



The Economic Value of Academic Research and Development in Wisconsin



GE Healthcare, Wauwatosa

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EXECUTIVE SUMMARY

Academic research and development is a \$1.1 billion industry in Wisconsin. It is driving the creation of thousands of jobs, directly and indirectly, and helping our core industries stay competitive in a changing world.

In 2007, the last year for which complete figures are available from the National Science Foundation and other sources, science and engineering research at Wisconsin's academic institutions totaled \$1.067 billion. Much of that research was clustered at the UW-Madison, one of the world's leading research universities, but more than \$200 million took place at private institutions and other UW System campuses.

Why is a state's academic R&D effort important? In the developing "knowledge economy," university research is a key component of entrepreneurial activity. Look at the nation's most vibrant technology hubs, and research universities are important drivers of technology creation and transfer.

- The North Carolina Research Triangle is fueled by Duke University, the University of North Carolina, and North Carolina State University.
- Silicon Valley benefits from the sophisticated science and technology developed at Stanford University, the University of California-San Francisco and the University of California-Berkeley.
- Boston has pre-eminent institutions such as Harvard, the Massachusetts Institute of Technology and Boston College to drive its entrepreneurial churn.

The same is true for Austin, Texas (University of Texas), Atlanta (Georgia Tech University) and, closer to home, Madison and the UW-Madison.

Wisconsin has many more universities, but they tend to be underutilized assets from the standpoint of research and development and technology transfer. Without a broader foundation in academic R&D, Wisconsin will find it difficult, if not impossible, to leverage these assets in pursuit of a robust, high-tech and knowledge-based economy for the 21st century.

Thanks to decades of investment in people and facilities, Wisconsin has developed a strong base for academic R&D, but now it's time to broaden that base. It won't be easy. There are forces at work that could erode Wisconsin's academic research advantage and threaten the state's ability to produce high-wage, private-sector jobs.

With sophisticated research at UW-Madison, Wisconsin receives a good share of federal funding for academic R&D. However, the corrosive force that threatens its standing is a 25-year trend toward weaker state support for higher education. In the past decade alone, state appropriations as a percentage of the total UW System annual budget have declined from 33.75 percent in 1997-98, when an \$880 million state appropriation was applied to \$2.6 billion UW System budget, to 24.21 percent in 2006-07, when a \$1.04 billion state allocation covered less than one-fourth of the \$4.3 billion UW System budget.



THE STATE OF ACADEMIC R&D IN WISCONSIN

In this study, the Wisconsin Technology Council has examined the state of academic R&D in Wisconsin, how much is being spent on such research, the sources of the funds, and the effect of academic R&D spending on the general economy. Among the highlights:

- Private and public academic research institutions in Wisconsin spent about \$1.067 billion on direct science and engineering research activities in the latest fiscal year for which complete records are available. That spending translated to 38,376 direct and indirect jobs, using generally accepted multiplier estimates of the U.S. Department of Commerce, Bureau of Economic Analysis (36 direct and indirect jobs for every \$1 million in R&D spending). The UW-Madison also received another \$72 million in non-science and engineering research dollars in FY2007, mainly in education, business and the humanities; the Commerce Department multiplier does not as easily translate to that R&D spending.
- If the jobs created by academic research spending in Wisconsin were reported as a separate category within the labor market statistics of the state Department of Workforce Development, it would represent a significant sector in its own right. For example, paper manufacturing employs 33,830 people in Wisconsin, printing 39,920, and plastics and rubber products 32,380.
- With academic R&D spending of \$1.067 billion from federal, state and private sources, Wisconsin ranks 13th among the 50 states, according to the National Science Foundation. Most of the UW-related R&D spending in science and engineering (\$840.7 million) took place on the UW-Madison campus. The state's per capita spending on academic R&D was \$283 in FY 2007, according to the State Higher Education Executive Officers organization. That was just above the U.S. per capita average of \$277.
- The \$1.067 billion S&E total also includes \$172 million in research spending by private institutions, such as the Medical College of Wisconsin, the Milwaukee School of Engineering, Marquette University, and Lawrence University. It does not include about \$42 million in S&E spending by the Marshfield Clinic and the Blood Center of Wisconsin's Blood Research Institute, as neither institution fits the NSF definition of an academic institution. However, both institutions work closely with such institutions.

Since FY 2002, the state's higher education effort, as measured in per FTE student, has been declining as well. With notable exceptions such as the Wisconsin Institutes for Discovery, which is under construction on the UW-Madison campus and promises to usher in a new era of scientific collaboration, the decline in public support has undermined the infrastructure that otherwise could have supported more broad-based academic research in Wisconsin.

This is happening at a time when Wisconsin's efforts to produce globally competitive goods and services is generating greater export activity, and when the state is striving to attract and retain knowledge-based workers. The retention issue is monumental in a state that invests heavily in K-12 education, only to see these "investments" leave after college graduation and contribute to the tax base of states such as California.

Unless the state stems the slide in higher education funding, it could become an also-ran in the knowledge economy, and it could weaken its ability to compete for merit-based federal research grants. Such grants typically go to states with state-of-the-art laboratories, well-compensated researchers, a healthy environment for scientific research, and a willingness to collaborate to leverage its intellectual and physical resources.



TomoTherapy, Madison

- Wisconsin fell just outside the top 20 states (23rd overall) with total R&D expenditures of \$3.8 billion. If not for Wisconsin's relatively high ranking in academic R&D, the state would slip out of the top half of all U.S. states in total research and development spending.

RECOMMENDED READING

This study contains recommendations to ramp up academic research and development, perhaps make it easier to translate the resulting university discoveries into entrepreneurial activity, and then help foster the growth of promising technology-based companies. They begin with a call for the Governor and the Legislature to use the 2009-2011 state budget bill to begin the process of restoring state support for UW System operations. Wisconsin faces a stiff budget challenge in the next biennium, as do most other states, but the erosion in the UW budget has been relatively steady for years and cannot continue if the state wants to advance its position in the knowledge-based "New Economy." Such investments pay dividends down the road, both for the economy and for state revenue coffers.

To drive more research on UW System campuses outside of Madison, the study also urges that the UW System, with the support of the Legislature, do more to free the time of hundreds of non-Madison campus professors who have the credentials and the desire to conduct high-level R&D. Specifically, more time should be freed for activities like grant writing and research, collecting preliminary data, managing a lab, and keeping up with new discoveries reported in scientific journals.

We also call on state and university policy makers to remove any impediments that prevent UW System professors from commercializing their discoveries. The Board of Regents should review conflict-of-interest rules that may slow or even prevent the transfer of technology from the laboratory to the marketplace. Faculty should be encouraged to pursue entrepreneurial ventures, collaborate with one another and with industry, commercialize research results, take part in the appropriate business plan contents, and pursue entrepreneurial ventures without penalty. So-called "safe harbor" agreements at other universities may serve as a model for reform in this area.

Wisconsin Technology Council presents these and many more policy ideas to elevate Wisconsin's standing, not only in academic R&D but also in the global economy.



ACADEMIC R&D

THE VALUE OF ACADEMIC RESEARCH IN WISCONSIN

Public and private academic research institutions in Wisconsin spent a combined \$1.066 billion on direct science and engineering research activities in fiscal year 2007, according to the latest figures from the National Science Foundation. Using generally accepted estimates of the U.S. Department of Commerce, Bureau of Economic Analysis (a conservative estimate of 36 direct and indirect jobs for every \$1 million in R&D spending), that spending translated into 38,376 jobs.

If the jobs created by academic research spending in Wisconsin were reported as a separate category within the labor market statistics of the state Department of Workforce Development, academic R&D would represent a significant industry sector in its own right. By way of comparison, paper manufacturing employs an estimated 33,830 people in Wisconsin; printing, 32,920; plastics and rubber products, 32,380; construction of buildings, 29,150; the federal government 29,100; real estate and rentals, 27,680; and wood product manufacturing, 23,790.

Within a total non-farm workforce of 2,882,500 (October 2008), Wisconsin's academic research sector would represent about 1.5 percent of the state's total workforce. Put another way, academic research would account for more jobs than could be filled by the civilian labor force in 48 of Wisconsin's 72 counties based on September 2008 employment figures, including: Chippewa County (county seat: Chippewa Falls), 33,527 workers; Columbia County

(Portage), 31,491 workers; and Waupaca County (Waupaca), 28,061 workers. Moreover, jobs created through academic research pay substantially more, on average, than the 2005 Wisconsin per capita personal income of \$33,278 per year.

(It is worth noting that in addition to its nearly \$841 million in science and engineering R&D, UW-Madison received \$72 million in R&D support in business, education and the humanities, ranking the school No. 1 in the nation for FY 2007.)

In an age when relentless innovation is identified as the best way for America to maintain a competitive edge in the global economy, and when "knowledge-based" industries are being developed to drive Wisconsin's economic growth, it is critical that state support is increased for the academic research conducted at various Wisconsin colleges and universities.

Universities and other research institutions with an academic focus are the engines of discovery and innovation in science, engineering, and computing technology, which fuels advances in agriculture, manufacturing, services, and other economic sectors. As this report demonstrates, the return on investment in academic research is high; continuing disinvestment on the part of state government could undermine Wisconsin's economic competitiveness.

WHAT IS A RESEARCH UNIVERSITY OR INSTITUTION?

Traditionally, a research institution was simply defined as an institution whose primary mission was to conduct research, train graduate students in how to conduct research, and (more recently) transfer the knowledge acquired through research to the marketplace.

In the past few years, another dimension - collaboration - has been added, and Wisconsin institutions have made a strategic decision to embrace it. Not just within their institutions - such as the anticipated collaborations across biology, computer science, and bioengineering at the Wisconsin Institutes of Discovery - but with colleagues in other research universities and in industry.

One of the best illustrations of this is the recent launch of the Wisconsin Genomics Initiative, a collaborative effort in personalized medicine involving the Marshfield Clinic, the University of Wisconsin-Madison, the Medical College of Wisconsin, and the University of Wisconsin-Milwaukee.

For several years, Wisconsin's best thought leaders have preached the value of leveraging the state's existing assets, and the Wisconsin Genomics Initiative is a perfect example. This exercise in collaboration will fuse the strengths of these four institutions, including Marshfield Clinic's "bio-bank," the largest collection of DNA samples in the nation. In all, 20,000 people have agreed to take part in a personalized medicine project, allowing the clinic to tap into medical data that dates back at an average of 29 years per patient. Combined with the clinic's well-established electronic medical records and its ability to mine data within its electronic records and its genetic database with analytical tools, and these capabilities form the basis of the genomics initiative.

Not to be outdone, UW-Madison offers expertise in regenerative medicine, stem-cell biology, and super computing power. The Medical College of Wisconsin brings the ability to analyze individual samples for specific disease traits, and UW-Milwaukee adds pieces like its new School of Public Health and the ability to reach a large urban population.

Paul DeLuca, associate dean for research and graduate programs at UW-Madison's School of Medicine and Public Health, said the genomics initiative would produce "a monstrous amount" of genomic and medical data that will be analyzed by computer scientists at the UW. The analysis could identify biomarkers that indicate susceptibility to conditions like heart disease.

The initiative marks the first time the state's four largest research institutions have worked together on a project of this magnitude, and it could be a sign of things to come - especially as federal granting agencies like the National Institutes of Health have begun to favor collaborative approaches when deciding which institutions receive grants.

The Wisconsin Genomics Initiative has the potential to put Wisconsin in the forefront of personalized medicine, which is defined as the ability of scientists and medical professionals to predict a person's propensity to develop a particular disease and tailor a preventive care plan to the individual. As a result, the project expects to compete for large federal grants that will fund the research and its applications.

