“Our faculty members are contributing new ideas and new technologies across a very wide spectrum of disciplines. This is the power of a major research university — creating an environment where people from many disciplines can work together to solve major problems.”

—Eva J. Pell, Vice President for Research, Dean of The Graduate School
Penn State faculty members continue to conduct significant research that not only advances knowledge but also serves the nation in important ways and helps improve the quality of life for all Americans. Penn State’s research expenditures increased once again in fiscal 2001 for major programs in life sciences; medicine; nanotechnology; materials engineering; defense; transportation; children, youth, and families; and other research areas which promise to make life better. If spending for research and creative activity from all sources of support are considered, including federal and Commonwealth funding, private industry, foundations, University infrastructure support, and institutional cost sharing, total expenditures for organized research at Penn State reached $472 million in fiscal 2001. The comparable figure for fiscal 2000 was $440 million.

In the most recent rankings compiled by the National Science Foundation, based on fiscal 2000 data, Penn State was 11th among all universities and 8th among public research universities in total research expenditures. The same analysis of all U.S. research universities ranked Penn State first in materials and metallurgical expenditures, third in psychology, third in engineering, fifth in chemistry, and eighth in agricultural sciences.

A hallmark of the Penn State approach to research is the integration of education, outreach, and research. Our outstanding faculty acquire research grants, then work with students, both graduate and undergraduate, to solve complex problems and translate the solutions into applications that will make life better — for, as is well known, universities are the major sources of the new knowledge that underlies novel commercial concepts, future products, and improved processes.

To maintain our preeminence as a research institution, we are finding new ways to provide faculty with resources to experiment with ideas. Our new Discovery Fund will give the University a major advantage in pursuit of developing research that will transfer to commercial applications. This philanthropic fund will provide resources to seed early stage research not yet competitive for external support, and gap funding to move research through a “proof of concept” phase to ready it for economic development.

“Our scientists and scholars are recognized nationally and internationally as some of the best in their fields. This leads to some very exciting and productive research collaborations.”

—Eva J. Pell, Vice President for Research, Dean of The Graduate School
The FY2001 figures show a more than 7 percent increase in total research expenditures, bolstered by a 9 percent increase for research funding from all external sources. Expenditures on grants and/or contracts from federal sources rose 9 percent with significant increases from several major federal sources:

- NASA funding increased 78%, exceeding $20 million
- U.S. Marine Corps support for the Marine Corps Research University, which is housed at Penn State, increased 83% to $5 million
- U.S. Department of Transportation support doubled to a total of nearly $4 million
- Office of Naval Research support for ARL was up nearly 8% to a new all-time high of $75 million
- U.S. Department of Agriculture support increased more than 6% to $4.7 million

Contrary research expenditures, conducted for Commonwealth of Pennsylvania agencies such as PennDOT, the Department of Environmental Protection, and the Pennsylvania Department of Agriculture, increased more than 20 percent. Research expenditures from all other external grants and contracts, such as industry projects, foundation grants, and subcontracts from other universities, increased more than 10 percent.

These figures include grants, contracts, and cooperative agreements from federal, state, industry, and other private sources; research appropriations from the federal government and the Commonwealth of Pennsylvania; and University research and infrastructure support. The totals include research expenditures for University institutes, consortia, and general research funds.
This year, the University restructured and expanded support for interdisciplinary research in five strategic areas: Life Sciences; Materials Research; the Environment; Children, Youth, and Families; and the newly established Social Science Research Institute. Working at the boundaries of traditional disciplines, these institutes and consortia serve as focal points for innovation and bring together faculty from every College. Together with our extensive research in defense programs, research executed within these Strategic Initiatives represents 58 percent of the University’s total research expenditures.

**STRATEGIC RESEARCH INITIATIVES**

Sponsored Funding and Consortium Support

- Environment $24M
- Materials $42M
- Social Sciences $20M
- Life Sciences $89M
- CYF $13M

These figures include only external restricted funds for research, as well as consortium, institute, and research support funds allocable to these initiatives. The figures do not include college general funds or government appropriations.

