Competitive, balanced, interdisciplinary

By Henry C. Foley, Vice President for Research and Dean of the Graduate School

Three key words best describe Penn State’s research enterprise: competitive, balanced, and interdisciplinary. They set Penn State apart from its peers and form the core of our strategic approach to creating new knowledge. They help to ensure that this knowledge has relevance for solving some of the most pressing problems facing humankind.

**Competitive**
Research spending for a university can be compared to revenues for a business corporation. You’ll note in Figure 1 that Penn State’s overall expenditures have increased steadily over the past decade. The University has experienced, on average, a $33 million annual increase in total research and development (R&D) expenditures during that period—equivalent to growth at an annually compounded rate of about 5.9 percent.

Those numbers speak to Penn State’s ability to compete successfully for federal and private-sector dollars. Within the Commonwealth of Pennsylvania alone, the ability to
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compete for federal research funding is extremely important. For every $1 million that flows into Pennsylvania in support of research at our university, thirty-six jobs are created, and the ripple effect of that economic impact is vast. Penn State is an enormous economic engine that helps to drive the Commonwealth’s economic prosperity.

A resounding testament to the University’s success in competing for private-sector support is its consistent standing among the nation’s top universities in support from industry—among the top three in 2010, according to the National Science Foundation. Our partners range from large multinational corporations to small start-up companies.

Any mention of competitiveness should include Penn State’s winning the national competition for the U.S. Department of Energy’s Energy Innovation Hub initiative for energy-efficient buildings. Our proposal for the Greater Philadelphia Innovation Cluster for Energy-Efficient Buildings bested those by teams from California, New York, Massachusetts, and Texas. Penn State now leads a consortium of twenty-two public and private organizations that form the Greater Philadelphia Innovation Cluster. The cluster’s goal is to develop practical ways to reduce the annual national energy budget for buildings by 50 percent by the year 2020, and to establish a new industry for retrofitting older commercial buildings.

Overall, Penn State ranked ninth in the nation in total research and development expenditures from all sources, public and private—clear evidence of the University’s preeminence as one of America’s research powerhouses (see Figure 2). We would not have this enviable level of support, and we would not show the year-to-year increases in support that we consistently show, if we were not competitive.

**Balanced**

In contrast to some universities of similar size, no single funding source dominates research at Penn State. We do not have all our research eggs in one basket, so to speak.

As Figure 3 shows, the University’s research spending totaled $804.8 million for fiscal 2011. That sum includes $477.1 million from federal sources and $107.4 million from private industry. All of these totals are record highs. Penn State has the faculty expertise, infrastructure, and willingness to work with our partners in the public and private sectors to create a critical mass of resources for the public good. The

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**Figure 2**

**Research and Development Expenditures at Universities and Colleges**

**FY 2009, IN THOUSANDS OF DOLLARS**

<table>
<thead>
<tr>
<th>RANK</th>
<th>INSTITUTION</th>
<th>2008</th>
<th>2009</th>
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<tr>
<td>1.</td>
<td>Johns Hopkins University</td>
<td>1,680,927</td>
<td>1,856,270</td>
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<tr>
<td>2.</td>
<td>University of Michigan (all campuses)</td>
<td>876,390</td>
<td>1,007,198</td>
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<tr>
<td>3.</td>
<td>University of Wisconsin—Madison</td>
<td>881,177</td>
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<tr>
<td>4.</td>
<td>University of California, San Francisco</td>
<td>885,182</td>
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<tr>
<td>5.</td>
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<td>871,478</td>
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<td>842,027</td>
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<tr>
<td>7.</td>
<td>Duke University</td>
<td>766,906</td>
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<tr>
<td>8.</td>
<td>University of Washington</td>
<td>765,135</td>
<td>778,046</td>
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<tr>
<td>9.</td>
<td>Penn State (all campuses)</td>
<td>701,130</td>
<td>753,358</td>
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<tr>
<td>10.</td>
<td>University of Minnesota (all campuses)</td>
<td>682,662</td>
<td>740,980</td>
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**Figure 3**

**Research Expenditures by Source**

**FY 2011, TOTAL: $804,789,000**

1. Federal $477,086,000
2. University $142,351,000
3. Commonwealth of Pennsylvania $77,979,000
4. Industry and other $107,373,000
No single funding source dominates research at Penn State.

The diverse nature of our research pursuits means that our portfolio is well balanced, as illustrated in Figure 4.

Other measures indicate a careful balance as well. Considering federal funding exclusively, for example, combined support from the National Science Foundation and the National Institutes of Health in fiscal 2011 accounted for about 16 percent of our total expenditures. This past year Penn State strengthened its position as one of the nation’s elite medical enterprises by earning one of the highly coveted NIH Clinical and Translational Science Awards—a five-year, $27.3 million grant.

The Department of Defense accounted for 20 percent of our federal total for research and development projects, primarily at the Applied Research Laboratory and the Electro-Optics Center, which have long time working relationships with the U.S. Navy and Marines, CIA, FBI, and other government agencies.