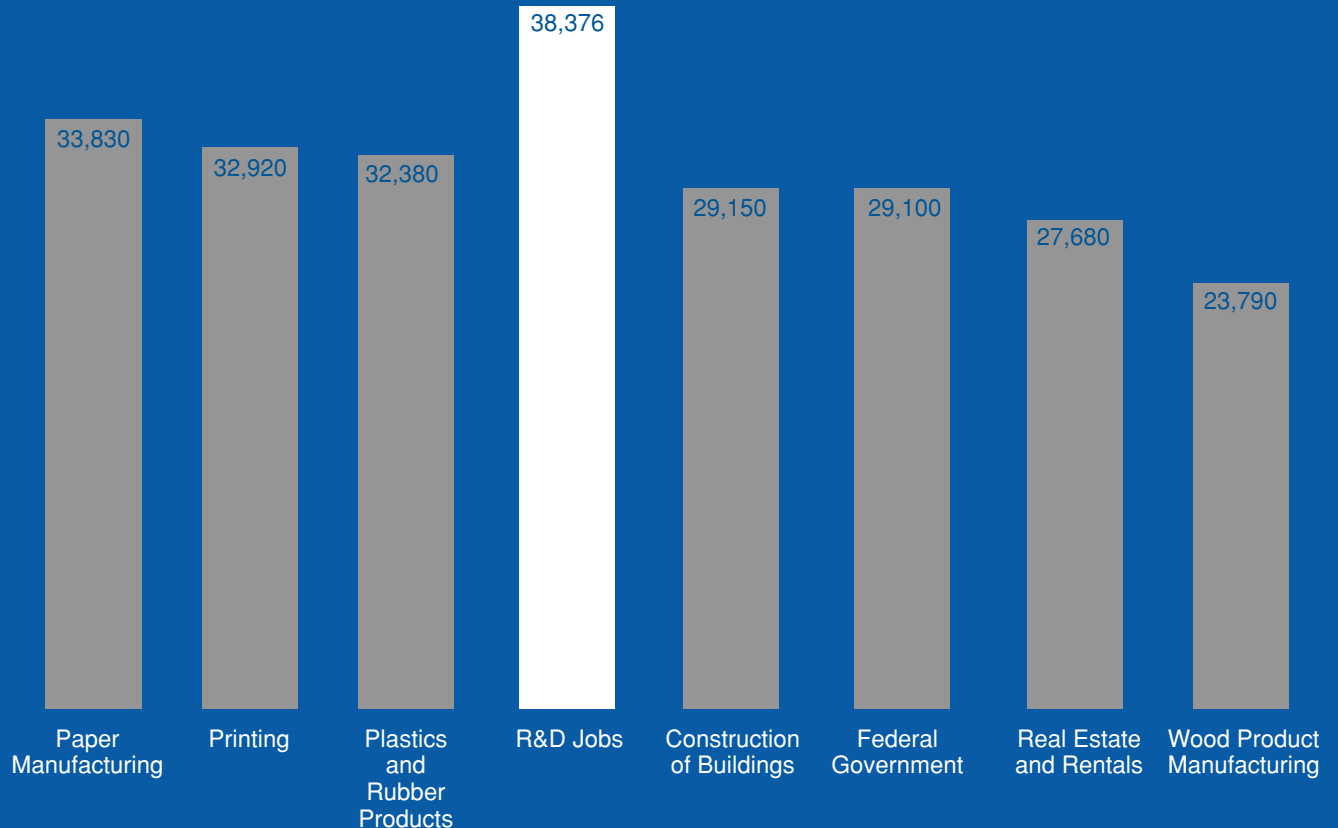
Dr. Elias Zerhouni, the outgoing director of the NIH, has described the initiative's proposal to NIH as "one of the very best in the world."

More than that, it demonstrates the potential value of R&D investment in Wisconsin.

Academic research accounted for more jobs than could be filled by the civilian workforce in 48 of Wisconsin's 72 counties, including Chippewa County, 33,527 workers; Columbia County, 31,491 workers; and Waupaca County, 28,061 workers.

Academic R&D jobs compared to other employment sectors*

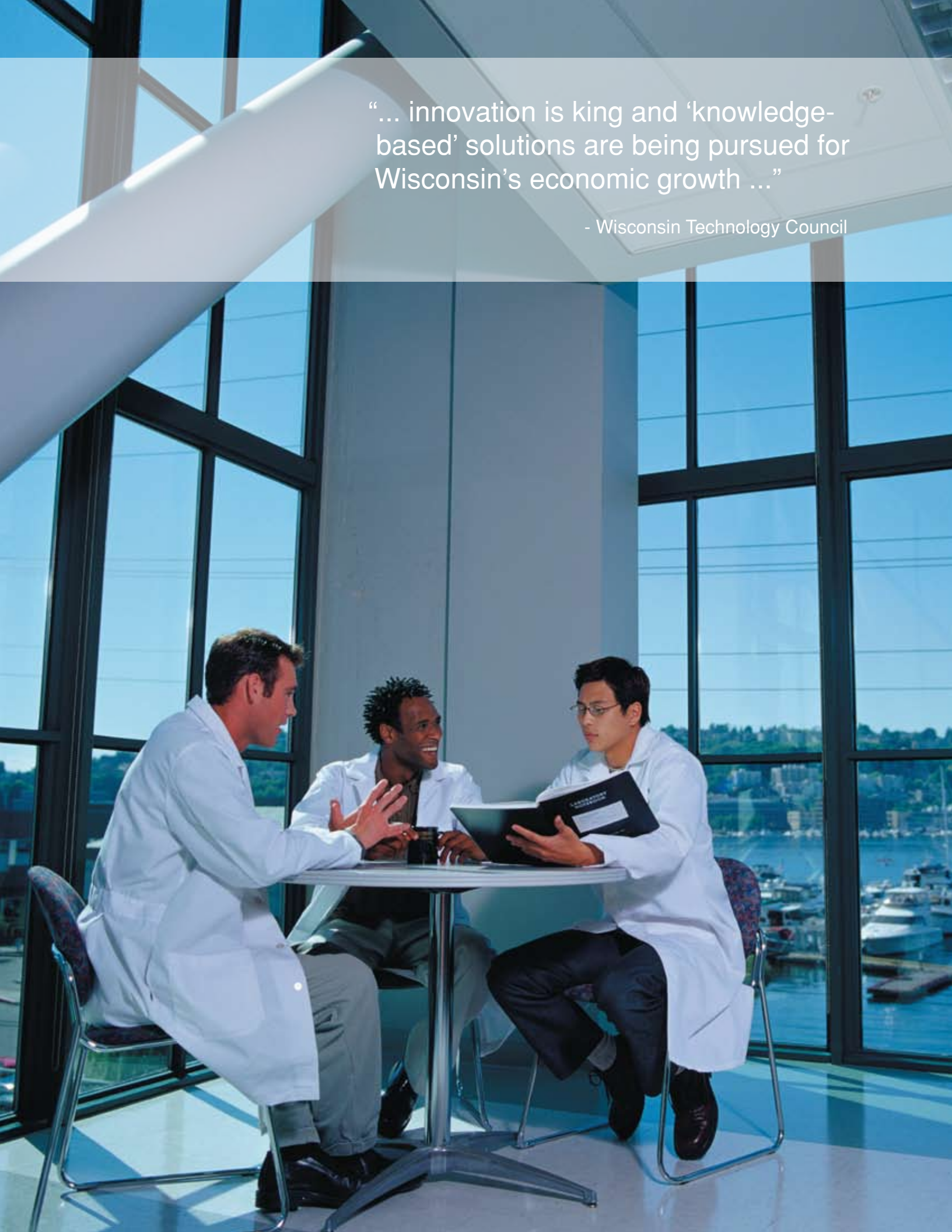
(In 1,000s of people)



*Estimates based on U.S. Commerce Department multiplier of 36 jobs created for every \$1 million in academic R&D spending.

“... innovation is king and ‘knowledge-based’ solutions are being pursued for Wisconsin’s economic growth ...”

- Wisconsin Technology Council



A BRIEF HISTORY OF ACADEMIC R&D

The concept of a research university was born in Germany in places such as the University of Göttingen, founded in 1737, and the University of Berlin, established in 1810.

In the United States, universities began to fulfill the research and development function in the late 1800s. The idea spread from Johns Hopkins University, which began in 1876 and remains a top grant-winning institution, and spread to Clark University in 1890, Stanford University in 1891, and the University of Chicago in 1892.

In Wisconsin, research has been conducted on the UW-Madison campus since the late 1800s. In 1900, the university was one of 14 founding members of the Association of American Universities; today, only 60 research universities qualify for membership in this organization.

While the United States has long enjoyed the tradition of public universities offering professional and classical education, the concept of also offering agricultural and technical education is newer. It didn't happen by accident. In 1863, President Lincoln signed the Morrill Act, creating a land grant system of universities to provide practical education in agriculture and engineering. The Hatch Act of 1887 established a network of federally funded agricultural experiment stations. Passage of the Smith-Lever Act in 1914 created the Cooperative Extension Service to work in partnership with universities. The "Extension," as it became known in Wisconsin and elsewhere, transferred knowledge from the laboratories of the university to the farm fields of America.

Today, about 250 U.S. universities consider themselves research universities, although the leading 100 research institutions account for about 70 percent of the research space and 80 percent of total research expenditures. The top 20 research universities – a category that includes UW-Madison – account for about one-third of total academic research expenditures in the U.S.

Wisconsin's comprehensive universities outside of Madison are among the 672 U.S. academic institutions that perform basic and applied research, and that number is increasing. In the developing knowledge-based society, universities have a growing role to play in creating, nurturing, and deploying intellectual capital, and taking one

additional step. The term "university technology transfer" refers to the commercialization of university discoveries and innovations. In the past quarter-century, such transfer has taken on increasing importance to the U.S. and Wisconsin economies.

Three factors have contributed to the recent rise of university tech transfer activity:

- The enactment of the federal Bayh-Dole Act in 1980 gave universities the right to claim title to inventions made during federally sponsored research. Before 1980, fewer than 250 patents were issued each year to universities, and many valuable discoveries languished "on the shelf." In FY 2006, that number had grown to 3,255 patents issued, according to the Association of University Technology Managers. In the same year, those universities filed 15,908 patents and reported 18,874 invention disclosures.
- The rise of biotechnology R&D and, more generally, research in the life sciences since the early 1980s also boosted the number of research universities with offices of technology licensing. Today, at least 70 percent of all license income earned by universities comes from the life sciences, with the remainder mainly from the physical sciences, including engineering. In Wisconsin, research involving human embryonic stem cells and induced pluripotent stem (iPS) cells provides an interesting case study, and has resulted in the development of Cellular Dynamics International, a promising Madison company that has a chance to advance the field of personalized medicine.
- State governments have joined the federal government and private industry in supporting R&D, increasingly providing financial support that can be used for capital investments, hiring "star" faculty, or engaging in partnerships with private institutions that might otherwise not be possible.

Given this rich history, it's essential that the state of Wisconsin begin to reverse the decline in funding support for academic research and development in its university system.

THE BAYH-DOLE ACT AND THE EXPANSION OF ACADEMIC R&D

Lame duck sessions of Congress are rarely noted for landmark legislation, but a bill passed by Congress following the 1980 presidential election proved to be the exception.

It has evolved into such an exception that it is credited with accelerating university technology transfer and for the development of technology industries in university communities such as Madison, Austin, Texas, and North Carolina's Research Triangle Park (Raleigh, Durham, and Chapel Hill.)

When the Bayh-Dole Act was passed, it certainly wasn't hailed as a game-changer, but it gave universities the right to patent their intellectual property and license it to companies for commercial development. In so doing, Bayh-Dole has been transformative.

THE VALUE OF ACADEMIC R&D

The act is named for its chief authors, former Indiana Sen. Birch Bayh, a Democrat, and former Kansas Sen. Robert Dole, a Republican. Since the passage of Bayh-Dole, federal support for academic research and development has risen from \$4.1 billion in fiscal year 1980 to \$30.4 billion in FY 2007, according to the National Science Foundation.

Before the law was enacted, many believe the United States was losing its technological edge. Since its passage, university research has produced thousands of inventions, including the nicotine patch, three-dimensional surgery technology, the Google search engine, the Citracal calcium supplement to help prevent osteoporosis in women, the TomoTherapy radiation therapy system, and Vitamin D metabolites and derivatives. The latter two should sound familiar to Wisconsin citizens – they are UW-Madison discoveries.

In 1990, Third Wave Technologies of Madison, which has developed a leading product to test for cervical cancer, became the first start-up company whose technology was patented and licensed by the Wisconsin Alumni Research Foundation, UW-Madison's licensing arm. There now are 60 start-up companies using technology licensed by WARF.

This continuing investment expands human knowledge, improves healthcare and quality of life, and helps educate the next generation of science and technology leaders, a process that is essential to the long-term economic and physical security of the United States.

It's important to note that new products and processes do not automatically arise from university research. Patents, licenses, development, capital, marketing, and manufacturing capacity are all required as well.

Collectively, that's called technology transfer. When Bayh-Dole was passed in 1980, there were 25 universities involved in technology transfer; now, there are more than 300.

Howard Bremer, who served as WARF's patent counsel at the time Bayh-Dole was enacted, traveled to Washington, D.C. on several occasions to testify on behalf of the bill. "The result of Bayh-Dole is that research at universities has been more fully transferred for the public's benefit," said Bremer, now counsel emeritus for WARF. "Without Bayh-Dole, this would not have happened in every instance."



UNIFORM POLICIES

Under federal law, as provided by the Bayh-Dole Act, non-profit organizations – including universities – may retain title to inventions created from research funding by the government. (The federal government also receives a non-exclusive, irrevocable license to the invention.)

Under Bayh-Dole, a university must do as follows:

- Disclose each new invention to the federal funding agency within two months of the inventor disclosing it to the university.
- Decide whether or not to retain title to the invention within two years.
- File a patent application within one year of electing to seek title.
- License the rights to innovations to industry for commercial development; small businesses receive preference.