Contact: Robert McGrath, Associate Vice President for Research (814-863-9580; mcgrath@psu.edu; www.research.psu.edu/ir)

**APPLIED RESEARCH LABORATORY**

Penn State’s largest single research unit, with annual research expenditures in excess of $100 million provided primarily by the U.S. Navy, ARL is a university center of research excellence in naval sciences and technologies, with leadership in undersea missions and related areas. ARL provides technical innovations for national security, economic competitiveness, and quality of life. Core competencies include: acoustics, guidance and control, thermal energy systems, hydrodynamics, hydroacoustics, propulsor design, materials and manufacturing, navigation and Global Positioning Systems, communications and information, and graduate education. ARL supports approximately 200 students. In 2001, its faculty received three Navy Meritorious Civilian Service Awards.

**CHILDREN, YOUTH & FAMILIES CONSORTIUM**

The CYFC promotes research on critical social issues such as preventing health risk and behavior problems, improving family functioning, understanding and serving rural communities, and understanding and promoting the cognitive, social, and academic development of children. This year the CYFC provided financial support and many hours of consultation to a broad array of promising collaborative research projects, a number of which obtained significant external funding. Highlights include: examining how young children develop visual perception and use it to direct their motion and maintain postural stability (National Science Foundation); the conference “Youth Risk Reduction in South Africa: A Working Conference” (National Institute on Drug Abuse); and investigating youth involvement in self and community development in Chile (Fondo Nacional de Ciencia y Tecnología).

**FAMILIES**

Third in expenditures in the nation, Penn State’s psychology research program includes a study now in its ninth year designed to prevent conduct problems in adolescents by involving schools and parents working together to promote youth academic and social-emotional competencies. A sociology study on marital stability over the life course is one of the longest running national studies of marriage and the only such study containing detailed information on marital quality and interaction. This study has produced 57 scientific journal articles, five book chapters, and an award-winning book, *A Generation at Risk: Grow Up in an Era of Family Upheaval*. A major new study of child well-being and family functioning, Welfare, Children, and Families: A Three-City Study, is currently collecting data in Boston, Chicago, and San Antonio. This study is a multiuniversity effort involving collaboration with Johns Hopkins, Harvard, Northwestern, and Texas.

“Where lovers fitly matched be in mutual duties, they agree,” says the caption for this emblem in George Wither’s emblem book, printed in 1635. Other emblems appear on the cover. Courtesy Penn State Special Collections. The English Emblem Book Project of the University Libraries’ Electronic Text Center is making this older form of text available on the World Wide Web. According to the introduction on emblem.libraries.psu.edu, “An emblem book represents a particular kind of reading. Unlike today, the eye is not intended to move rapidly from page to page. The emblem is meant to arrest the sense, to lead into the text, to the richness of its associations.”
ENVIRONMENTAL CONSORTIUM

The EC is an emerging network of faculty who focus on problems of degraded air quality; loss of ecological diversity; global environmental change; environmental impacts on human, animal, and plant health; green engineering and industrial ecology; and management of water resources. Highlights include: an integrated assessment of the watersheds and estuaries across the Atlantic Slope from the Appalachian Mountains to the coastal beaches of the Mid-Atlantic states involving 15 Penn State researchers and five other organizations (USEPA, $6 million); modelling earth system history to better understand future global change (National Science Foundation, $2.4 million); investigating the physical and chemical forces behind how bacteria stick to surfaces (National Science Foundation, $2.55 million); a study of the role of peroxisome proliferator-activated receptors in skin cancer (National Institutes of Health, $869,000).

