University Research In Ohio

Question: What is the research productivity of Ohio's research-oriented universities?

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.

National Answers: Prior to 1985, when the first state efforts to enhance research were initiated, Ohio universities' share of federal- and industry-funded research was extremely low and declining. Since 1985 Ohio universities have increased their share both of federal and industry supported research (for federal supported research from 40% below the national average to 27% below the national average and for industry-funded research from 30% below national average to 3% below national average).

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, OBR, working with the research universities in the state, has recently developed **The Ohio Plan**.

The programs developed have five major objectives, consistent with the key characteristics of *focus, synergy, connecting research to commercialization, and alignment of available state-wide resources* as stated in **The Ohio Plan**:

- To strengthen the ability of Ohio's universities to attract sponsored research dollars;
- To encourage collaborative research through centers which address research questions from multi-disciplinary perspectives;
- To enable universities to use these added resources to conduct research likely to have an impact on Ohio's economy and/or quality of life of its citizens and to foster development in research areas that are critical to the economy of the future;
- To attract the highest quality, most productive faculty and students to Ohio universities and to stimulate a research environment within the university community that enhances the quality of faculty scholarship, graduate and undergraduate education; and
- To develop collaborative research relationships with Ohio companies and federal laboratories and/or to provide the research impetus for new business start-ups.

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.

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. The **Eminent Scholars Program** was reinstated in FY 2001 to assist universities in attracting additional outstanding scholars and researchers. 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 Answers: Since 1985 Ohio universities have:

- More than tripled their annual research funding base, increasing total research expenditures from $261M to $826M, a rate of growth 18% above the national average;
- Increased federal research support by 193%, a rate of increase 18% above the national average;
- Increased industrial-supported research expenditures 371%, a rate of increase 40% 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 three most recent fiscal years for which data is available (FY 1997, 98, 99), Ohio's universities have:

- Received 865 invention disclosures from faculty and graduate students;
- Filed 451 patent applications;
- Executed 174 license and option agreements with industry and business;
- Been granted 267 patents; and
- Formed 19 start-up companies.

What is the future for research at Ohio's universities? Ohio's investment in university research has been used to support research projects in many different disciplines, with each university focusing on areas in which it has unique capabilities. Despite this variation, there appears to be a clustering of projects in five different research areas, each of which are supportive of one or more of the focus areas of **The Ohio Plan** of nanotechnology, biotechnology, and information technology. These research areas are:

- *Biotechnology, bioengineering, and medical sciences;*
- *Manufacturing;*
- *Materials;*
- *Information sciences; and*
- *Environmental sciences.*

These research areas were classified according to the nature of the skills and problems involved in their development, and not by their possible application to various technology areas. Most applications in today's rapidly changing technological world require input from most, if not all, of these research areas. For example, applications to nanotechnology requires input from manufacturing and materials, while biotechnology applications would require input from all five research areas. Examples of efforts underway in each of these areas follow.

Biotechnology, Bioengineering, and Medical Sciences: Extensive resources exist at Ohio universities in diversified fields that are important not only to the control and eradication of diseases (human, animal, and plant) and illnesses, but also to the development of technologies to better understand, measure, and further investigate these maladies. OBR programs have supported a collaborative center involving three universities that focuses on research in gene structure analysis, transgenic bioreactors, and structural biology. Other multi-institutional centers are directed toward the study of cardiovascular materials and the investigation of medical imaging techniques, analyses, and uses. There are major research efforts in drug design, functional genomics and proteomics, bioinformatics, computational biology, tissue engineering, and gene therapy. A research center was recently funded by OBR that will study the application of microelectromechanical (MEMS) technology to medical therapeutic devices. Significant bioengineering research initiatives are underway at a number of Ohio universities that support research in a wide range of areas that utilize engineering concepts to address biomedical problems and vice versa, including functional electrical stimulation, bio-microelectromechanical (Bio-MEMS) systems, and human workplace performance.