In addition, universities must share with the inventor any income eventually derived from the patent. Any remaining income, after technology management expenses, must support scientific research or education.

A principal value of having universities retain control of patent rights is that it ensures that research findings remain available for further use in the classroom and laboratory.

Why does the government allow universities or their patent and license agencies to keep control of government-funded inventions? Doing so gives people and companies incentives to commercialize technology, which sparks innovation and yields other benefits for society.

In the 1960s and 70s, the pace of innovation was slow. Very little federally funded research was leading to commercial applications, mainly because there were no incentives for universities or researchers to find partners to do so.

Mainly, there were penalties. Tight restrictions on licensing, varying patenting policies among federal agencies, and the lack of exclusive manufacturing rights for government-owned patents made most companies shy away. By 1980, only 5 percent of government-owned patents resulted in new or improved products.

Bayh-Dole was passed to break the logjam. With the help of policies and procedures pioneered by Bremer and WARF, the act created a uniform government patent policy and allowed universities and other non-profit organizations (such as WARF) to retain title to federally-funded inventions and to work with companies on bringing them to market.

A cycle of research, tech transfer, and profit – which enabled additional investment in university research – was created. Universities now conduct roughly 60 percent of the basic research conducted in the United States.

Four years after the passage of Bayh-Dole, the one significant modification to the law was passed, as Congress allowed the granting of exclusive licenses for the full term of a patent. This further strengthened the law's impact by giving private-sector firms more incentive to invest in technology development.

TRUE TECHNOLOGY TRANSFER

The law is not without its critics, even in academia. Some believe Bayh-Dole makes no distinction between patentable discoveries that need further development to be useful, and research discoveries that can be put to use immediately for the benefit of scientific investigation. Since universities have the opportunity to file patent applications on basic research discoveries, the argument goes that this may actually hinder rather than promote biomedical research.

This would represent a minor tweaking of the law, but there is no hard empirical evidence to support this view – only anecdotal instances.

Another belief holds that if the government pays for the research, then government should own the patents, but that would eliminate the incentive for technology transfer.

As Bayh, himself, said during a 2006 visit to the UW-Madison campus, having government own the patents did not result in technology transfer that would benefit the public.

“That’s the problem that existed in 1976, 1978, when we started investigating and found that we had spent \$30 billion dollars to create 29,000 patents that were just sitting there gathering dust - with nobody benefiting from the expenditure of that \$30 billion,” he said.

An invention, Bayh noted, is not worth anything unless somebody develops it and brings it into your home or business. “That’s not going to happen,” he added, “unless the university or a small business is able to gain ownership and license it out to the industry.”

Perhaps the most serious threat to Bayh-Dole is attempts to weaken the patent system. Andy Cohn, manager of government and association relations for WARF, is concerned about various proposals to make patents more expensive to obtain, make it harder to legally challenge patent infringers, and limit damages that can be collected from infringers.

Cohn said the Federal Reserve Bank of Cleveland illustrated the connection between patents and economic development in a 2005 study. The study found that patents are the largest factor influencing the differences in income between states.

Cohn also noted that Bayh-Dole was passed at a time of economic distress, and should not be weakened now that the nation faces an even graver economic threat. “For Bayh-Dole to work as it has, we need to maintain a strong patent system,” he said. “In a terrible recession, one way to work our way out is to support innovation and support a strong patent system.”





“The driving force of economic growth is investment in human capital – skills and ideas – rather than investment in machines and buildings.”

- Researcher Steve Dorwick

MEASURING THE ECONOMIC IMPACT OF ACADEMIC R&D

Spurred on by Bayh-Dole and other trends and incentives, academic R&D continually is changing the landscape of the United States and the global economies. But how can we measure the economic effects of academic R&D in the university component of America's innovation ecosystem?

Since it was launched a decade ago, the annual Licensing Activity Survey of the Association of University Technology Managers (AUTM) has become a trusted and valued source for data on the transfer of academic research for commercial application.

The FY 2006 AUTM Licensing Activity Survey, the most recent year in which such figures are available, included 189 responding research institutions in the U.S. (universities, hospitals, and other institutions), and provides a compelling case for strong funding of academic research and technology transfer. The survey showed the following U.S.-only results.

- Total research support exceeded \$45.4 billion, a 6.8 percent increase over the 2005 total of \$42.3 billion – the largest absolute increase since 2003 (\$3.54 billion) and the third largest increase since 1997.
- Research support from federal sources totaled \$30.872 billion.
- Research support from industry sources totaled \$3.178 billion.
- Research support from all other sources, including foundations and state governments, totaled \$11.35 billion.
- 18,874 invention disclosures were reported, up 8.5 percent over FY 2005.
- 15,908 patent applications were filed, up 7.2 percent over FY 2005.
- 3,255 patents were issued, down 0.7 percent from FY 2005.
- 4,963 new licenses were signed.

- 12,672 income-yielding licenses were managed. (Each single license represents a one-on-one relationship between a company and a university, hospital, or research institution that earns income on products that benefit society).
- 697 new commercial products were launched in 2006 from active licenses, making it 4,350 new products introduced since FY 1998. That's the equivalent of nine products every week, or more than one per day (1.32) of each year.
- 553 new companies were established, which represents 2.2 new companies for every working day of the year. Since 1980, the year Bayh-Dole was passed, there have been 5,724 new spinouts linked to academic R&D – more than one company every two days during what AUTM called "9,498 days of innovation." As AUTM notes, each start-up is based on a platform of academic technology designed to address real market needs, and staffed by well-paid employees that return the favor by paying taxes to the local, state, and federal governments.
- Nearly 5,000 new relationships were formed by licensing agreements between companies and responding institutions; more than 550 start-ups are included in that number. Currently, there are 12,600 active relationships, reflected by licenses yield income rewarding students and faculty for their contributions to what AUTM calls "the supply chain of innovation."

In 2006, technology transfer enjoyed record staffing levels, with total employees in excess of 1,800, but these employees delivered a great deal of bureaucratic bang for the taxpayers' buck. The accomplishments listed above were achieved by offices with 3.5 LFTE as the median number of licensing personnel, and a total median office size of 6 FTE that manages intellectual property at U.S. institutions that generate more than \$45 billion of combined research.

In the AUTM report, the UW-Madison reported \$831.9 million in science and engineering research expenditures, with a cumulative 2004-06 total of \$2.4 billion and cumulative adjusted gross income ('04-'06) of \$138.8 million. Other FY 2006 UW-Madison metrics included:

- Licenses and options executed: 159
- Cumulative active licenses: 907
- Invention disclosures: 464
- U.S. patents issued: 69
- New patent applications: 203
- Start-ups: 7

RATE OF TECHNOLOGY TRANSFER

The fact that UW-Madison, which enjoys a lofty status in terms of academic R&D expenditures, produced only seven start-up companies in FY 2006 raises a concern about the rate of technology transfer in Wisconsin.

According to a 2006 study by the Milken Institute, the UW System ranks ninth among the top universities worldwide in biotechnology patents, but ranks lower in transferring that technology to commercial applications. In terms of the ability to transfer intellectual property into commercial uses, the study of nearly 500 universities worldwide said the UW System and WARF ranked 22nd, behind the Big Ten universities of Minnesota, Michigan, and Illinois. The Massachusetts Institute of Technology ranked first in technology transfer.

There are two diametrically opposed beliefs about Wisconsin's inability to transfer more research to the market. One holds that university conflict of interest management procedures are fairly draconian, and they place a mental block in the way of faculty who might otherwise try to market technology.

Bill Gregory, a professor of electrical engineering at UW-Milwaukee and chief science officer for NovaScan, a medical technology company spun out of university, serves on the Wisconsin Technology Council. The Tech Council has recommended that the Wisconsin Board of Regents conduct a review of conflict of interest rules that may impede UW System professors from commercializing their discoveries.

"It's not just a conflict of interest, there also is a community of interest," Gregory said. "What we're urging is not any specific changes in statutes at this point. What we're urging is that the statutes be re-examined."



The other view, held by WARF managing director Carl Gulbrandsen, is that there are more layers of review elsewhere, including California. In 2008, he told the Wisconsin Technology Network that California scientists have to clear two regulatory hurdles to commercialize their work: first, rules imposed by their respective universities; second, another set of state rules established as part of Proposition 71, which is the ballot measure that established the California Institute for Regenerative Medicine to fund stem cell research with \$6 billion in principle and interest on general obligation bonds.

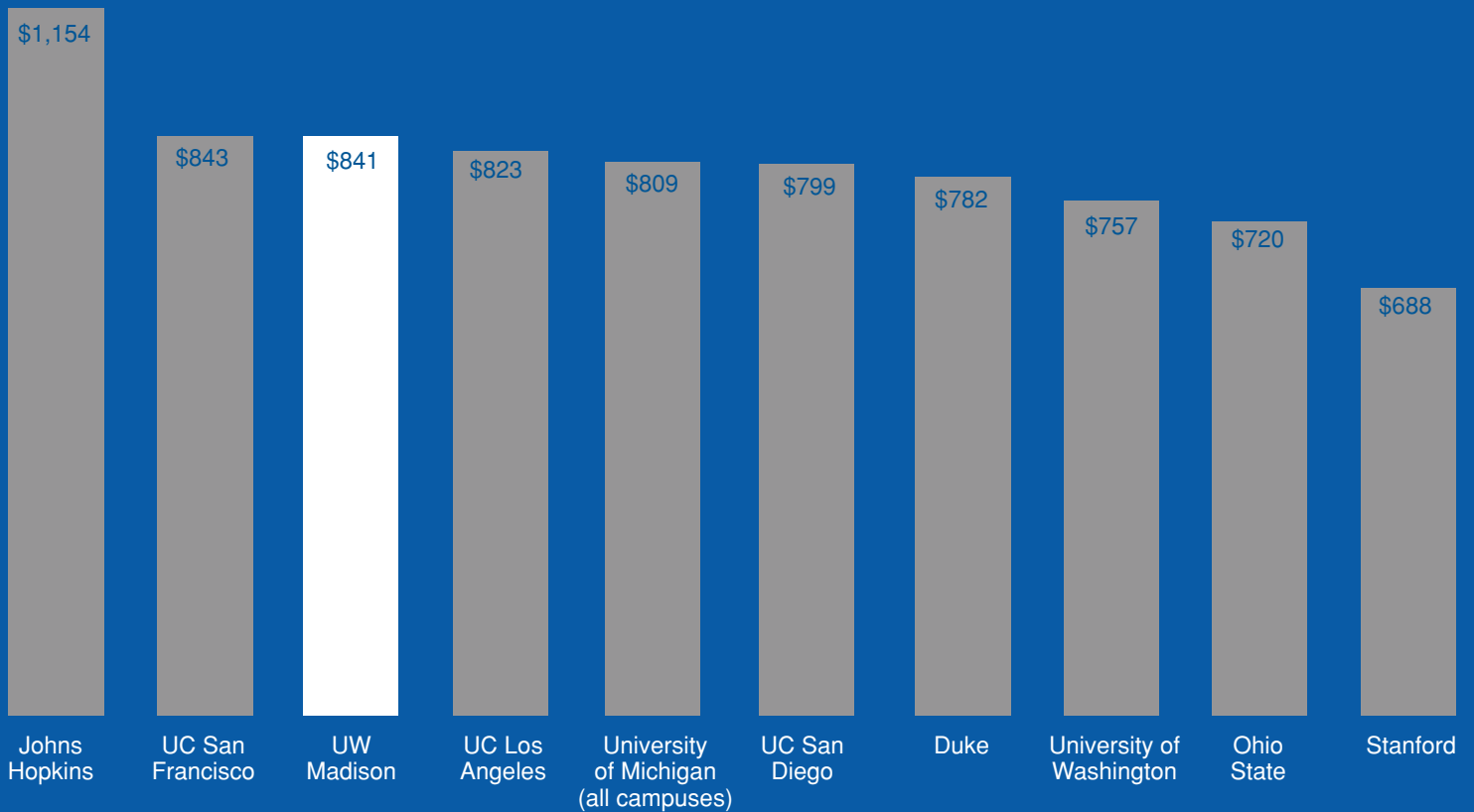
UW-Madison scientists only have to go through the university, not the state as well, Gulbrandsen noted.

Wherever the truth lies, it would be worthwhile for the Board of Regents to conduct the aforementioned review of conflict of interest rules, or otherwise make efforts to clear up any misunderstandings or misconceptions that research professors may have.

Gregory provided another reason to boost the formation and survival of high-tech start-ups. He said the mechanism that larger companies use to acquire new technology is changing. Rather than license raw technology out of the lab, more companies are looking for verification that a commercial market really exists, and that often requires a start-up company to "make a go of it," he indicated.