INSTITUTE FOR THE ARTS & HUMANITIES

The IAH fosters excellence in the arts and humanities by supporting individual projects, interdisciplinary groups, and planned programming such as lectures, symposia, conferences, exhibitions, and performances. Highlights this year include: Mellon Issues in Interpretation Seminar, which brought together advanced graduate students from a range of universities to explore traditional and revisionist approaches to medieval literature (Andrew W. Mellon Foundation); Art, Technology, and the Body Symposium: Performative Sites, with 50 artists and critical theorists of international renown and over 500 participants ($200,000 in internal and external grants); Critical Studies in the Arts Colloquium Series: “Writing Artists’ Lives: The Problem of Biography in the Non-Verbal Arts”;

LIFE SCIENCES CONSORTIUM

This year, research expenditures in the life sciences exceeded $89 million and encompassed work on diabetes, cancer, and other diseases; on the Penn State Artificial Heart; and on physiological factors affecting drug and alcohol addictions. Other highlights include: the five-year Floral Genome Project (National Science Foundation, $7.3 million), which brings together researchers from five universities to identify genes which control reproduction in 15 different flowering plants; and establishment of a new laboratory for developing transgenic strains of mice to study how groups of genes work in combination to control development, evolution, and disease (National Institutes of Health, $2 million). The LSC sponsors the competitive award of seed grants to encourage the exploration of innovative ideas and annually awards fellowships to more than 132 students. In 2001, construction of a new life sciences building began that will house interdisciplinary teaching and research activities. Five centers of research excellence were identified: Developmental Biology, Neurosciences, Plant Biology, Toxicology, and Carcinogenesis and Genomics.

MATERIALS RESEARCH INSTITUTE

This year the merging of the Materials Research Laboratory and the Materials Characterization Laboratory with MRI was completed: MRI now encompasses all of the University’s materials research community. Highlights include: establishment of the Materials Research Science Engineering Center on Collective Phenomena in Restricted Geometries (National Science Foundation); several research centers in nanoscience and technology, including Nanocell Approaches to Molecular Computing (Defense Advanced Research Projects Administration) and three separate Nanoscale Interdisciplinary Research Teams (NIRTs) on Artificially Engineered Nanoscale Ferroelectrics, Control of Nanostructures via Metal-Carbon Interactions over Multiple Length Scales, and Semiconductor Nanowires—Building Blocks for Nanoelectronics (National Science Foundation). As the only university to be awarded three separate NIRTs within the highly competitive NSF selection process, Penn State is clearly identified as a national leader in nanoscience and technology.

MARINE CORPS RESEARCH UNIVERSITY

The United States Marine Corps selected Penn State to be The Marine Corps Research University in 1999. The MCRU incurred research expenditures of $7.5 million during fiscal 2001. Highlights include: specialized research programs in signal intelligence, radio frequency propagation, and electronics for MC Expeditionary Forces; establishment of the Center for Protective Technologies to study the response of structures and structured materials to blast loadings; model development for MC Human Resource Development and Optimization; programs for the MC Family Advocacy and New Parent Support Programs; and, in one of the MCRU’s largest program areas, a multitude of Logistics Education and Training Programs are being provided to MC Base Commanders and operations support officers.

SOCIAL SCIENCE RESEARCH INSTITUTE

The SSRI was launched in July 2001 to promote communication and collaboration across the full range of social science disciplines and provide a shared infrastructure to conduct high-quality studies more economically. It is comprised of a number of research centers: The Population Research Institute, one of the foremost U.S. research and training programs in the population sciences; the Institute for Policy Research and Evaluation, a center of basic and applied interdisciplinary research involving the design, analysis, and evaluation of public policies and programs; and the Center for Health Care and Policy Research, which addresses the antecedents and consequences of the organization, delivery, and financing of health services. The SSRI also houses the newly created Survey Research Center, which advances research and training in survey methods and meets the need for state-of-the-art and comprehensive survey services to support social science research.
For faculty and students at Penn State, the opportunity to do relevant and applied research is central to the educational experience. Such research is also vital to our country’s economic health. Through the integrated efforts of the seven Technology Transfer units at Penn State, federal, state, private, and industrial funds are transformed into benefits for everyone.