Manufacturing: The importance of manufacturing to many Ohio companies has led to the development of numerous research and training programs at Ohio universities, many in conjunction with the Edison Centers. Areas included in these programs are simulation and analysis of manufacturing systems; dynamic mechanical systems, with a special focus on the automotive and aviation industries; ergonomics; flow and thermal analysis; and safety and rehabilitation. A major center, funded in part by OBR, focuses on MEMS systems. In addition to studying new microfabrication and nanotechnology fabrication techniques for the development of nanoscale sensors, transducers and drivers, the center also provides companies across the state with new technologies to use in their manufacturing processes. This center involves the majority of research universities in the state in addition to the two major federal government research centers in Ohio. Other multi-university research centers involve studies to improve rapid prototyping processes; to develop novel microfabrication methods for non-silicon medical devices; to study micromachining technology in analytical chemistry; to develop of advanced instrumentation for machinery acoustics and vibration research; and net shape manufacturing.

Materials: The need for new and better materials in the development of almost all current and new technological areas is a continuing quest. Ohio's universities and OBR have concentrated a large portion of their resources on developing and maintaining significant expertise in this area. An excellent example is the field of polymers, where Ohio has recognized expertise and capabilities in their design and application. The use of polymers in composite materials for the automotive and aviation industries, for improvements in roadways and bridges, as well as for nanoscale polymer platforms for electronics, are some of the focus areas of researchers at Ohio universities. Liquid crystal research in one Ohio university center is now being directed toward nano-fabrication technology using liquid crystals as templates, optical communications and computing, as well as investigating their interactions with biomolecules for the purpose of amplifying and quantifying biological events. The specialties of the university material research centers that OBR has helped to fund in recent years include: sharing advanced items of equipment, improving material characterizations techniques; the

study of surface engineering using polymers as surface modifiers; development and study of nanostructured materials; and the development of materials with unique conductivity characteristics for specialized applications.
Information Sciences: Specific research expertise exists at Ohio universities in human-computer interactions, database systems, modeling, simulation, the use of distributed computing to solve complicated scientific problems, the development of algorithms for compression and transmission of large image databases, networking technologies, virtual environment technology, and computer-aided VLSI digital design. A bioinformatics initiative at several universities will position these universities to be a major resource for the molecular description of normal and abnormal development and numerous pathogenic processes. A Geographic Information Systems Network established by a consortium of universities enables them to assemble and manage spatially referenced data to address environmental monitoring and management issues. Of particular interest is the development of computer aided "D-to-D" (data to decision) systems which provide the basis for new integrated approaches to mapping and urban monitoring. An Asynchronous Transfer Mode Technology Center was funded by OBR to study and test the networking research problems that need to be solved in routing, congestion control, circuit allocation and management, and performance evaluation. This technology is gaining popularity for telecommunications and computer networking due to its capability to provide high-bandwidth data transfer in real time.

Environmental Sciences: An OBR Investment Fund award helped to establish a Bioprocessing Research Consortium to address environmental waste problems associated with agriculture, industrial, food, paper, and chemical products. Research activities are directed at developing value-added products from agricultural commodities and industrial byproducts, waste treatment, environmental bioremediation, and efforts to develop and commercialize innovative bioprocessing technologies. Other ongoing research efforts are investigating air quality issues such as: particle formation, growth, dynamics, and transport in various industrial and environmental systems, with a focus on fundamental processes that are important for pollution control and risk assessment analysis. Other programs are studying the role of gene-environment interactions in the etiology of complex human diseases such as diabetes, stroke, obesity, and lung cancer. Research in water quality processes has focal areas in biofilm-based wastewater treatment processes and transport mechanisms in biofilms and chemical transformations of toxic pollutants such as trace metals and pesticides in the aquatic environment. Another research center focuses on developing clean coal technologies for use by Ohio's energy producers.

Campus Answers: Research-oriented universities vary in their research productivity.

Research Expenditures
(In Thousands)
Doctorate Universities
Fiscal Years 1985 and 1999