Top 10 Institutions in Science and Engineering Fields

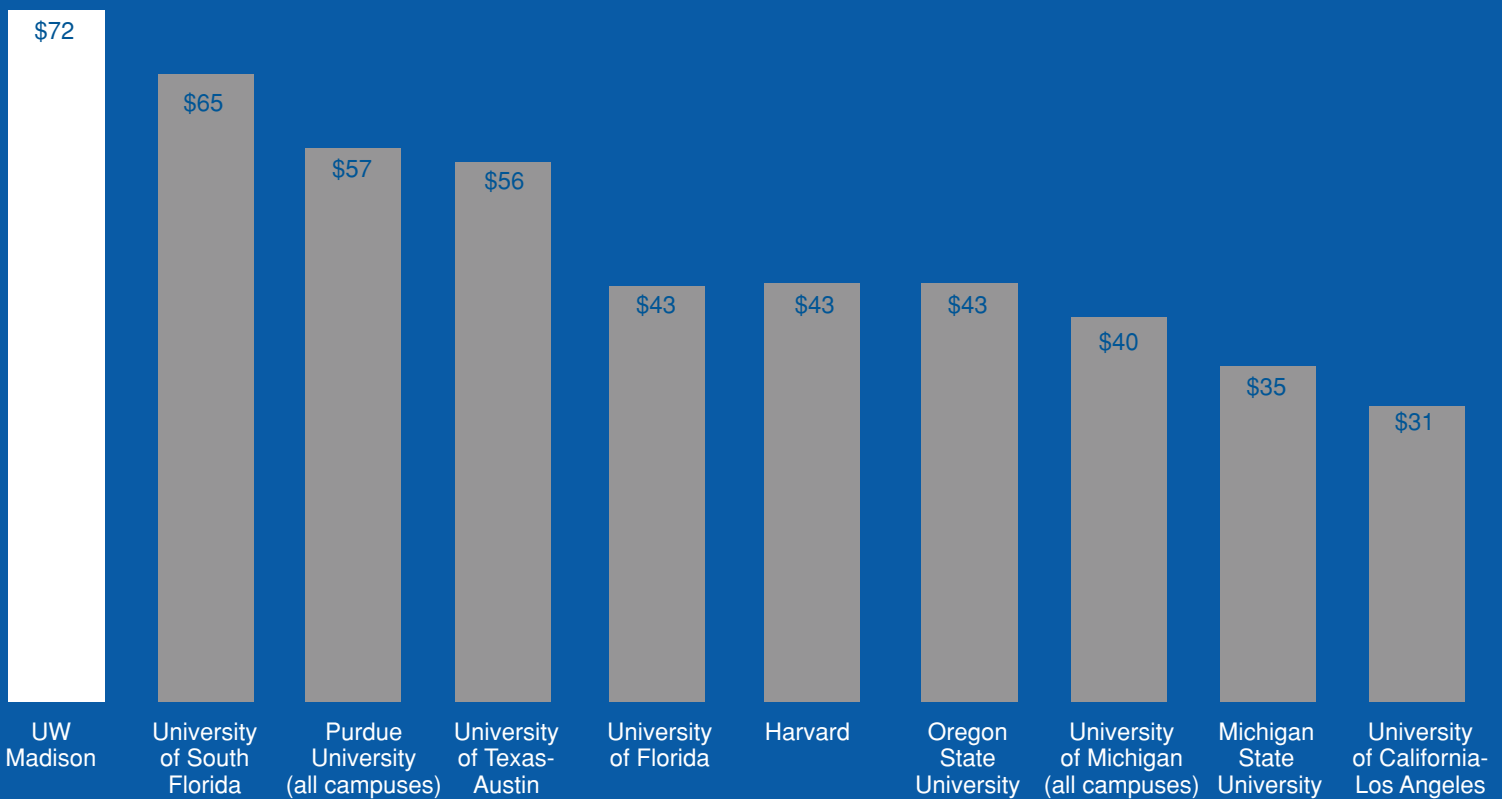
Millions of current dollars



Total Science and Engineering Fields: \$49.4 billion at 672 institutions
Source: National Science Foundation

Top 10 Institutions in Non-Science and Engineering Fields

Millions of current dollars

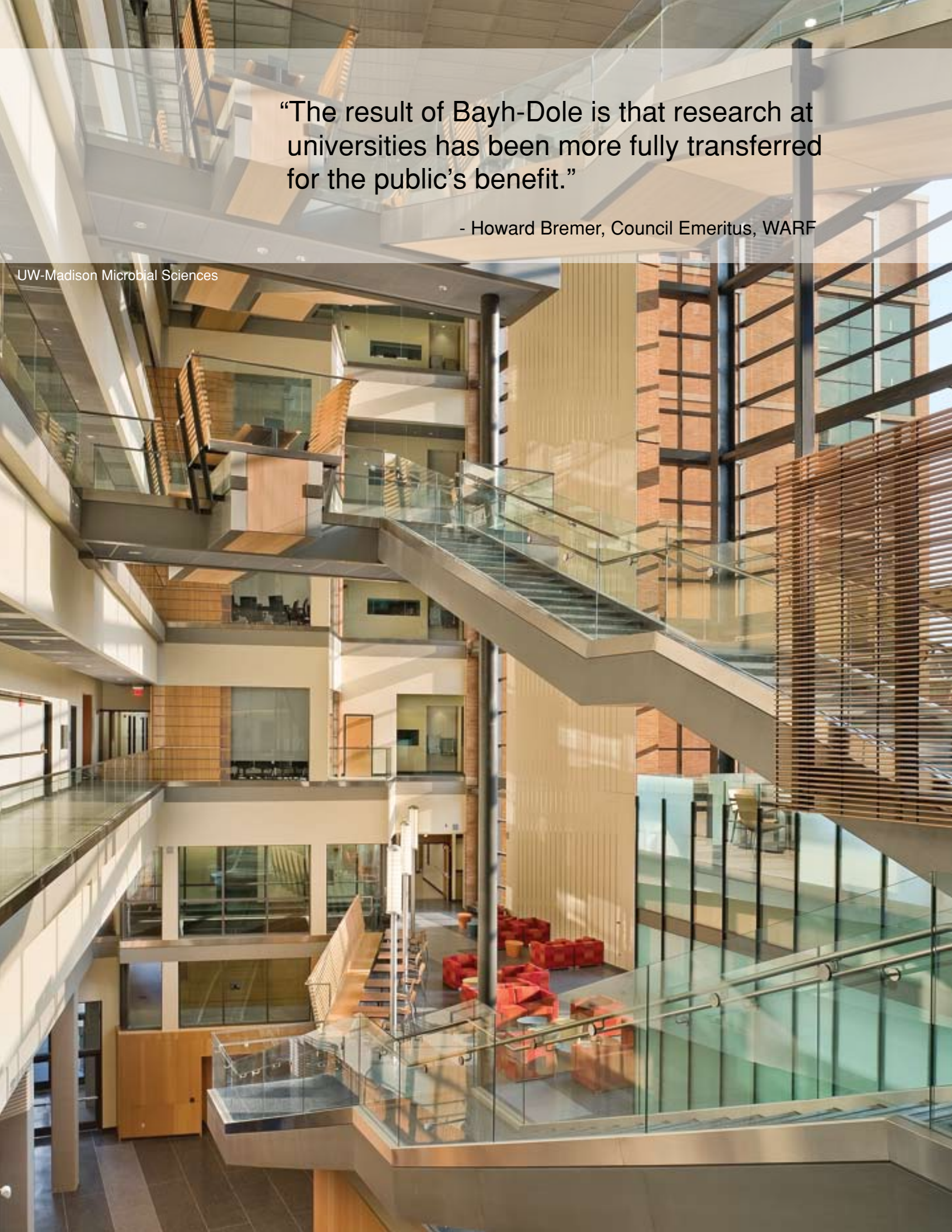


Total Non-Science and Engineering Fields: \$2.037 billion
Source: National Science Foundation

“The result of Bayh-Dole is that research at universities has been more fully transferred for the public’s benefit.”

- Howard Bremer, Council Emeritus, WARF

UW-Madison Microbial Sciences





RECESSIONARY CONTEXT

Dr. Kevin Cullen, AUTM vice president of metrics and surveys, said the value of academic technology transfer to the innovation economy is significant, but only part of the story. He said AUTM is developing additional metrics because the financial return from licensing, while important, is but one component academic R&D. He cited other mechanisms that should be measured along with licensing, including contract and collaborative research, consultancy, professional training, and entrepreneurial spin-outs.

“One of the things that we at AUTM are keen to stress is that the licensing activity is only part of what we think is the broader socio-economic impact of academic of R&D,” he said. “One of the things I always like to stress is to not look at licensing as THE measure of economic impact.”

In the context of the nation’s sinking financial fortunes, some economic perspective is offered by Robert M. Berdahl, president of the Association of American Universities, in a Nov. 12, 2008, letter to House Speaker Nancy Pelosi and Senate Majority Leader Harry Reid. Making the case for continued academic research as part of FY ‘09 economic stimulus package, Berdahl notes that research universities can play a role in confronting the challenges posed by the economic recession.

“Our universities,” he wrote to congressional leaders, “will play an important role in addressing many of these challenges – from finding alternative sources of energy to improving healthcare to increasing the understanding of the complex world of the 21st Century.”

Elsewhere, Berdahl has been equally outspoken about the solutions that can be derived from broad-based, interdisciplinary research. In an Oct. 27 speech at the University of Missouri, he gave policymakers more to think about.

“While it may take several decades to build a world-class university,” he said, “it takes much less time to destroy it by neglect.”

AUTM’s Cullen, who has worked in the private sector at Fortune 500 companies such as Proctor & Gamble, advises policy makers to approach university budgets with the economic value of academic R&D in mind.

“If you’re thinking about the economy as a business, the way out of the recession is through innovation,” Cullen said. “I think very few people would argue that innovation and technology improvement is going to be a fundamental part of how we get back to sustainable economic growth.”

HOW DOES WISCONSIN'S ACADEMIC R&D COMPARE TO OTHER STATES?

If not for Wisconsin's relatively high ranking in academic R&D, the state would slip out of the top half of all U.S. states in overall research and development spending. It is essential that state government ramps up its funding commitment to academic R&D in Wisconsin, or the state risks falling behind in the 21st century, knowledge-based economy.

Research and development expenditures by industry, government sources, foundations and academic institutions vary widely by state. In terms of overall R&D (academic and other sources), the most recent year in which figures are available is 2005, when the U.S. reported \$323 billion in R&D expenditures, according to the National Science Foundation (NSF). (By comparison, colleges and universities alone reported R&D expenditures of \$49.4 billion in FY 2007). In 2005, Wisconsin ranked 23rd nationally with \$3.8 billion in total R&D.

In terms of overall 2005 figures, the 10 highest ranking states accounted for 60.5 percent of total U.S. R&D expenditures. In order from one to 10, those states were: California, Michigan, Massachusetts, Texas, New Jersey, Maryland, New York, Illinois, Pennsylvania, and Washington. The top 20 states accounted for 71.8 percent of the U.S. total of \$323 billion; California alone accounted for just under one-fifth of the total at \$63.9 billion. The bottom 20 states accounted for just 5.6 percent of all R&D spending.

In FY 2007, Wisconsin ranked an impressive 13th among the 50 states with science and engineering academic R&D spending of \$1,066,688 billion from federal, state, and private sources, according to the NSF. The funding sources for Wisconsin academic R&D include (with totals rounded): the federal government, \$611 million; institutional funds, \$290 million; state and local government,

\$39.6 million; industry, \$31.3 million; all other sources, \$94.8 million. That total does not include \$72 million in non-science R&D spending at the UW-Madison, mainly in business, education and the humanities.

Of the \$1.066 billion in R&D spending by all UW System campuses in the 2007 fiscal year, most (\$840.7 million) took place on the UW-Madison campus. The figures reported by the National Science Foundation also include \$54 million in R&D spending combined by other UW System campuses, including (rounded figures): UW-Milwaukee, \$40 million; UW-La Crosse, \$3.4 million; UW-Stevens Point, \$3.1 million; UW-Superior, \$2.5 million; UW-Eau Claire, \$1.3 million; UW-Oshkosh, \$1.1 million; UW-Green Bay, \$1 million; UW-Platteville, \$540,000; UW-Stout, \$360,000; UW-River Falls, \$287,000; UW-Whitewater, \$223,000; UW-Parkside, \$218,000.

Wisconsin's annual academic R&D figures also include \$172 million in research spending by private institutions such as the Medical College of Wisconsin (\$158.2 million), Marquette University (\$9.74 million), and the Milwaukee School of Engineering (\$3.74 million), and Lawrence University (\$301,000).

The figures do not include research spending by the private Marshfield Clinic Research Foundation (roughly \$25 million annually) or the Blood Center of Wisconsin (\$17 million). These budgets should be included in the state total, however, because such research is conducted in close association with other institutions and/or private industry.