For example, Advanced Interfaced Technologies (AIT), a growing technology start-up company, is pioneering a set of breakthrough Digital Active Sensing™ (DAS) technologies that allow novel and extremely effective ways to interact with computers. Although it seems difficult to replace the ubiquitous mouse and keyboard, AIT has identified specific situations in which it is possible to create a very high-bandwidth human-computer interface using DAS. An early example was the iMap system created by AIT’s founder, Rajeev Sharma of Penn State, in August 1999. This easy-to-use speech/gesture interface to a digital map attracted worldwide acclaim.

Another start-up company, Molecular Electronics Corporation (MEC), is developing polymer-based electronic components and devices and molecular electronic technology in which single molecules function as transistors. This new technology could dramatically increase transistor density in computers and other electronic devices, compared to the conventional silicon-based technology. MEC is based on intellectual property developed (and under development) by faculty at Yale University, Rice University, and Penn State.

Contact: Gary W. Weber, Assistant Vice President for Research (814-863-9580; gweber@psu.edu; www.techtransfer.psu.edu)

Pharmacologist Mark Kester has developed a way to use ceramide, a naturally occurring growth-arresting lipid, to prevent stenosis (narrowing) and restenosis (renarrowing) after vascular or surgical intervention in a blood vessel, such as occurs in routine balloon angioplasty. Since it was first performed in 1977, balloon angioplasty has become immensely popular. About a million coronary angioplasties are done in the U.S. each year, and another 500,000 elsewhere in the world. In most of those cases, the procedure saves patients from a far more serious step: open-chest surgery and heart bypass. But for 20 to 30 percent of angioplasty patients, restenosis is severe enough that a second procedure is required after only six months. When used to coat balloon catheters and stents, ceramide dramatically reduces the response of smooth muscle cells, whose growth can lead to the renarrowing of the artery. In experiments, restenosis in ceramide-treated arteries was decreased by over 90 percent. The findings were published in the cardiology journal *Circulation Research* in September 2000. This patent-pending Penn State technology has been exclusively licensed to MD3, a three-year-old medical device company with patented expandable stent technology, in return for royalties and equity in MD3. The company and Penn State believe that the two technologies are complementary.

### RESTENOSIS

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### INTELLECTUAL PROPERTY OFFICE

The IPO manages and commercializes the intellectual property developed at Penn State. It evaluates inventions for patentability and develops strategies to market them to industry.

The licensing of intellectual property (IP) has changed significantly with marked increases in the number of equity positions being taken. In the University’s history through 1999, three equity-based licenses were completed; in 2000 there were four, and in 2001 there were eight. The increased use of equity makes possible arrangements with small faculty-based, start-up companies that were impossible previously, and provides an approach for commercializing new technology that is not yet ready for adoption by larger companies. With this approach, technology that would have been lost is made useful for the citizens of the Commonwealth and the world.

To further engage the University community in the process, a committee comprised of the research deans of the major research colleges, at-large faculty, an external entrepreneur, and IP administrators now screens all unlicensed IP and determines where university resources should best be applied to optimize the commercialization of the technology. This approach has increased the percentage of IP patenting fees recovered by 35 percent along with improved participation and buy-in.

Additionally, the licensing officers have been focused into disciplines

### FY00 FY01

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<th>Invention Disclosures</th>
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<td>U.S. Patent Applications</td>
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<tr>
<td>Revenues</td>
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*Not included in FY01 revenue is the equity Penn State holds in ten start-up and established companies.
aligning with the research colleges to improve coupling with faculty, college administrators and continuity of knowledge and expertise.

