

University Research In Ohio

Question: What is the research productivity of Ohio's research-oriented universities and what are their plans to enhance their research productivity and increase their commercialization activities?

Why ask about research productivity of universities? The research conducted at our universities not only provides the new knowledge so critical to industrial growth, it also prepares individuals to work productively—and to compete effectively—in an economy that places a premium on high-quality human resources. Technology transfer from university to industry is most often achieved by the influx of students from the university to the work force. More recently, universities have expanded their role in economic development by providing intellectual capital, library resources, and sharing common use scientific equipment. Responding to these opportunities, many industries have located around universities in business incubators, research parks, and separate facilities. The surrounding industries can provide contract teachers, internships, and employment opportunities for students and graduates. Thus, universities can serve as "epicenters" of teaching, research, and economic activity.

Statewide Strategies: Research-oriented universities in Ohio and the Ohio Board of Regents have collaborated on developing programs that allow each university to build on its own unique strengths and, at the same time, stimulate projects that enhance partnerships among universities and between industry and universities. These efforts began with the Selective Excellence Program that was approved by the Ohio General Assembly in 1985. At that time, the General Assembly recognized the importance of university research to the economic well-being of the state, as well as the contributions universities made to the quality of life of its citizens. Recognizing that in an era of rapid technological change, knowledge expansion, and the need for effective communications in a global society, investment in university research is even more critical than in 1985.

As delineated in last year's progress report, OBR, working with the research universities in the state, had developed **The Ohio Plan**. This research strategy emphasized the need for a major investment by the state to develop world-class research facilities and enhance the state's commercialization efforts of the resulting knowledge and technology. In February 2002, Governor Taft introduced the **Third Frontier Project**, a ten year \$1.6 billion plan to strengthen Ohio's economy, which is designed to be the successor to **The Ohio Plan**, and which includes many of its elements. The similarities include a focus on creating high value jobs through increased applied research and commercialization of new technologies, and the creation of a substantial State capital financial commitment, although the financing is now based on future possible bond funding. The investments in research and technologies originally envisioned in **The Ohio Plan** are represented in the **Third Frontier Project** in the development of **Wright Centers of Innovation**.

How does the state support research programs of universities? Recognizing the importance of investments in university research to the state, the Ohio General Assembly has initiated and continued three major research support programs. These programs are the **Action Fund**, the **Hayes Investment Fund**, and the **Research Challenge Program**. The vast majority of funding for research is provided by the federal government and by industry. In light of this, the state has adopted the strategy of utilizing its research grant programs as vehicles for leveraging federal funds, identifying and building areas of unique strength with the potential for national competitiveness, and stimulating partnerships among Ohio universities and industries.

The **Action Fund** provides matching capital funds for external research opportunities. The **Hayes Investment Fund** offers collaborative opportunities to university researchers by providing grant support for capital equipment and/or facilities to inter-institutional research consortia. Awards in the form of interest-free loans are available for non-collaborative research. The **Research Challenge Program** is performance funding that provides support for new initiatives through lump sum allocations made to universities on the basis of past success in attracting external research support. Together, these three direct research support programs, along with the indirect and/or partially supported programs delineated below, provide a synergistic approach to the enhancement of university research in the State of Ohio. The **Third Frontier Project** will provide additional funding to further enhance university research while also providing significant linkages with Ohio's existing and emerging industry base.

In addition to the direct research support programs, several other OBR programs indirectly or partially support the university research efforts. The **Ohio Supercomputer Center**, partially funded by OBR, is a research resource for all Ohio university faculty and students who require such computational power for their research activities. The **Ohio Aerospace Institute** is also partially funded by OBR and brings all of the engineering colleges together with Wright Patterson Air Force Base (WPAFB) and the NASA Glenn Research Center to address aerospace-related problems. As a result of the recent review of all doctoral programs, a **Priorities in Graduate Education** fund was established to enhance those programs where Ohio is under-invested. The five engineering schools in relative proximity to WPAFB have formed the **Dayton Area Graduate Studies Institute** to better focus their graduate level engineering education and research efforts. Finally, the doctoral subsidy that OBR provides to all universities with programs at this level provides partial funding for faculty and graduate student research efforts.