The NSF breakdown of the funding sources for Wisconsin's academic R&D revealed the state ranked 16th in federal funding, 26th in state and local funding, and 19th in industrial support.



The state and local funding, where Wisconsin ranked 20th in our 2004 report, continues to be influenced by declining state funding for the UW System. State appropriations as a percentage of the total UW System annual budget have declined from 33.75 percent in 1997-98, when an \$880 million state appropriation was applied to a \$2.6 billion UW System budget, to 24.21 percent in 2006-07, when a \$1.04 billion state allocation covered less than one-fourth of the \$4.3 billion UW System budget.

Wisconsin cannot compete with a California in size or economic might, but is there a way to measure Wisconsin's total R&D effort that might reflect the intensity of the state's effort? Yes - one way of controlling for the size of each state's economy is to measure each state's R&D level as a percentage of its gross state product. That percentage is referred to as R&D intensity or concentration.

Although Wisconsin ranked 19th in state GDP in 2005, it ranked only 28th in terms of R&D intensity with a ratio of 1.75, according to the NSF.

Overall, the nation's ratio of total R&D to gross domestic product was 2.60 percent in 2005, down from 2.69 percent in 2000. The top 10 rankings for state R&D intensity were, in descending order: New Mexico, 7.55; Maryland, 5.78; Massachusetts, 5.55; Michigan, 4.94; Connecticut, 4.64; Rhode Island, 4.56; Washington, 4.37; the District of Columbia, 4.04; California, 3.95; and New Jersey, 3.48.

New Mexico, which ranked first in R&D intensity ratio, is particularly interesting because it ranked only 38th among the 50 states in GDP.

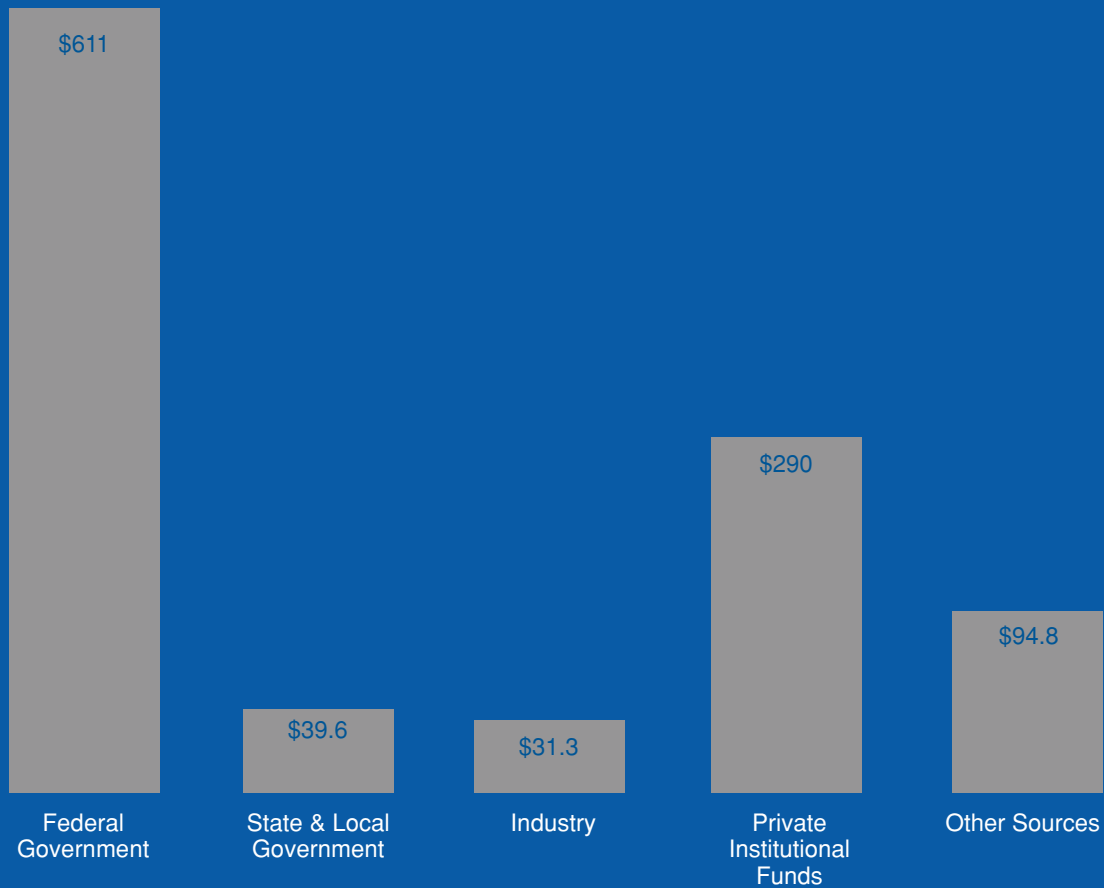
Wisconsin's comparatively weak R&D effort is important because of the correlation between the intensity of a state's effort and its economic growth. According to figures from the U.S. Bureau of Economic Analysis, eight of the top 10 states in terms of per capita GDP in 2007 also were among the top 20 states in terms of R&D intensity. Those eight states and their rank in terms of R&D intensity (in parenthesis) were: Delaware (13th), Connecticut (5th), Massachusetts (3rd), New Jersey (10th), California (9th), Virginia (17th), Minnesota (12th), and Colorado (15th). The notable exceptions were New York (32nd in R&D intensity) and Alaska (45th).

If not for academic R&D in Wisconsin and the ability of academic institutions to attract federal research dollars for that purpose, Wisconsin would slip out of the top half of all U.S. states in overall research and development spending. It is important to note that many of the nation's fastest-growing states also rank among the highest in overall R&D spending.

And yet, state support for academic R&D has been threatened by budget cuts affecting the UW System. These budget cuts have taken place at a time when savvy states are investing more in academic R&D and their overall infrastructure for technology development.

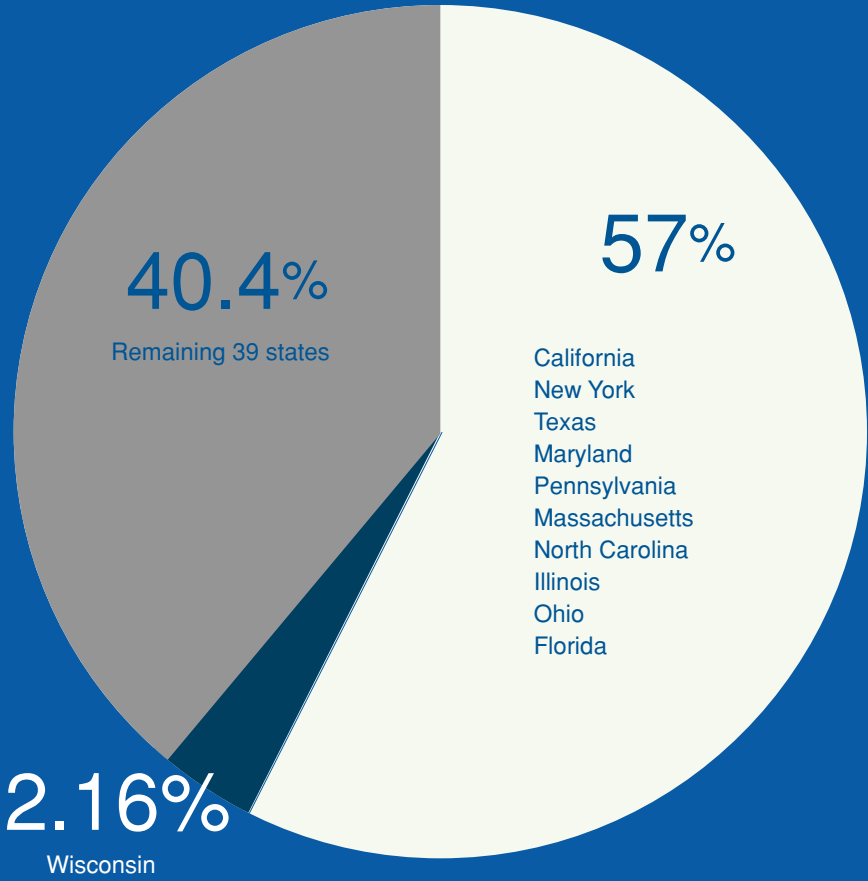
Sources of science and engineering academic R&D Spending in Wisconsin

Millions of dollars, rounded figures



Total: \$1,066,688
Source: National Science Foundation

Top 10 States in terms of Academic R&D Spending in the United States



Source: National Science Foundation

PUBLIC SUPPORT HOW THE UW SYSTEM COMPARES TO OTHER STATES

Through support for science and technology development, state governments can play a pivotal role in expanding economic growth.

In recent years, states have employed several policies to promote science and technology. Many have specifically targeted economic development initiatives to grow the bioscience industry, which tend to flourish in communities with top-notch university, hospital, and other centers of research, with a special focus on the creation of high technology firms and the use of advanced technologies in the traditional manufacturing and service sectors.

Common to these plans is the acknowledged importance of maintaining and strengthening the research and development (R&D) capacity of the states' colleges and universities, encouraging "home grown" businesses by providing support to entrepreneurs rather than seeking to recruit firms in other states, and facilitating the incorporation of new technology into processes and products.

Based on two reports from the Battelle Memorial Institute, this targeting approach has paid dividends. In a report titled "Growing the Nation's Bioscience Sector: State Bioscience Initiatives 2006," Battelle reported that the U.S. is home to 1.2 million bioscience jobs spanning more than 40,000 business establishments – many of them spun out of university research.

A 2007 report titled "The Biosciences in the United States: A Regional Perspective," said 25 metropolitan areas had total bioscience employment that exceeds 10,000, including Madison and Milwaukee, which are two anchors on along the I-Q Corridor that stretches from Chicago to the Twin Cities of Minnesota. Nationally, the report said that bioscience salaries averaged \$65,775, compared to

\$39,003 in the overall private sector, meaning that states that make these investments reap more tax receipts as more wealth is created.

The 2007 report also said that of the 361 metropolitan statistical areas with some bioscience employment, 193 have a specialization in at least one of the four major bioscience subsectors: drugs and pharmaceuticals; medical devices and equipment; research, testing, and medical labs; and agricultural, feedstock, and chemicals. Madison was one of only two MSAs, along with Lincoln, Neb, to have a specialization in all four subsectors. (In the 2008 report, Madison was the only city to be listed as specialized in all four subsectors).

Since states also have played an important role in research and development initiatives, particularly through their research universities, it stands to reason that expanding such policies statewide in communities with a UW System campus would expand results.

Yet overall, Wisconsin's commitment to its university system has been backsliding until recently, according to an FY 2007 report titled "State Higher Education Finance" compiled by the State Higher Education Executive Officers (SHEEO).

For fiscal year 2007, state and local governments in the U.S. appropriated \$83.5 billion for general operating expenses of public and independent higher education institutions, an increase of \$6 billion or 7.7 percent over 2006. After experiencing a decline from \$7,131 to \$5,957 in per FTE student public higher education appropriations from FY 2002 to FY 2006, Wisconsin actually stabilized to \$6,176 in FY 2007. Still, the five-year comparison represents a reduction of 13.4 percent.



In terms of per FTE support, Wisconsin lagged behind neighboring Illinois (\$7,032), but ahead of Minnesota (5,875), Michigan, (\$5,353), Iowa (\$5,723), and Indiana (\$5,351), which suggests there is an opportunity for Wisconsin to make more of a regional play simply by getting back to its 2002 level of \$7,131. Wisconsin ranked 29th nationally in FTE support, behind life science rivals such as California (\$7,083), North Carolina (\$8,854), and Texas (\$8,074).

The SHEEO report also tracked state-by-state per capita higher education spending and higher education spending per \$1,000 of personal income. Wisconsin's \$283 in per capita spending ranked 22nd nationally, and its per \$1,000 in personal income support of \$7.86 ranked 23rd nationally.

Perhaps Wisconsin can't do a great deal about its population disadvantage as compared with California and Texas, but it can close the gap with the top states on FTE and per capita measures.

THE SOUTHWEST'S RISING STAR

New Mexico serves as an instructive state. New Mexico has vaulted to third, behind only sparsely populated states like Alaska and Wyoming, in appropriations for FTE (\$9,516). That represents a 19.8 percent increase since 2002.

New Mexico is number two, behind only Wyoming, in terms of per capita higher education spending at \$521, and is first in terms of higher education spending per \$1,000 of personal income at \$16.57.

Not coincidentally, New Mexico is a rising star in the 2008 State New Economy Index released by the Ewing Marion Kauffman Foundation and the Information Technology & Innovation Foundation. The index measures 29 indicators that ranks states on their economic structure and ability to compete nationally and internationally, and while New Mexico still ranks 29th overall, its commitment to higher education support has helped it to move into the top 10 states in several important categories, including:

- Non-industry investment in R&D, first.
- High-tech jobs, second.
- Number of scientists and engineers, third.
- Venture capital, eighth.
- Technology in schools, ninth.