**INDUSTRIAL RESEARCH OFFICE**

Penn State ranks fourth nationally in industrially-sponsored research funding. The IRO focuses on industries of significant importance to the Commonwealth. Through a collaboration with the Penn State Intellectual Property Office, the RCO helps Penn State faculty and administrators identify and secure sources of intellectual property. The RCO helps Penn State faculty and administrators improve coupling with faculty, college administrators and continuity of knowledge and expertise.

The RCO helps Penn State faculty and administrators, and potential management team members, giving companies specific and personal attention in order to determine where University resources might prove beneficial.

**RESEARCH COMMERCIALIZATION OFFICE**

The RCO helps Penn State faculty and staff create new companies based on University research and technologies. It works closely with Penn State’s Intellectual Property Office. The RCO can identify and secure sources of early stage capital, such as seed funding programs, angel investors, venture capital funds, etc., as well as mentors and potential management team members. Space for start-up companies is available in the Innovation Park at Penn State and in the Penn State Zetachron Center for Science and Technology Business Development, a gift of Dr. and Mrs. Wally Snipes and family.

Through a collaboration with the Chamber of Business and Industry of Centre County, seven start-up biotechnology companies are being incubated at Zetachron Center; each is based on research from University labs or is directed by a Penn State alumnus. They are: Mitotyping Technologies (Terry Melton), Centre Ingredient Technologies (Mohamad Farbood), Keystone Food Science (Fenjin He), EIERICO (Joe Duffey), Templar (Doug Gregor), ChiralQuest (Tim Hurley), and SaRonix (Sean Bietz).

**CHIRAL QUEST**

Chiral chemicals can exist in two forms, one the mirror image of the other, like a right hand and a left hand. That fact is one of the most challenging problems facing pharmaceutical companies today: Two thirds of the drugs now on the market are chiral drugs, which means that of their forms one is good, the others are often ineffective. Penn State chemist Xumu Zhang has developed asymmetric catalysts to synthesize only the preferred form of such chiral compounds. Several families of his catalysts, consisting of multiple invention disclosures and patent applications, were licensed in October 2000 to Chiral Quest LLC, a start-up company organized by Technology Assessment and Development, Inc., a State College, Pennsylvania, company. Penn State Research Foundation received equity in Chiral Quest. Development of the licensed asymmetric catalyst technologies will continue both in Zhang’s University laboratory and in Chiral Quest’s laboratory in the Zetachron Center. Chiral Quest intends to license this Penn State technology widely throughout the pharmaceutical, pharmaceutical intermediate, and catalyst industries.

**PENNSYLVANIA TECHNICAL ASSISTANCE PROGRAM**

PENNTAP helps Pennsylvania businesses improve their competitiveness by providing free technical assistance and information to help resolve specific technical questions or needs that can be addressed within a limited amount of time. PENNTAP serves every county in Pennsylvania with a network of technical specialists who have specific areas of technical expertise.

**SMALL BUSINESS DEVELOPMENT CENTER**

The Penn State SBDC is part of a national network of more than 950 centers, 16 of which are based at colleges and universities in the Commonwealth. Since 1999, MBA candidates working at the Penn State SBDC as part-time consultants have contributed more than 1500 hours of assistance to area small businesses. The Environmental Management Assistance Program, new in 2001, is one of six lead centers in the state. The Environmental Specialist covers 19 counties and three other SBDCs; in addition, three undergraduate students work on research related to clients’ environmental issues.

**BEN FRANKLIN TECHNOLOGY CENTER OF CENTRAL & NORTHERN PENNSYLVANIA**

The BFTC of Central and Northern Pennsylvania provides financial support, technology and management experience, and ways to link public, private, and educational resources to strengthen the high technology components of the state’s economy. It is one of four regional centers of the Commonwealth’s Ben Franklin Technology Development Authority. At the beginning of FY01, 31 research projects were funded with over $3.4 million in Ben Franklin funds and $14.2 million in private-sector cash and in-kind funds.