		FISCAL YEAR 1985				FISCAL YEAR 1999		
	Total	Federal	Industry	Other	Total	Federal	Industry	Other
U.S. Total	$9,539,438	$5,975,503	$551,255	$3,012,680	$26,947,465	$15,732,045	$2,012,658	$9,202,762
% Increase since 1985					182.5%	163.3%	265.1%	205.5%
Ohio Total	$261,448	$161,058	$17,048	$83,342	$826,336	$471,673	$80,319	$274,344
% Increase since 1985					216.1%	192.9%	371.1%	229.2%
National Rank	9	9	10	N/A	11	10	8	N/A
Per-Capita Share Index	0.605	0.598	0.686	0.821	0.743	0.726	0.967	0.712
CAMPUS DATA								
Ohio State University	$103,350	$53,240	$7,140	$42,970	$322,810	$135,216	$52,034	$135,560
% Increase since 1985					212.3%	154.0%	628.8%	215.5%
National Rank	23	31	20	N/A	19	34	5	N/A
Case Western Reserve	$51,598	$42,182	$2,408	$7,008	$182,332	$140,178	$6,157	$35,997
% Increase since 1985					253.4%	232.3%	155.7%	413.7%
National Rank	62	42	70	N/A	46	32	91	N/A
University of Cincinnati	$42,709	$24,924	$1,880	$15,905	$153,002	$100,325	$5,989	$46,688
% Increase since 1985					258.2%	302.5%	218.6%	193.5%
National Rank	80	74	87	N/A	61	50	93	N/A
University of Dayton	$25,005	$21,272	$2,556	$1,177	$36,937	$30,755	$4,454	$1,728
% Increase since 1985					47.7%	44.6%	74.3%	46.8%
National Rank	106	80	65	N/A	145	117	109	N/A
Wright State University	$8,263	$2,956	$1,077	$4,230	$23,131	$12,365	$1,717	$9,049
% Increase since 1985					179.9%	318.3%	59.4%	113.9%
National Rank	163	186	121	N/A	175	176	168	N/A
Ohio University	$5,811	$2,295	$180	$3,336	$21,437	$10,544	$2,843	$8,050
% Increase since 1985					268.9%	359.4%	1479.4%	141.3%
National Rank	183	196	207	N/A	185	187	138	N/A
Kent State University	$3,855	$2,225	$63	$1,567	$11,083	$8,212	$656	$2,215
% Increase since 1985					187.5%	269.1%	941.3%	41.4%
National Rank	203	198	232	N/A	219	203	219	N/A
Medical College of Ohio	$6,886	$5,145	$0	$1,741	$12,467	$9,219	$237	$3,011
% Increase since 1985					81.0%	79.2%	N/A	72.9%
National Rank	173	159	N/A	N/A	211	197	244	N/A
University of Toledo	$1,790	$1,005	$100	$685	$11,819	$5,682	$1,245	$4,892
% Increase since 1985					560.3%	465.4%	1145.0%	614.2%
National Rank	236	228	221	N/A	215	220	188	N/A
University of Akron	$3,596	$1,350	$1,056	$1,190	$16,279	$7,140	$2,150	$6,989
% Increase since 1985					352.7%	428.9%	103.6%	N/A
National Rank	207	216	124	N/A	197	211	157	N/A
Cleveland State Univ.	$3,788	$1,498	$235	$2,055	$11,893	$3,655	$1,448	$6,790
% Increase since 1985					214.0%	144.0%	516.2%	230.4%
National Rank	206	212	194	N/A	213	233	176	N/A
Miami University	$1,684	$945	$167	$572	$10,964	$3,302	$1,073	$6,589
% Increase since 1985					551.1%	249.4%	542.5%	N/A
National Rank	240	234	208	N/A	220	240	198	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%	N/A
National Rank	237	224	205	N/A	262	261	241	N/A
NEOUCOM	$1,062	$673	$0	$389	$3,389	$1,693	$43	$1,653
% Increase since 1985					219.1%	151.6%	N/A	324.9%
National Rank	260	243	N/A	N/A	263	264	268	N/A

Technology Transfer and Commercialization Activities Ohio Universities FY 1997- 99

Institution	Invention Disclosures Received	Total U.S. Patent Applications Filed	Licenses & Options Executed	Gross License Income Received	Licenses & Options Yielding License Income	U.S. Patents Issued	Start-up Companies Formed
Ohio State University	246	90	56	$5,617,204	90	69	2
Case Western University	153	85	23	$1,944,732	44	43	3
University of Cincinnati	137	95	30	$9,839,734	42	30	6
University of Dayton	60	26	6	$2,140,798	15	22	2
Wright State University	17	6	17	$324,268	31	5	0
Ohio University	45	25	4	$1,311,448	10	12	1
Kent State University	31	22	8	$813,561	18	10	1
Medical College of Ohio	18	12	2	$78,678	18	17	0
University of Akron	72	52	12	$569,331	40	26	1
University of Toledo	54	16	5	$62,799	14	14	0
Northeastern Ohio University College of Medicine	12	14	6	$354,730	6	10	1
Miami University	6	4	1	$4,000	1	4	0
Cleveland State University	14	4	4	$45,000	2	5	2

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