According to U.S. Census statistics, New Mexico has a population of nearly 2 million people, less than half of Wisconsin's population of 5.6 million. New Mexico has 132,440 students enrolled at its colleges and universities, while the UW System puts Wisconsin higher education enrollment at 173,000 students.

In 2008, the top five states in making the transition to the New Economy were Massachusetts, Washington, Maryland, Delaware, and New Jersey. In the SHEEO report, these states also had healthy results in terms of appropriations per FTE, led by Massachusetts (\$7,348), Washington, (\$6,736), Maryland (\$7,586), and New Jersey (\$7,275). Among that group, only Delaware, with an FTE of \$5,914, had a lower number than Wisconsin.

WISCONSIN PERFORMANCE INDICATORS

Overall, Wisconsin slipped three spots to 33rd among the 50 states in building the new, knowledge-based economy, according to the 2008 State New Economy Index.

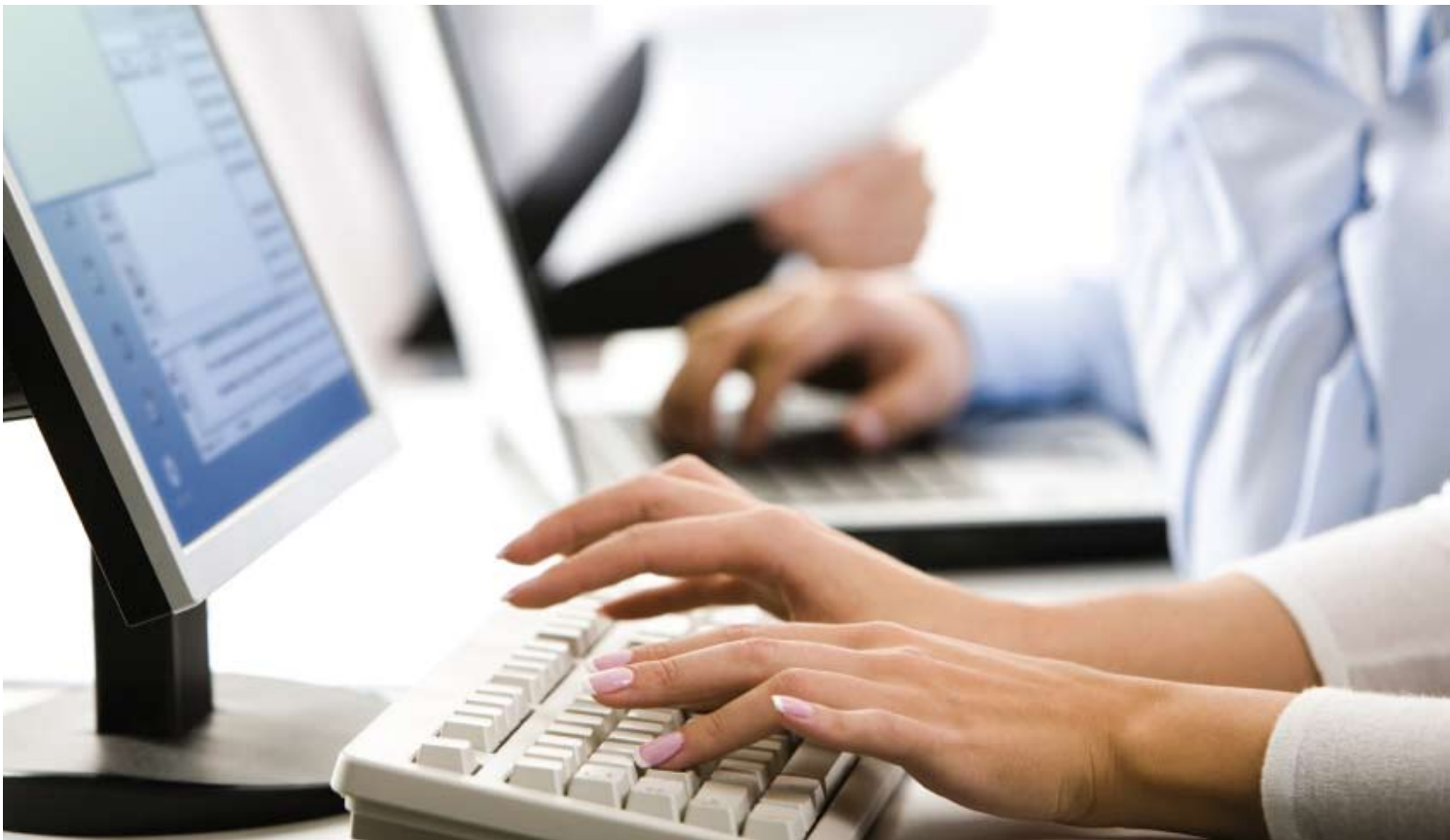
While Wisconsin ranked in the lower half of states overall and low in several information technology and entrepreneurial measures, it ranked in the top 15 in three technology categories: e-government, the new category of health information technology, and industry investment in research and development.

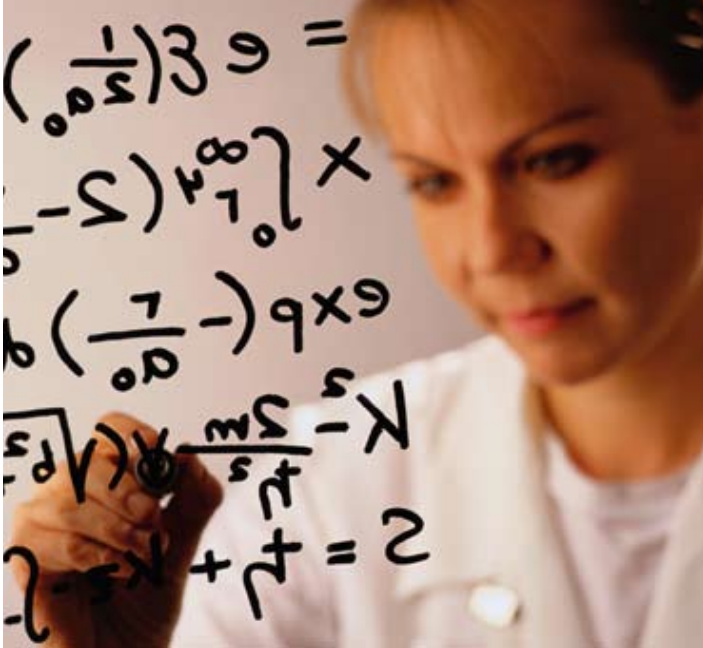
Conversely, the report indicated that Wisconsin ranked only 31st in venture capital, 32nd in high-tech jobs, and 27th in gazelle jobs. The latter category, in which Wisconsin dropped four spots in the national ranking, measures jobs in fast-growing companies, or "gazelles," as a share of total employment. These jobs are considered a sign of a dynamic economy and an adaptive state economy because they are created in companies with annual revenue that has grown 20 percent or more for four straight years. According to the Kauffman report, gazelles are responsible for as much as 80 percent of the jobs created by entrepreneurs.

In terms of the so-called "brain drain," Wisconsin ranked 22nd in the migration of U.S. knowledge workers, but only 39th in the immigration of knowledge workers.

Despite moving down overall, Wisconsin ranks in the top 20 states in several categories, including: E-government, 10th; health information technology, 12th; industry investment in R&D, 15th; value-added manufacturing, 21st; technology in schools, 19th.

However, it could do better in several other technology categories, including: Broadband and telecommunications, 24th; scientists and engineers, 24th; non-industry investment in R&D, 24th; workforce education, 25th; online population, 34th; and entrepreneurial activity, 43rd.





In addition, Wisconsin ranks among the lower half of states in the following categories: fastest-growing firms, 27th; IT professionals, 28th; Internet domain names, 29th; inventor patents, 30th; alternative energy use, 31st; initial public offerings, 39th; online agriculture, 40th; and job churn, a product of new business start-ups and existing business failures, 44th.

The New Economy index is designed to answer the following question: To what degree does the structure of state economies match the ideal structure of the New Economy?

While life science dominates in many states, the principal driver of the New Economy is the information technology revolution, according to Dr. Robert D. Atkinson, president of the Information Technology and Innovation Foundation. He said the most promising New Economy advances will be connected to a state's ability to use information more effectively, which also is true in the bioscience industry.

The decision of Microsoft and Google to open offices in Madison, which was done both for the access to computing expertise at UW-Madison and to attract UW graduates, is a testimony to the state's underrated prowess in information technology.

Universities can be instrumental in the economic growth of metropolitan areas. Much like Harvard and MIT have helped make Boston a bioscience hub, and like Georgia Tech University has played a key role in Atlanta's economic renaissance, stepped up academic R&D support can help UW-Stevens Point and UW-Eau Claire be more of an economic engine for their respective areas.

It's a part of the "grown-your-own" strategy endorsed in the New Economy report. Atkinson said principles that should guide state policy makers include a focus on higher-wage jobs and per capita income growth, which requires a much different strategy than approaches based on cost and relocation incentives. "I think they have to move the pendulum back to growth from within, in particular entrepreneurial growth," he said.

OTHER IDEAS FOR HOW THE FEDERAL GOVERNMENT CAN STIMULATE R&D

As Barack Obama takes office as the nation's 44th president, he faces deep, immediate challenges in revitalizing an economy caught in recession. Jolting the economy back to life through stimulus measures that include "shovel-ready" projects financed in large part by federal borrowing is central to his plan.

How should Obama and members of Congress define "shovel-ready" as they consider ideas for jump-starting an economy slowed by real-estate speculation, financial mismanagement and oil price shocks? Let's hope they look beyond the commonly accepted definition and embrace a description that includes the picks and shovels of the 21st century.

Most people think of bridges, roads and other public works projects when they hear the phrase "shovel-ready." Given the weary nature of the nation's transportation systems, and the need to quickly employ tens of thousands of workers, there's no doubt many of those needs will be deemed shovel-ready.

The economy would also respond, however, to additional investments in the nation's high-tech and knowledge-based toolkits. In the race to compete globally, the United States needs more than road and bridges. Here are six examples of "shovel-ready" ideas for a new age:

- **Invest in "broadband communications."** This is a catch-all phrase for high-speed transmission mediums that have the capacity to transmit data, voice and video over long distances simultaneously. Higher broadband penetration allows small businesses, which account for

60 percent of new jobs in America, to expand to new online markets. It creates more businesses related to information technology, one of the fastest-growing sectors in the U.S. economy. It helps rural communities attract businesses that otherwise might only flourish in urban settings. Telecom companies say they can't afford to install broadband in many areas; targeted federal investment would help.

- **Reauthorize the federal Small Business Innovation Research (SBIR) program.** Launched in 1982, this program has enabled 700,000 small businesses to develop cutting-edge products. Eleven federal agencies granted about \$2.3 billion in the latest year for merit-based research and development projects. Over time, SBIR and related programs have created 1.5 million jobs in small companies that typically employ high-wage scientists and engineers. It's a program that works – so why not reinvest?
- **Modernize America's health information technology.** The push for improving health-care delivery, quality and efficiency must involve better electronic medical records and health-information technology. Wisconsin can provide ready examples of what works. Epic Systems in Verona serves some of the world's largest hospitals and clinics with its electronic medical records, and the Marshfield Clinic's electronic records system has drawn national attention as well. Washington need not reinvent this particular wheel, but invest in what's already working and save money and lives while creating jobs.

- **Speed conversation and alternative energy technologies.** Gasoline prices are still under \$2 per gallon as 2009 begins, but it won't stay that way forever. Investing now in alternative energy research, including "next generation" biofuels, wind and solar, only makes sense. Existing conservation technologies can help make old and new buildings alike more energy efficient. The Great Lakes Bioenergy Research Center in Madison, a \$135-million federal investment, will serve as a focal point for research around next-generation biofuels.
- **Follow up the nation's investment in mapping the human genome.** "Personalized" medicine is an outgrowth of the mapping of the human genome, which was completed in stages culminating in April 2003. This emerging ability to tailor treatments to individual patients is a trend that would revolutionize the practice of medicine and drug development. The Wisconsin Genomics Initiative is one prominent project to speed discovery. Former National Institutes of Health director Elias Zerhouni called the Genomics Initiative "one of the very best proposals in the world" when it was announced in October 2008 at the Marshfield Clinics.

- **Pay for the America Competes legislation.** This act, passed in 2007, responded to recommendations in the National Academy of Sciences' report on "Rising Above the Gathering Storm." The act calls for more research and development spending and strengthening science, technology, engineering and math education. The law has been debated and passed with bipartisan support; full funding is the recommended next step.