Statewide Results: Since 1985 Ohio's doctorate universities have (see tables for complete details):

- Increased their annual research funding base by a factor of 3.46, increasing total research expenditures from \$261M to \$913M, a rate of growth 18.6% above the national average;
- Increased federal research support by 207.7 %, a rate of increase 10.5% above the national average;
- Increased industrial-supported research expenditures 412.3%, a rate of increase 42.6% above the national average; and
- Leveraged OBR's research investment by a factor of more than 12 to 1.

The increase in market share of both federal and industrial research by Ohio's universities as evidenced by the per capita data, as well as the leveraging of Ohio's research investment through the OBR's programs, has indeed been significant. However, the goal of continuing the rate of growth in externally-funded research and continuing to improve the quality of our research efforts will become increasingly difficult to achieve in future years. Decreasing resources on the federal level are apt to make it even more challenging to obtain federal research funding. Likewise, an increasing number of researchers competing for available funding, both from federal and industrial sources, will create a research environment that is even more competitive than in the past. Ohio's universities are still below the national average in federal support, which constitutes about 80% of the total external research support nationwide to all universities. Initiatives now underway by a number of other states will also have an impact on Ohio's ability to compete for these external research dollars.

In addition to the increase in external support for the faculty and graduate student research efforts, Ohio's research universities have been actively transferring the knowledge generated to the industrial and business community. According to the Association of University Technology Managers Licensing Survey results and data provided by the universities, during the six most recent fiscal years for which data is available (FY 1997, 98, 99, 2000, 01, 02), Ohio's universities have:

- Received 2040 invention disclosures from faculty and graduate students;
- Filed 1095 patent applications from faculty and graduate students;
- Executed 373 license and option agreements with industry and business;
- Been granted 569 patents; and
- Formed 59 start-up companies.

The rate at which these technology transfer activities are occurring is increasing, as in the most recent two fiscal years (FY 2001 & 02), the universities received 815 invention disclosures, filed 446 patent applications, executed 138 license and option agreements, had 193 patents issued to them, and formed 31 start-up companies. ***Particularly impressive is the fact that in the past two fiscal years the number of start-up companies formed from research and technology activities initiated at our universities was more than double the number formed in the previous four fiscal years.***

What is the future for research at Ohio's universities? The **Wright Centers of Innovation** are proposed to be a collaboration among Ohio business and industry, Ohio's higher education and non-profit research institutions, and the State of Ohio to pursue tightly focused, innovative, research-based economic development opportunities. The Centers will be encouraged to include the entire spectrum of activities including research, technology development, product development, and commercialization. The development of a technologically adept workforce will be an important associated consideration, though it will not be directly funded through the Wright Centers of Innovation program. Economic development is a crucial issue for Ohio and, therefore, it is the **Vision for the Wright Centers of Innovation to:**

Increase the success of business and industry already in the state and strengthen the ability to attract and grow new industries and jobs in Ohio. This will be accomplished by concentrating investments on Ohio's current and emerging research strengths in those major categories of technology with the highest commercialization and development potential.

The Centers will work in partnership with industry. Business will help develop the concept for the Centers and provide financial sponsorship. The private sector will be critical in identifying and pursuing commercialization opportunities and advising on which areas of research have the greatest potential for commercialization. Investments will be made in programs that can demonstrate scientific and technological excellence, potential to commercialize research findings, and an ability to leverage significant non-state research support. Collaborative endeavors among the universities will be strongly encouraged.

In a recent Battelle study five areas of research were identified as "core technology and research strengths" in not only universities in the state but also in federal research laboratories and both public and private research organizations located throughout the state. By concentrating funding for the **Wright Centers of Innovation** in these five focus areas the state will be building upon existing areas of strength and greatly enhance the chances of success. The areas of core technology and research strengths identified in the Battelle report and to be used as the focus areas for the **Wright Centers of Innovation** are:

• **Advanced materials:** The development of new classes of materials with unusual properties (e.g., strength, wear characteristics, and electromagnetic properties) is expected to open up a broad range of opportunities, including new product development, research leading to next-generation machines, improvements in product performance and cost, and waste-free products. The typical research activities include the processing of metals, ceramics, polymers and composite materials.