| 1985-2001 | Jobs Created | 6,315 |
| Jobs Retained | 4,478 |
| New Products | 327 |
| Processes Improved | 210 |

| FY01 | Industry R&D (Direct Involvement) | $3.1 M |
| Industry R&D (Facilitated) | $1.8 M |
| Fed/State Initiatives (Facilitated) | $4.0 M |

| FY01 | Cases of Technical Assistance | 560 |
| Clients’ Cost Savings | $2.3 M |
| Clients’ Increased Sales | $7.5 M |
| Clients’ Capital Investments | $1.4 M |
| Jobs Created/Retained | 35/210 |
| Client Satisfaction | 99% |

| 1997-2001 | Funding Secured | More than $9.4 M |
| Jobs Created | More than 500 |
| Persons/Hours of Training | More than 900/3000 |
| New Businesses Opened | Approximately 45 |
Innovation Park’s second privately developed, 40,000-square-foot multi-tenant building was constructed in 2001, bringing the amount of multi-tenant space to 90,000 sq. ft. and the total build-out in the Park to 440,000 sq. ft. The new facility is fully leased with tenants representing the electronics, communications, and engineering industries. SaRonix, an electronics firm headquartered in Silicon Valley, has opened an engineering design center there to take advantage of proximity to the Penn State Nano-fabrication Facility and to tap into Penn State’s expertise in electrical engineering and materials science. The Industrial Research Office helped SaRonix make valuable University links, while the Pittsburgh Digital Greenhouse provided resources to assist with the move to Pennsylvania.

Eight new tenants entered the Park last year, four in the business incubator and four in multi-tenant facilities. Real Time Devices, Inc. moved from the business incubator to expanded facilities at 103 Innovation Boulevard. For development of Phase 3, Innovation Park has joined with Innovation Capital Partners. Principals C. B. Richard Ellis and L. Robert Kimball and Associates bring expertise and experience in real estate, engineering, and architectural services that will enable ongoing development to meet tenant needs. ICP will break ground for a multi-tenant building in 2002.

Innovation Park partnered with the local economic development organization, the Centre for Business and Industry of Centre County, to develop a planned expansion of the Park’s Technology Center. The 22,000-square-foot addition to the facility will double the amount of business incubator space available for start up companies in the Centre Region. Another effort to support entrepreneurial development in the region led and sponsored by Innovation Park is the development of a local entrepreneur networking organization, the Centre County Technology Entrepreneur Roundtable.

During 2001, 39 percent of Innovation Park tenants used undergraduate student interns in their businesses and 20 percent worked with graduate students from across the University, including the College of Agricultural Sciences, the College of Arts and Architecture, the Smeal College of Business Administration, the College of Communications, the College of Earth and Mineral Sciences, the College of Education, the College of Engineering, the College of Health and Human Development, and the Eberly College of Science.

Innovation Park tenants hired 26 Penn State graduates. In addition, Park companies used University labs, licensed University intellectual property, and sponsored research projects. Over 90 percent of Park tenants used amenities in the Park, including the Penn Stater Conference Hotel and Daybridge Child Care Center, the Penn Stater conference facility, The Nanofab Facility and Materials Characterization Lab, and the Behavioral Endo Lab.

The National Science Foundation sponsored Regional Center for Manufacturing Education in Nanotechnology is a unique educational partnership. It provides students from all of the Pennsylvania community colleges and the State System of Higher Education Universities access to specialized course offerings and hands-on laboratory training within Penn State’s $25 million Nano-fabrication Facility. This educational partnership opens new job opportunities to students and provides the Commonwealth with a uniquely skilled workforce to support existing industry and attract additional high-tech companies to our region. Penn State’s excellence in nanoscience research, which forms the basis of pioneering innovations in ultra-small electronic components and medical sensors, is nationally recognized. This unique laboratory, one of only five such university facilities in the nation, was established as part of the NSF’s National NanoFabrication Users Network (NNUN) in 1995.

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