The size of the stimulus package is up for debate in early 2009 as Democrats and Republicans spar over how much deficit spending is healthy – and how much is simply passing on debt to the next generation. Whatever the total, the picks and shovels of the nation's R&D community should be prominent tools in the box.





UW-Superior



UW-Stout



UW-River Falls



UW-Eau Claire



UW-Stevens Point



UW-Green Bay



UW-La Crosse



UW-Oshkosh



UW-Madison



UW-Milwaukee



UW-Platteville



UW-Whitewater



UW-Parkside

ACADEMIC R&D

A TOUR OF THE UW SYSTEM



By now, many state residents can identify the research programs of UW-Madison, the UW System's flagship campus. From groundbreaking stem cell research to developing the alternative energy of the future as part of the Department of Energy's Great Lakes Bioenergy Research Center, UW-Madison's reputation as a pre-eminent research university is well established. Federal and state governments, along with private sources, spend close to \$1 billion per year for research and development on the Madison campus.

However, relatively few Wisconsinites know about the sophisticated science and possible commercial applications being developed, at minimal cost, at state universities from Whitewater to Superior.

State Sen. Julie Lassa, for one, doesn't believe there is a great deal of awareness in the Legislature about the level of academic research that's being conducted on the comprehensive UW campuses outside of Madison. "I'm not sure there is very much awareness in the Legislature

of the type of research that's going on (statewide)," said Lassa, D-Stevens Point. "I think maybe legislators, if they do have a campus in their district, know some of what's going on in terms of R&D on that campus."

Maliyakal John is the managing director of the WiSys Technology Foundation, a subsidiary of WARF that supports the research and educational programming of UW campuses outside of Madison. He says there are about 15 major research programs facilitated by WiSys on the comprehensive campuses that either have produced or could produce patented and licensed technology for commercialization, and train students on cutting-edge technology to prepare them for high-paying jobs.

In addition, there are plans to bring another 50 programs that will be brought online in the next three to four years. Among them are the projects described below. Note how often academia and the private sector already are collaborating to bring technologies to the market.

UW-MILWAUKEE

The university's Research Growth Initiative is designed to provide internal seed funding for the university's best scholarly work, and it has raised more than \$122 million for a capital campaign to improve its facilities, including a new engineering campus on the Milwaukee County Grounds. UW-Milwaukee also has established industry partnerships with the likes of Rockwell International, but that's not all.

Associate professor Bertram Ezenwa has developed a medical device technology for the treatment of osteoporosis, a disease that affects 40 million Americans. Whole-body vibration now is used to combat osteoporosis in elderly populations, and Ezenwa has developed a vibrating technology platform to simulate muscle growth and bone density. WiSys has entered a contract with OEM Fabricators in Woodville, Wis. (near Eau Claire) to manufacture and market the device. Currently, the project is in the clinical development and testing phase with UW-Madison, and clinical organizations such as Aurora Medical and the Mayo Clinic may join the project.

NovaScan, a company based on technology developed by electrical engineering professor Bill Gregory, is developing non-invasive cancer detection systems. Using patents licensed from WiSys, NovaScan is developing technology for electrical property enhanced tomography (EPET), which measures the electrical properties of materials and can identify different types of tissues, including healthy and unhealthy ones. EPET holds the promise for earlier detection of diseases like breast cancer but because the technology can be applied in different ways, the company faces a decision as to which application has the most immediate market potential.

As part of another promising program, the UW-Milwaukee Research Foundation has entered into a licensing agreement with MPP Group, LLC, a Wauwatosa-based biopharmaceutical company, to develop a series of compounds to treat alcohol addiction. MPP Group will develop the compounds to produce an FDA-approved therapeutic agent for the treatment of alcohol addiction, which affects about 17 million Americans. Licensing revenue would be reinvested in future UW-Milwaukee research.

The family of compounds was developed by James Cook, a UW-Milwaukee distinguished professor of chemistry. The compounds interact with certain neurotransmitters in the brain to block the euphoric effects of alcohol without inducing anxiety or sedation. In addition, Cook's research has led to the discovery of other potential therapeutic compounds, several of which have been distributed by WiSys to Wisconsin pharmaceutical companies such as NeuroAmp in Milwaukee and Mithridion in Middleton, where further development could lead to the treatment of diseases of the central nervous system.

UW-EAU CLAIRE

UW-Eau Claire has two ongoing programs with industrial applications. The first one is by Professor David Lewis, who is collaborating with the Marshfield Clinic to develop superior warfarin-based drugs. Warfarins are drugs that prevent blood clotting, but these drugs have serious side effects, causing 4,000 people a year to die because of uncontrolled bleeding. A total of 21.1 million warfarin prescriptions are written annually.

Lewis and his Marshfield Clinic collaborator, Dr. Michael Caldwell, are looking at the chemistry and genetics of warfarin metabolism to come up with a safer, more effective version of existing drugs, which would have significant medical implications. The program is in its second year; within the next year or two, Lewis hopes to develop molecules with therapeutic applications.

WiSys also is beginning to work with another group at UW-Eau Claire led by Doug Dunham, professor of physics, director of the university's Materials Science Center and a key player in the NanoRite Innovation Center. The group is working to develop electronics technology that could improve the efficiency and reception of cell phones, and reduces battery usage and therefore adds to battery life. "We're just beginning the discussion with them," John said. "UW-Eau Claire hopes to attract companies to manufacture the products. It's an exciting opportunity for us."

UW-GREEN BAY

UW-Green Bay, encouraged by interim chancellor David Ward, has significant programs in sustainable “green” technology. The most interesting program is one that could convert food product waste, a plentiful source of biomass, into a new biofuel. John Katers, associate professor of natural and applied sciences, and Mike Zorn, associate professor of chemistry, also are studying the use of animal manure in biofuels.

Zorn’s areas of research include the development of photocatalysis for biogas generation from organic waste such as food waste, dairy manure, and paper waste. While there are yet no breakthroughs to suggest that such biofuels could be used at the large scales necessary for commercialization, the work could find a practical use for a material that contributes significantly to the waste stream. If successful, it also could contribute to Wisconsin’s drive to be a leader in biofuel development and energy independence.

UW-LA CROSSE

UW-La Crosse has a variety of technologies in development, including a program to develop therapeutic drugs from mushrooms and other fungi collected from all over the world. The university has a unique collection of such fungi and medicinal plants, and a research team led by professor Aaron Monte is studying bioactive compounds produced by these mushrooms. They isolate and screen hundreds of compounds for anti-bacterial activity and also are collaborating with several laboratories, including UW-Madison and UW-Milwaukee, to screen these compounds for possible use as treatments for cancer and cystic fibrosis.

Monte and his cohorts, who have uncovered some bioactive compounds, have formed a company called Mycophyte Discovery, LLC. Eventually the company hopes to commercialize some of these compounds, and it would license the technology from WiSys, which has filed two patents related to technology developed thus far.

“I want to caution that these are all long-term programs,” Maliyakal John said. “It takes many years of work before we can be confident that these potential drugs will have therapeutic implications.”

UW-OSHKOSH

Chemistry professor Charles Gibson is working on two different programs involving nanotechnology, which is the study of very small-scale materials. In the first program, Gibson is looking to make nano materials that can be used for superior lighting applications, light-emitting diodes (LEDs), and other lighting sources. He has found that nano materials are more efficient than existing lighting compounds.

Gibson, who has formed a company called Oshkosh Nanotechnology, LLC, also is working on a program for super capacitors, which are electrical components that offer very high energy storage capacity in a small area. In that type of capacitor, energy storage is accomplished with a static charge rather than the electro-chemical process inherent in existing batteries. The work has implications for battery life in a variety of electronic products, and Gibson has developed super capacitors that have good commercial potential.

UW-PARKSIDE

At Parkside, WiSys is assisting Professor Daphne Pham with the development of a research tool for the life sciences. She has isolated a “promoter,” which is a gene fragment capable of directing the expression of proteins in cells. Researchers that want to produce a protein in large quantities, including proteins for therapeutic applications, can attach this promoter to the gene fragment of the protein and induce the cell to manufacture the protein in large quantities.

UW-PLATTEVILLE

Platteville is one of the most advanced campuses in terms of nanotechnology, and chemistry professor Jim Hamilton has achieved several important nanotechnology breakthroughs. Hamilton and his scientific and business partner, student co-inventor Philip Streich, have developed a way to dissolve materials previously thought to be insoluble, specifically nanotubes and graphite. Graphite is used in making graphene, a thin layer of carbon that conducts electricity 100 times faster than silicon and 500 times faster than steel.

Graphene Solutions, LLC, a nanotech company led by Hamilton, had the top business plan in the 2008 Governor's Business Plan Contest. The company, which is seeking investors, plans to manufacture purified carbon nanotubes and graphene (graphite microsheets) with target markets of research labs and LCD product display manufacturers interested in increasing the electrical and mechanical efficiency of their products.

UW-RIVER FALLS

At River Falls, the focus is on biotechnology and the clinical sciences. Dr. Tim Lyden is working on tissue engineering and cancer-related stem cell research. Tissue engineering has implications in vaccine production, protein production for research, and as a research tool for the life sciences. Tissue engineering also could result in taking cells and tissues and growing them outside the body so eventually they can be used for implantation back into the body to improve or replace bone, cartilage, or blood vessels. This is the way many people think about tissue engineering, which is a term used interchangeably with regenerative medicine.

Meanwhile, Dr. Brian Smith is developing new varieties of plants and crops that are more suitable for Midwestern agriculture. He has completed development of a plum variety that can be another revenue stream for Wisconsin farmers, and he's attempting to do the same for strawberries.

UW-STEVENS POINT

Stevens Point has two prominent professors that are working in the materials space. Mike Zach has developed patterned nanowires that can be grown into circuits and components for manufacturing materials that have vastly improved material properties. By improving nanowire patterned consistencies, Zach believes researchers can avoid tangled masses of wires when making large quantities of nanowires; the technology can be applied in core Wisconsin industries such as healthcare, electronics, and manufacturing.

Professor John Droske is developing biodegradable polymer composites for bio implantable material that can be placed in the body for orthopedics and other medical uses. He's also investigating whether a polymer adhesive can bind bone fragments together so that once the bone is healed, the binding material will degrade.

UW-STOUT

UW-Stout already reaches about 50 companies a year to help them address industry challenges and is planning the formation of a new Discovery Center to further interact with area businesses. Once that center is started, the university also wants to develop its own technologies, some of which will be in collaboration with industry. Stout has significant potential for helping the plastics and polymer industries, and potential for designing biomedical devices.

Additional UW-Stout research has focused on areas as diverse as cognitive neuroscience, saltwater "sinkholes" in freshwater lakes, and advanced composites.

Its designation as a polytechnic university will enable it to conduct a great deal of applied research as part of its corporate outreach, especially in the growth corridor between Minneapolis and Eau Claire.

UW-SUPERIOR

From its perch atop the state, UW-Superior plans to make its R&D mark in the biofuels industry. The university has some funding and has begun to recruit faculty members to work on its biofuels project, and representatives of WiSys will meet with university officials early in 2009 to help them collaborate with other UW campuses that have expertise in the biofuels area. At this time, the university has yet to determine whether it will develop biofuels with a microbial approach, or whether the fuels will be of plant origin.

UW-WHITewater

Whitewater has several prototype projects related to using electronic games in the educational realm. The same concepts used by players in Massively Multiplayer Online Role-Playing games, where large numbers of players interact and otherwise communicate in the virtual world, could be applied to education to teach project collaboration.

John expects UW-Whitewater to form a group to develop different types of games for instructional use, including distance learning programs, nursing, and perhaps to teach children the rules of different sports. WiSys has taken the Whitewater group, plus representatives of UW-Madison's Advanced Distributed Learning Co-Lab, to Oshkosh because of UW-O's significant interest in the educational applications of electronic games, and because the ADL Co-Lab puts on an annual Games, Learning, and Society Conference and has collaborated with similar groups at the University of Florida.

This potential collaboration, which could someday include groups from UW-Stout and UW-Eau Claire, would work on gaming programs for various fields. WiSys is putting together a symposium on electronic games that will be held at either UW-Whitewater or UW-Oshkosh.

Electronic games are a burgeoning industry in Wisconsin with companies like Raven Software and Big Rooster in Madison, Human Head in Milwaukee, and Frozen Codebase in Green Bay.

SO MANY PROJECTS, SO LITTLE TIME

UW system professors are doing all this with limited time and funds for actual research, most of which is done on their own time. Maliyakal John has developed an inventor-mining program to identify research-oriented professors, and he advocates freeing non-Madison professors of some of their teaching responsibilities so they can pursue grants and conduct research.

"Every forward-thinking undergraduate university in the country is moving toward integrating research into teaching their students," Maliyakal John said. "This is something the UW System cannot afford not to do."

