Computer systems analysts-----	5.03%
Software developers, applications	3.88%
Network support specialists-----	4.93%
Actuaries	4.93%
Architectural/engineering-----	3.75%
Aerospace engineers	6.72%
Industrial engineers-----	5.16%
Material engineers	5.96%
Mechanical engineers-----	4.51%
All other engineers	6.65%
Mechanical drafters-----	4.48%
All other engineering drafters	6.05%
Electro-Mechanical technicians-----	4.92%
Industrial engineering technicians	5.53%
Mechanical engineering technicians-----	5.11%
All other engineering technicians	6.05%
Life/physical sciences-----	5.20%
Food scientists & technicians	4.09%
Physicists-----	3.87%
Chemists	4.58%
Materials scientists-----	7.25%
Hydrologists	3.95%
Biological Technicians-----	4.14%
Chemical technicians	6.43%

Source: U.S. Bureau of Labor Statistics

## Entrepreneurs Among Researchers, etc., in Ohio

Occupational Class	Self-Employed*	Other Privately Employed*
Computers/math	4,700	113,000
Architect/engineering	3,800	87,900
Life/physical sciences	2,800	28,800
<b>Combined</b>	<b>11,300</b>	<b>229,700</b>

\* - Numbers are rounded. Source: U.S. Census Bureau<sup>2</sup>

# Research and Development: Work Force Trends and Projections



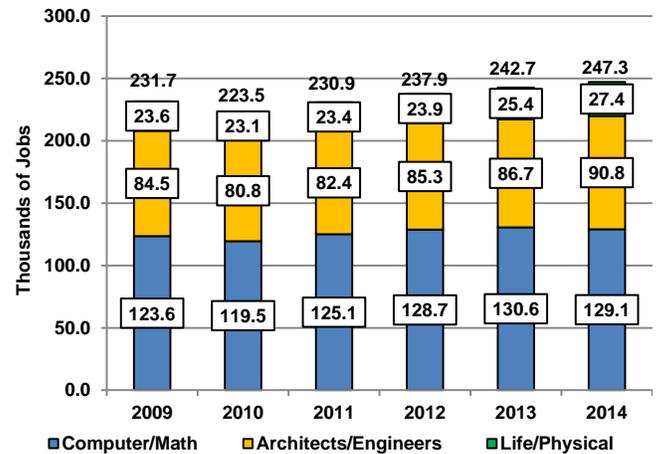
## Recent Occupational Trends

- The number of people in Ohio working in high-tech occupations rose 10.7 percent from 223,500 to 247,300 during the 2010-2014 period according to the U.S. Bureau of Labor Statistics (U.S. BLS) annual May surveys. By comparison, total employment in Ohio rose 5.7%.
- High-tech employment fell from 231,700 to 223,500 during the later stage of the recession and the beginning of the recovery. Since 2010, though, high-tech jobs have grown 10.7 percent. Ohio's portion of all U.S. high-tech jobs has remained nearly constant at 3.5 percent despite the variations in absolute numbers.
- High-tech employment growth has been driven by computer and math-related jobs, which rose 8.0 percent almost without interruption from 119,500 to 129,100. Specifically, job growth within the math-related portion of this sector is principally due to added actuaries and statisticians, while computer-related job growth reflects more applications software developers and systems analysts.<sup>1</sup>
- Architectural- and engineering-related jobs have grown by 12.4 percent since a low point in 2010. Almost 1,500 industrial engineers were added between 2010 and 2014. Employment in life and physical science jobs has grown 18.4 percent, adding 3,800 jobs.