• **Biosciences:** The advent of biotechnology over the past 20 years has revolutionized biomedical and agricultural research, enabling the use of detailed information about the operations of cells and molecules to pursue more focused interventions on disease processes. One key aspect to the continuing advancement of the biosciences is its strong technology convergence with fields such as information technology, chemistry, nanotechnology, MEMS, and other engineering disciplines.

• **Instruments, controls, and electronics:** Major thrusts in the years ahead will be reconfigurable manufacturing systems involving adaptable, integrated equipment, processes, and systems, along with the ability to produce microdevices and undertake net shape forming and nanofabrication processes. Key advances will include novel design of machine tool components; reliable on-line, remote/wireless sensing techniques; enhanced metrology; and robust control technologies to improve the effectiveness and the responsiveness of the unit manufacturing processes. Key enabling technologies include robotics, MEMS, and advanced algorithm development.

• **Power and propulsion:** Power and propulsion systems are the basic drivers of the industrial age. But, this area is far from a relic of the past. From automobiles to aerospace to industrial combustion to device batteries, power and related propulsion systems remain critical technologies and continue to undergo significant advances.

• **Information technology:** The ability to collect, manage, process, interpret, present, deliver, and protect information in real-time involving large-scale data across distances and different media is

becoming a ubiquitous requirement for our society. Continued fundamental advances in research areas such as high-speed networking and large-scale data processing, data mining and data visualization, distributed computing, and software algorithm development for artificial intelligence and embedded systems are critical to ensure the benefits of our advancing information society.

These core research areas at our universities translate into technologies that can be applied, used, and developed by a broad range of Ohio's existing and emerging industries. Ohio's challenge is to improve its ability to develop, design, and manufacture, integrating the best of science into a new generation of advanced processes and products. The **Third Frontier Project** will provide the resources needed to begin the process to achieve this goal.