Industry-sponsored research, which accounted for about 13 percent of our total R&D spending in fiscal 2011, is of course largely targeted toward specific applications. We work with private-sector partners to address some of our society’s most critical issues in health and medicine, energy and the environment, water, food, transportation, housing, and many other areas.

As a final measure of balance, consider that according to the most recently published NSF data, these fields at Penn State ranked among the nation’s top ten in total science and engineering (S&E) expenditures: chemical engineering, electrical engineering, materials engineering, atmospheric sciences, earth sciences, mathematics, computer science, agriculture, psychology, and sociology. And fields as varied as political science, astronomy, and chemistry missed the national top ten by just one notch.

Interdisciplinary

The interdisciplinary approach to research at Penn State is perhaps our greatest strength, and the characteristic that most distinguishes the University from other institutions. I’ve mentioned the Clinical and Translational Science Award and the Greater Philadelphia Innovation Cluster as examples of how Penn State competes successfully for research support. Both of these also are superb illustrations of the collaborative nature of our research enterprise, since they include faculty from across our traditional academic colleges.

The academic colleges represent the foundation of our knowledge within traditional disciplines. For more than a century, Penn State extended the frontiers of knowledge within these disciplines with great success; but at the same time, research became narrower and more specialized. A similar process was happening at universities throughout the nation.

Then in the mid-1980s, the National Science Foundation began to move away from funding discipline-specific research and toward supporting a more interdisciplinary approach.

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**Figure 4**

Expenditures on Organized Research

**BY UNIT FOR FISCAL YEAR 2010–2011**

**TOTAL EXPENDITURES: $804,789,000**

1. Agricultural Sciences 13%
2. Arts and Architecture, Business, Communications, Law, Nursing 1%
3. Defense-Related Research Units 22%
4. Earth and Mineral Sciences 9%
5. Education 3%
6. Engineering 14%
7. Health and Human Development 6%
8. Information Sciences and Technology 1%
9. Liberal Arts 4%
10. Medicine 12%
11. Eberly College of Science 13%
12. Other 2%
Other funding agencies followed suit. The administration at Penn State
quick to recognize this shift, began creating a number of new-prominent
research institutes and centers whose very existence depends upon collabo-
raration. Such entities as the Materials Research Institute, The Huck
Institutes of the Life Sciences, Social Science Research Institute, and Penn State
Institutes of Energy and the Environment have swept aside traditional (and often
rigid) disciplinary barriers and created new, flexible groupings of faculty and
student researchers based on task-specific problem solving.

The matrix in Figure 5 shows this at a glance. It identifies our major interdisci-
plinary research institutes and centers, and shows which of our academic
colleges participate in them. Historically, academic researchers shied away
from collaborative studies that might engage faculty from other disciplines.
Today, we at Penn State realize that real-world problems are complex and
the best solutions are those devised by a team whose members possess expertise
in any number of specialized subjects. That’s why interdisciplinary thinking
dominates our research and discovery processes University-wide.

Let’s look more closely at just one of our research portfolios: energy. It
includes faculty and students from the Colleges of Engineering, Earth and
Mineral Sciences, and Agricultural Sciences, engaged in areas that range
from fossil fuel combustion, to photo-voltaics and batteries, to biorenewable
fuels. It is not coincidental that a recent Thomson Reuters survey ranked
Penn State first among global universities over a ten-year period for citations
in energy and fuels. In addition, the U.S. Department of Energy recently
ranked Penn State ninth nationally in expenditures on energy-related
research.

What’s on the horizon? Many things, of course, but shale gas looms
particularly large because of its potential impact on millions of Americans
and especially on the citizens of the Commonwealth of Pennsylvania. Penn
State already is identifying the opportunities and the challenges presented
by the Marcellus Shale. Geographic information systems, geosciences, natural
gas engineering, economics, supply chain management, rural health, law,
environmental engineering, and the basic sciences all come into play. Penn
State researchers—faculty and students—are participating in all aspects.

We expect to push even further in bringing together various individuals
and units with specialized knowledge in a team approach to problems that
demand novel solutions.

Informing the learning experience
Penn State shapes and nurtures its research enterprise for the express pur-
pose of creating and disseminating new knowledge that will benefit the citizens
of the Commonwealth and the nation. The research and scholarly creativity
our faculty perform also inform the education that our students receive,
making the quality of that learning experience second to none. One might
say, in fact, that research is baked into the University’s DNA. It’s an integral
part of who we are at Penn State, and what we do.

Figure 5
Faculty Participation in Interdisciplinary Institutes by Academic College

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<th></th>
<th>Materials Research Institute</th>
<th>The Huck Institutes of the Life Sciences</th>
<th>Penn State Institutes of Energy and Environment</th>
<th>Social Science Research Institute</th>
<th>Institute for CyberScience</th>
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