## Projected Growth

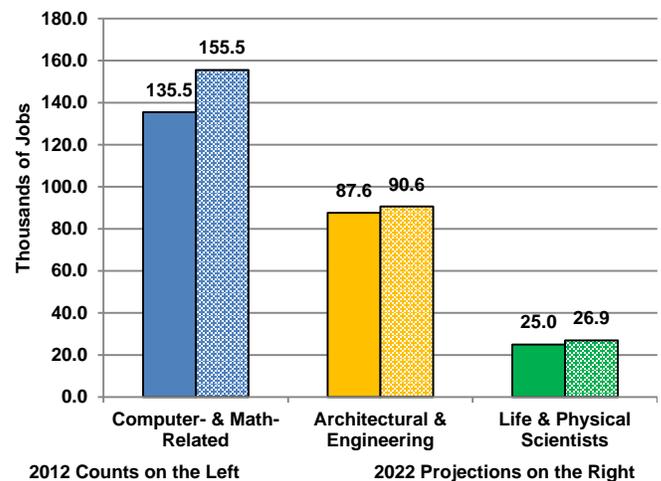
- High-tech jobs may rise 10.0 percent from 248,090 in 2012 to 272,970 by 2022 – a prediction from the Ohio Dept. of Job and Family Services' Labor Market Information division (ODJFS/LMI).<sup>2</sup> By comparison, the total number of jobs in Ohio is forecast to rise 8.3 percent.
- Computer- and math-related jobs may rise 14.7 percent from 135,540 to 155,480. Within this category, growth may be driven by the addition of systems analysts, software developers, user support specialists, and network and systems administrators – each of these five occupations is growing at an even faster rate and adding from 1,100 to more than 6,000 jobs. All 15 occupations in this category are predicted to add jobs.
- Life and physical science jobs may rise 7.8 percent from over 24,970 to 26,910. Biological technicians may lead this growth, adding the largest number of jobs and at one of the fastest rate among the 27 occupations in this category.
- Architectural and engineering jobs may rise 3.4 percent from 87,580 to 90,580. 21 of the 32 occupations are expected to gain jobs, led by civil engineers.

## Recent Trends in “High-Tech” Occupations



Source: U.S. Bureau of Labor Statistics<sup>2</sup>

## Projected Growth of “High-Tech” Occupations



Source: ODJFS/LMI<sup>2</sup>

## “High Tech” Occupations Forecast to Add 1,000 or More Jobs by 2022

Specific Occupation	Predicted Job Gains
Computer Systems Analyst	5,910
Applications Software Developer	4,720
Computer Support Specialist	3,340
Network & Computer Systems Administrator	1,460
Civil Engineers	1,170

Source: ODJFS/LMI

Notes: 1 – The rapidly developing nature of computer-related work and associated reconceptualization make additional specific comparisons difficult; 2 – U.S. BLS and ODJFS/LMI figures for 2012 differ due to the time lengths – one month vs. one year, respectively – and perhaps other methodological differences; 3 – Excluding epidemiologists.