**Research Expenditures
(In Thousands)
Doctorate Universities
Fiscal Years 1985 and 2000**

	FISCAL YEAR 1985				FISCAL YEAR 2000			
	Total	Federal	Industry	Other	Total	Federal	Industry	Other
U.S. Total	\$9,532,977	\$5,970,230	\$550,863	\$3,011,884	\$29,596,635	\$17,199,786	\$2,145,038	\$10,251,811
% Increase since 1985					210.5%	188.1%	289.4%	240.4%
Ohio Total	\$261,448	\$161,058	\$17,048	\$83,342	\$913,839	\$495,520	\$87,337	\$330,982
% Increase since 1985					249.5%	207.7%	412.3%	297.1%
National Rank	9	9	10	N/A	10	10	8	N/A
Per-Capita Share Index	0.605	0.598	0.686	0.821	0.765	0.714	1.009	0.800
CAMPUS DATA								
Ohio State University	\$103,350	\$53,240	\$7,140	\$42,970	\$361,399	\$132,219	\$57,075	\$172,105
% Increase since 1985					249.7%	148.3%	699.4%	300.5%
National Rank	23	31	20	N/A	19	40	6	N/A
Case Western Reserve	\$51,598	\$42,182	\$2,408	\$7,008	\$193,057	\$150,586	\$5,890	\$36,581
% Increase since 1985					274.2%	257.0%	144.6%	422.0%
National Rank	62	42	70	N/A	50	31	97	N/A
University of Cincinnati	\$42,709	\$24,924	\$1,880	\$15,905	\$172,085	\$110,475	\$5,166	\$56,444
% Increase since 1985					302.9%	343.2%	174.8%	254.9%
National Rank	80	74	87	N/A	59	47	107	N/A
University of Dayton	\$25,005	\$21,272	\$2,556	\$1,177	\$39,345	\$31,717	\$5,598	\$2,030
% Increase since 1985					57.3%	49.1%	119.0%	72.5%
National Rank	107	81	65	N/A	148	120	101	N/A
Wright State University	\$8,263	\$2,956	\$1,077	\$4,230	\$29,092	\$12,543	\$2,968	\$13,581
% Increase since 1985					252.1%	324.3%	175.6%	221.1%
National Rank	161	187	123	N/A	168	184	145	N/A
Ohio University	\$5,811	\$2,295	\$180	\$3,336	\$23,767	\$11,695	\$1,591	\$10,481
% Increase since 1985					309.0%	409.6%	783.9%	214.2%
National Rank	186	197	211	N/A	185	192	184	N/A
Kent State University	\$3,855	\$2,225	\$63	\$1,567	\$10,817	\$7,736	\$708	\$2,373
% Increase since 1985					180.6%	247.7%	1023.8%	51.4%
National Rank	206	199	234	N/A	229	221	227	N/A
Medical College of Ohio	\$6,886	\$5,145	\$0	\$1,741	\$13,747	\$9,944	\$309	\$3,494
% Increase since 1985					99.6%	93.3%	N/A	100.7%
National Rank	175	161	N/A	N/A	218	204	275	N/A
University of Toledo	\$1,790	\$1,005	\$100	\$685	\$13,694	\$6,312	\$2,013	\$5,369
% Increase since 1985					665.0%	528.1%	1913.0%	683.8%
National Rank	235	226	225	N/A	220	237	170	N/A
University of Akron	\$3,596	\$1,350	\$1,056	\$1,190	\$19,495	\$7,081	\$3,090	\$9,324
% Increase since 1985					442.1%	424.5%	192.6%	683.5%
National Rank	211	215	126	N/A	197	230	141	N/A
Cleveland State Univ.	\$3,788	\$1,498	\$235	\$2,055	\$10,214	\$3,318	\$969	\$5,927
% Increase since 1985					169.6%	121.5%	312.3%	188.4%
National Rank	209	212	197	N/A	235	275	211	N/A
Miami University	\$1,684	\$945	\$167	\$572	\$10,674	\$2,674	\$1,663	\$6,337
% Increase since 1985					533.8%	183.0%	895.8%	1007.9%
National Rank	239	230	212	N/A	231	294	181	N/A
Bowling Green State U.	\$1,763	\$1,060	\$186	\$517	\$3,454	\$1,847	\$273	\$1,334
% Increase since 1985					95.9%	74.2%	46.8%	158.0%
National Rank	236	222	209	N/A	312	323	282	N/A
NEOUCOM	\$1,062	\$673	\$0	\$389	\$4,011	\$2,002	\$22	\$1,987
% Increase since 1985					277.7%	197.5%	N/A	410.8%
National Rank	258	239	N/A	N/A	304	317	394	N/A

NOTE: Individual universities **National Rank** is for all universities and colleges, not only doctorate universities.

Technology Transfer and Commercialization Activities Ohio Universities FY 1997- 2002

Institution	Invention Disclosures Received	Total U.S. Patent Applications Filed	Licenses & Options Executed	Gross License Income Received	U.S. Patents Issued	Start-up Companies Formed
Ohio State University	576	232	134	\$9,719,090	139	19
Case Western University	365	238	35	\$8,209,925	110	5
University of Cincinnati	377	189	68	\$26,442,109	71	13
University of Dayton	121	51	9	\$3,440,010	39	3
Wright State University	47	17	32	\$629,503	5	1
Ohio University	103	49	10	\$1,561,833	27	4
Kent State University	64	61	24	\$1,763,909	28	6
Medical College of Ohio	45	25	11	\$2,215,057	22	0
University of Akron	166	122	21	\$1,449,859	60	3
University of Toledo	91	63	12	\$143,388	37	1
Northeastern Ohio University College of Medicine	28	22	12	\$429,730	13	1
Miami University	13	11	1	\$16,000	10	0
Cleveland State University	31	11	4	\$106,976	6	3
Bowling Green State University	13	4	0	0	2	0

Source: The Association of University Technology Managers, Inc., 1997, 1998, 1999 and 2000 Licensing Surveys and university provided data.