Lassa likes the idea, but she said the university would have to figure out how to structure it because the mission of UW campuses outside of Madison is to be teaching colleges. "If we were to create that flexibility, we would have to make sure that the professors have time to do that kind of research," she said, "but also that students are getting the quality teaching time that we want them to have, and that their parents expect." Please turn to the next page to read a case study about what happens when professors get release time.

TAPPING A HIDDEN RESOURCE: ACADEMIC R&D IN THE UW SYSTEM

Eric Singasaas is the kind of professor you might not expect to find at a UW System campus outside Madison or Milwaukee. He's a Ph.D. botanist and biochemist at UW-Stevens Point with expertise in the biological production of hydrocarbons ordinarily made by plants. That puts him on the cusp of the emerging biofuels industry, a potential source of economic growth for Wisconsin.



But Singasaas is still very much a typical UW System professor in one major way: Until very recently, he's been tied to the classroom. With four classes and all the preparation time that goes into teaching them, Singasaas was hard-pressed until this academic year to find time to collaborate with other researchers, write grants, manage a laboratory and advise private industry – all things his peers at larger institutions do as a matter of course.

But Singasaas has now been relieved of part of his teaching load, and it's already paying off in terms of attracting research grants – a total of \$700,000 this year already, with good prospects for more. That pays for backfilling his teaching duties while pushing ideas out of the laboratory and into pilot projects that could create jobs for Wisconsin.

If more professors at Stevens Point and other UW System campuses could conduct more research, pockets of research excellence outside Madison and Milwaukee would be quicker to grow – and to seed local economies.

There are literally hundreds of UW faculty members outside Madison and Milwaukee who have the credentials and the desire to conduct high-level R&D, but the resources, facilities and necessary political culture for them to do so is often lacking. State lawmakers who want UW System campuses to contribute more to the state's economic well-being should think about changing that equation.

*Eric Singasaas, Ph.D.
UW Stevens Point*

The soft-spoken Singasaas is far from a complainer; he enjoys his work at UW-Stevens Point. But he also admits “there are opportunities to develop workloads that make better use of our skills and assets as a university.”

In the highly competitive world of grant-writing, professors at major research universities have at least two advantages: freedom to focus on writing the grant and the facilities to conduct the work. For professors outside doctoral campuses, it’s tough to keep up with scientific journals, collect preliminary data, manage a lab and write a grant when the work is squeezed between classes. The WiSys Technology Foundation (a subsidiary of the Wisconsin Alumni Research Foundation) helps some UW System professors with small grants to “buy out” teaching time while professors are writing grants, but that’s tapping only a fraction of the market.

If the UW System could release research-oriented professors from teaching, more R&D centers could emerge outside Madison and Milwaukee without diluting the efforts of those campuses. Right now, UW-Madison attracts nearly \$841 million per year in science-related R&D dollars and UW-Milwaukee about \$35 million. No other UW campus exceeds about \$3.5 million per year.

Critics might argue the four-year “comprehensive campuses” outside Madison and Milwaukee weren’t set up to conduct much research; they exist to teach. That’s true as far as it goes. But without the continued development of faculty through R&D and other paths, teaching can and will stagnate. Cutting-edge professors create value-added education – and a more valuable experience for the students.

The culture of “teaching only” can leave universities trapped in time. Consider the recent example of Beloit College, a distinguished private college known for its liberal arts. The Wisconsin Health and Educational Facilities Authority recently completed a \$56.26 million bond issue to finance the college’s new Center for the Sciences, which will consolidate the college’s science programs into one building and enhance interdisciplinary research.

Wisconsin is leaving money on the table by not fully developing its academic R&D potential. Let’s free more professors such as Eric Singasaas to do what they do best.





“If the slide in higher education funding effort continues, the academic R&D infrastructure in Wisconsin could deteriorate.”

- Wisconsin Technology Council

CONCLUSIONS

AND RECOMMENDATIONS

Some of the recommendations contained in the Wisconsin Technology Council's 2004 report on academic R&D have come to fruition.

For example, the Tech Council suggested that UW-Madison, the Medical College of Wisconsin, and the Marshfield Clinic re-examine an already strong collaborative research relationship to look for more opportunities to jointly attract research funding and conduct science. This year, these institutions, along with UW-Milwaukee, announced they would collaborate on the Wisconsin Genomics Initiative, an effort to put the state in the forefront of personalized medicine.


Another recommendation that was followed was the provision of state support for UW-Milwaukee's engineering campus. The university has established a capital fund, but the state also has provided funding to prepare a new campus for the UW-Milwaukee College of Engineering and Applied Science, which will be built on the Milwaukee County Grounds.

Therefore, our specific recommendations begin with a call for the state to establish more incentives to conduct inter-institution and interdisciplinary research. This is similar to an approach being followed in Minnesota, where the University of Minnesota and the Mayo Clinic have recently announced joint initiatives.

OTHER SPECIFIC RECOMMENDATIONS ARE AS FOLLOWS:

- Beginning with the 2009-11 budget, the Governor and Legislature should begin the process of restoring state support for UW System operations. Although many states have experienced similar budget difficulties, particularly in the current economic climate, the erosion in the UW budget has been relatively steady for years and cannot continue if the state wants to protect and advance its position in the knowledge-based "New Economy." Such investments pay dividends down the road, both for the economy and for state revenue coffers.
- As has been demonstrated nationwide, state support for capital improvements makes it possible to attract federal, industry, and private foundation dollars for research. Since case studies demonstrate a large and positive contribution from academic research to broad educational and social benefits, economic growth, and a growing rate of investment return, the Governor and the Legislature should increase efforts to invest in basic research at all UW System campuses. General obligation bonding should be considered as a funding source, given the long-term return on the investment, for remaining academic R&D needs at UW System schools.
- The Governor and Legislature should create a Wisconsin Innovation and Research Fund to help secure federal and corporate grants by providing small matching grants to UW System and private college faculty who collaborate with business on R&D.

- The University of Wisconsin System, with the support of the Legislature, should do more to free the time of hundreds of non-Madison campus professors who have the credentials and the desire to conduct high-level R&D. While the WiSys Technology Foundation helps some UW System professors with small grants to “buy out” teaching time while they write grants, more time should be freed for activities like grant writing and research, collecting preliminary data, managing a lab, and keeping up with new discoveries reported in scientific journals.
- The UW System should adopt a comprehensive strategy to capture value from intellectual property generated by System faculty through judicious and focused use of research grants and development funds, and encourage faculty to work with WiSys in commercializing technologies.
- The state should establish a matching grant to support WiTAG, a \$1 million, 4-year WiSys initiative to stimulate UW System research and development that will lead to long-term, extramural funding.
- The UW System should challenge its four-year campuses to develop new technologies that could take advantage of Wisconsin’s emerging biofuel and bioproducts industries. For example, the Governor’s consortium on bio-based Industry recommended that four UW campuses be taken off the electrical grid by harnessing renewable technologies. These technologies are being developed on UW System campuses.
- Allow the Wisconsin Health and Educational Facilities Authority to issue bonds to finance any project undertaken by a research facility, or to refinance the outstanding debt of a research facility. This is a limited but important expansion of WHEFA’s current charter.
- Urge the adoption of tax credits/refunds targeted at specific high-tech, high-growth industries. According to the National Science Foundation, just six industries account for three-quarters of industry-based R&D and 95 percent of federally funded industry R&D. These industries include electronic products, chemicals (including pharmaceuticals and medicines), computer-related services, aerospace and defense manufacturing, R&D service industries, and automotive manufacturing. Tax credit/refunds should be targeted at those industries that have the highest R&D and which Wisconsin has a competitive advantage, such as life sciences, medical devices, biomedical engineering, water technologies, medical imaging, computer design (where the state’s computing expertise, exemplified by the UW-Madison Computer Science Department, is vastly underrated), data processing, energy efficiency, biofuels, and control systems.
- Several states have enacted a “Super R&D tax credit.” Firms are eligible for the credit if their qualified research expenses increased by at least 50 percent over their average expenditure for the previous three years. Qualifying companies are awarded a credit in an amount equal to any new spending in excess of their three-year average. This is similar to a proposal made by Gov. Jim Doyle in late 2007. Concurrently, we recommend a review of existing tax credits with an eye toward consolidation and or “sun-setting” of those that may have outlived their usefulness.
- Support efforts to enhance STEM education, especially those that attract more young women and minority students to these disciplines (science, technology, engineering, and math). State and national workforce demands, as well as fundamental national security, underscore the need for more students that are skilled in science, technology, engineering, and math. This is best done through public-private programs that engage students at critical points of development. Examples include Project Lead the Way, First Robotics, STEM grants through the Department of Public Instruction, and the National STEM Equity Pipeline.
- Support proposals to attract federal research laboratories to Wisconsin. The successful effort to attract a \$135 million U.S. Department of Energy grant to create the Great Lakes Bioenergy Research Center, an example of a public-private initiative, should serve as an inducement for private colleges and universities to pursue other lab opportunities. The state could target “good fits” like a food safety lab that could work in conjunction with the state’s food processing industry.
- The Governor and the Legislature should establish a commission, similar to the Michigan Commission on Higher Education and Economic Growth, to explore policy options and track “best practices” in other states.



TO IMPROVE THE RATE OF TECHNOLOGY TRANSFER AND THE SUCCESS OF EARLY-STAGE COMPANIES:

- Remove impediments that prevent UW System professors from commercializing their discoveries. The Board of Regents should be encouraged to review conflict-of-interest rules that may slow or even prevent the transfer of technology from the laboratory to the marketplace. Faculty should be encouraged to pursue entrepreneurial ventures, collaborate with industry, commercialize research results, take part in the appropriate business plan contents, and pursue entrepreneurial ventures without penalty. So-called “safe harbor” agreements at other universities may serve as a model for reform in this area.
- Enact proposed improvements to Act 255, thereby increasing the amount of angel investor and venture capital tax credits available to those who invest in Wisconsin businesses. This would increase the pool of credits, extend the time period, and ensure there is no cap on eligible investment in any one year. The Legislature also should enact the proposed capital gains exclusion to increase investment in new Wisconsin businesses, and rebrand Act 255 as the Wisconsin Growth Capital Act.
- Make better use of state Technology Zone tax credits. Some communities have used them effectively; others have allowed them to languish. The Governor and the Legislature may want to consider a statewide tax credit zone, which now is done regionally, to reward communities that have put the credits to work but now may be bumping up against the current ceiling.
- As proposed by the Governor and others, double funding for current technology grants and loans from \$2.5 million to \$5 million annually to provide seed money to start-up companies and small businesses, and supply the matching funds required for federal research grant applications.
- Create a Small Business Innovation Research (SBIR) program at the state level. The federal SBIR program provides more than \$2 billion a year to small companies that are developing leading-edge technologies. Enacting a Phase I program at the state level would stimulate entrepreneurship and prepare inventors to seek federal SBIR funding, which is undergoing revisions that could result in fewer Phase I grants.
- Exempt R&D materials from the state sales and use tax. The Governor’s 2007-09 state budget proposal would have created five sales and use tax exemptions related to biotechnology. Three of the exemptions would apply directly to biotechnology businesses, while the other two would apply to businesses raising laboratory animals that are sold to biotechnology businesses. At the moment, there are no sales and use tax exemptions specific to biotechnology.

TO BOOST VENTURE CAPITAL FOR LATER-STAGE TECH COMPANIES:

- Explore opportunities for a Midwest regional venture investment fund supported by the investment boards of states in the Midwest region.
- Support the proposed Wisconsin Venture Capital Network, preferably in public-private form, with funds raised from higher state license fees charged to investment brokers that do business in Wisconsin, most of who are outside the state. The Wisconsin Department of Financial Institutions is drafting the details of the network, which would support venture capital formation in much the same way the Wisconsin Angel Network supports angel investing.

SUMMARY

For the better part of 100 years, Wisconsin has invested heavily in its academic research and development infrastructure. In UW-Madison alone, the state has an asset that most states can only dream of, but the Madison campus is hardly its only research asset.

For far less money than some states are belatedly investing in academic research and development, Wisconsin state government can target investments in campuses outside of Madison and reap the benefits associated with the transformation to a high-tech economy.

At a time when Wisconsin is working hard to nurture high-technology industries, it is critical that policymakers support the science and infrastructure that makes those industries possible. The global economy is changing,

and Wisconsin must continue to be innovative or risk being left behind. Supporting pioneering research sends a positive message to the scientists and science-based companies that already call Wisconsin home. Without that support, attracting and nurturing new technology companies, and attracting investment capital to support new enterprises, becomes extraordinarily difficult.

Wisconsin has a world-class advantage in academic research. That begins with the UW-Madison and other major institutions, such as the Medical College of Wisconsin and the Marshfield Clinic. However, it should better leverage all of its existing academic assets for the betterment of mankind and the state's economic future.

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