## 2014 Employment in "High-Tech" Industries\*

NAICS Code	Industry Name	Jobs in Ohio	Jobs in U.S.	Ohio as Percent of U.S.
-----	Total	5,183,462	136,613,609	3.79%
	Levels 1-3 combined:*	299,655	9,170,466	3.27%
	Level 1 Summary*	171,390	6,326,274	2.71%
3254	Pharmaceutical & medicine mfg.	4,984	280,079	1.78%
3341	Computer & peripheral eqpt. mfg.	1,344	158,558	0.85%
3342	Communications eqpt. mfg.	1,318	93,813	1.40%
3344	Semiconductor & other electronic component mfg.	6,179	368,202	1.60%
3345	Navigational, measuring, electro-medical & control instruments mfg.	10,078	390,014	2.58%
3364	Aerospace products & parts mfg.	16,597	486,689	3.41%
5112	Software publishers	5,494	310,902	1.77%
5179	Other telecommunications	2,746	82,152	3.34%
5182	Data processing, hosting & related services	5,710	276,843	2.06%
51913	Internet publishing & broadcasting & web search portals	4,781	161,289	2.96%
54131	Architectural services	4,906	166,225	2.95%
54132	Landscape architectural services	427	32,411	1.32%
54133	Engineering services	26,270	914,596	2.87%
	<b>54134 Drafting services</b>	<b>403</b>	<b>8,232</b>	<b>4.90%</b>
54136	Geophysical surveying & mapping services	315	18,792	1.68%
54137	Other surveying & mapping services	1,081	45,082	2.40%
54138	Testing laboratories	6,228	168,224	3.70%
5415	Computer systems design & related services	56,264	1,787,874	3.15%
54171	R & D in physical, engineering and life sciences	16,265	576,297	2.82%
	<b>Level 2 Summary*</b>	<b>46,081</b>	<b>1,139,806</b>	<b>4.04%</b>
2111	Oil & gas extraction	2,325	196,704	1.18%
2211	Electric power generation, transmission & distribution	12,997	389,879	3.33%
	<b>3251 Basic chemical mfg.</b>	<b>9,332</b>	<b>144,519</b>	<b>6.46%</b>
	<b>3252 Resin, synthetic rubber &amp; fibers &amp; filaments mfg.</b>	<b>5,840</b>	<b>92,795</b>	<b>6.29%</b>
	<b>3332 Industrial machinery mfg.</b>	<b>9,635</b>	<b>109,133</b>	<b>8.83%</b>
	<b>3333 Commercial &amp; service industry machinery mfg.</b>	<b>3,660</b>	<b>86,794</b>	<b>4.22%</b>
3343	Audio & video eqpt. mfg.	185	19,767	0.94%
3346	Mfg. & reproducing magnetic & optical media	283	17,095	1.65%
54162	Environmental consulting	1,824	83,120	2.19%
	<b>Level 3 Summary*</b>	<b>82,206</b>	<b>1,704,386</b>	<b>4.82%</b>
32411	Petroleum refineries	2,180	69,261	3.15%
	<b>3253 Pesticide, fertilizer &amp; other agricultural chemical mfg.</b>	<b>2,037</b>	<b>36,730</b>	<b>5.55%</b>
	<b>3255 Paint, coating &amp; adhesive mfg.</b>	<b>7,804</b>	<b>59,854</b>	<b>13.04%</b>
	<b>3259 Other chemical product &amp; preparation mfg.</b>	<b>5,043</b>	<b>82,264</b>	<b>6.13%</b>
	<b>3336 Engine, turbine &amp; power transmission eqpt. mfg.</b>	<b>4,432</b>	<b>99,375</b>	<b>4.46%</b>
	<b>3339 Other general purpose machinery mfg.</b>	<b>24,260</b>	<b>263,327</b>	<b>9.21%</b>
	<b>3353 Electrical eqpt. mfg.</b>	<b>8,480</b>	<b>143,572</b>	<b>5.91%</b>
3369	Other transportation eqpt. mfg.	850	32,297	2.63%
	<b>4861 Pipeline transportation of crude oil</b>	<b>555</b>	<b>10,708</b>	<b>5.18%</b>
4862	Pipeline transportation of natural gas	345	28,242	1.22%
4869	Other pipeline transportation	259	7,923	3.27%
5171	Wired telecommunications carriers	19,810	604,275	3.28%
5172	Wireless telecommunications carriers (exc. satellite)	3,043	155,471	1.96%
5174	Satellite telecommunications	57	9,078	0.63%
8112	Electronic & precision eqpt. repair & maintenance	3,051	102,009	2.99%

Sources: the U.S. Bureau of Labor Statistics data bases for current figures, industry definitions drawn from Daniel F. Heckler's "High-technology employment: a NAICS-based update," *Monthly Labor Review*, July 2005, pp. 57-72.

Notes: \* - "High-tech" industries are defined by their greater reliance on science- and technology-oriented employees engaging in research, developing new products and processes based on the research, or applying and maintaining new technologies. In Level 1 industries, the proportion of such employees is at least 5.0 times the overall average of 4.9 percent; i.e., such employees held about 25 percent or more of industry jobs. Level 2 industries have 3.0 to 4.9 times the overall proportion of those employees (about 14.8 to 24.7 percent), while Level 3 industries have 2.0 to 2.9 times the average (or 9.8 to 14.7 percent). **Bold type** – the industry is concentrated in Ohio; i.e., the proportion of national industry jobs found in Ohio is greater than the overall average of 3.79 percent. Abbreviations: eqpt. – equipment; exc. – except; mfg. – manufacturing; NAICS – the 2007 North American Industry Classification System; R & D – research and development.