UNIVERSITY OF MINNESOTA
Driven to Discover℠

ANNUAL REPORT

THE STATUS OF UNIVERSITY RESEARCH AND COMMERCIALIZATION OF INTELLECTUAL PROPERTY

FIVE YEARS FORWARD

BRIAN HERMAN, VICE PRESIDENT FOR RESEARCH

DECEMBER 11, 2015

PREFACE

Each year the Office of the Vice President for Research (OVPR) provides the Annual Report on the Status of University Research for the Board of Regents, summarizing the University's research metrics for the past year, documenting the trends in research productivity, scholarship and commercialization of intellectual property as well as benchmarking the University's performance and ranking within its peer group. In addition, the Vice President reports progress on a broad set of strategic priorities and principles that build upon the University of Minnesota's historical research strengths and strategies to address barriers to research success.

Produce **excellence**

Be **transformative**, lead not follow

Advance **transdisciplinary** work

Focus on critical **global challenges**

Present real, **measurable results**

These principles are the foundation for the strategic priorities of the University of Minnesota system-wide research strategic plan endorsed by the Board of Regents in February 2014.

The FY2015 annual report includes:

RESEARCH STATISTICS

FISCAL YEAR 2015

University of Minnesota faculty and staff competed successfully for **$754 million** in externally sponsored research awards in FY2015, **up 1.8% from FY2014**. This $13 million increase continues a sustained growth trajectory since FY2012. Also continuing to trend upward was the average total amount received per award, which increased from $157,000 per award in FY2014 to $165,000 per award in FY2015.

Figures 1 and 2 display more detail about the $754 million awarded from externally sponsored research, aggregating these data by funding source and by college or system campus, respectively. Figure 1 shows the University's total federal funding level at $463 million, which is down $27 million (5.5%) from the previous year; Private funding (Business & Industry and Other Private) together totaled $211 million and was up $25.4 million (13.7%) compared to last year; and funding from State & Local sponsors was up $14.7 million (22.7%). Overall the increases in nonfederal sources overcame the decrease on the federal side. The federal government continues to be the largest source for external research funding at 61% of new funding received in FY2015.

The drop in federal funding to the University tracked a decrease in overall NIH awards, which were down $67.6 million (23.5%). A financing delay of a $30.3 million NIH award to James Neaton in the School of Public Health accentuated this drop (if the award had been received, the University's NIH funding drop would have been $37.3 million or 13%). NIH awarded 583 grants to U of M researchers in FY2015, compared with 802 in FY2014.

John Deen in the College of Veterinary Medicine received a five-year award of up to $50 million from USAID for the

ONE HEALTH WORKFORCE

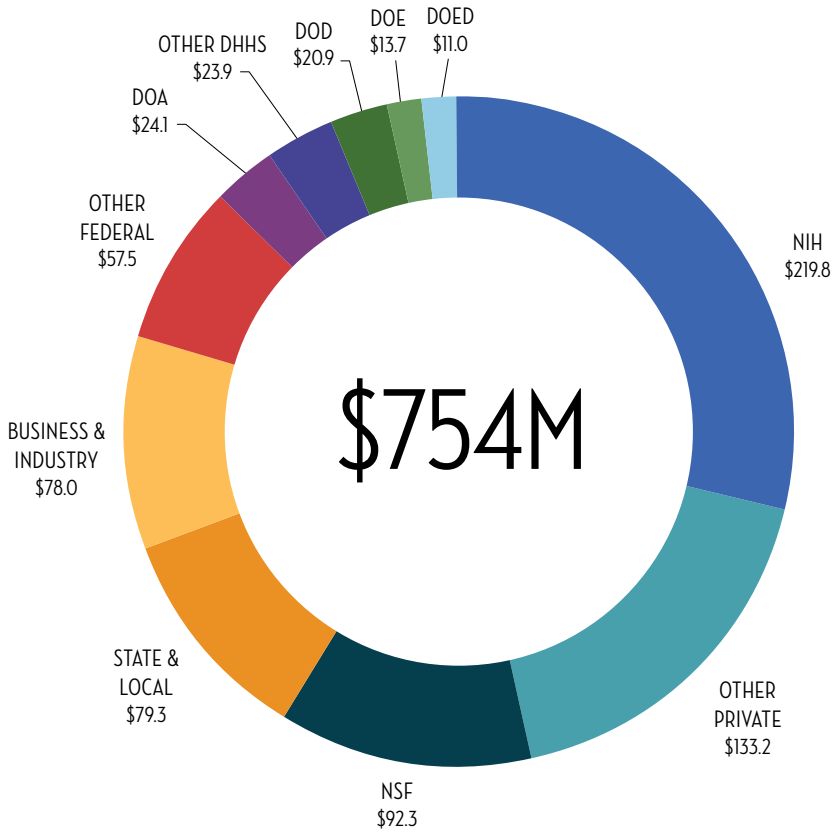
project, an international effort that involves multiple U of M colleges, Tufts and 24 other universities across Africa and Asia to ensure nations have skilled health care workers to battle the spread of infectious diseases.

Funding from the National Science Foundation, the second largest federal sponsor of research, was up $13.3 million, although there were fewer awards—306 in FY2015 compared to 339 in FY2014. Also showing an increase was the Other Federal group. When combined, the Other Federal agencies' funding was up $27.3 million (22%). The most significant contributor in the Other Federal category was United States Agency for International Development (USAID) funding for a large award of $27.9 million received by John Deen in the College of Veterinary Medicine for his project One Health Workforce. The NSF and Other Federal increases were not enough to keep overall federal funding to the University from dropping.

Funding awards from the State of Minnesota increased this year by nearly a quarter (22.7%), primarily due to two $8 million awards from the Minnesota Department of Human Services for the Minnesota Supplemental Nutrition Assistance Program Education (SNAP-ED). And, as was true last year, this increase is separate from the state's investment in Minnesota's Discovery, Research and InnoVation Economy (MnDRIVE), which is accounted for separately and not included in sponsored research totals.

Business & Industry funding was up $22.8 million (41.3%) in FY2015. This represents the largest increase in new Business & Industry funds in the last 10 years. **This funding source now accounts for more than 10% of all externally funded research**. In addition to the increased funds there are also a greater number of such awards received—1,239 this year compared with 1,190 in FY2014. Among the new funding highlights for the year was $17 million to James Neaton from Leidos Biomedical Research, Inc. for influenza studies and a clinical research center for Ebola. Medtronic provided Paul Anthony Iaizzo $5.1 million in funding for a medical device research project. Richard Bianco received $9.2 million in funding from W.L. Gore & Associates, Inc. for several different projects in the Experimental Surgical Services unit. The increase in Business & Industry funding can be attributed in part to a University strategy focused on enhancing public-private partnerships. We describe more about these partnerships later in the report.

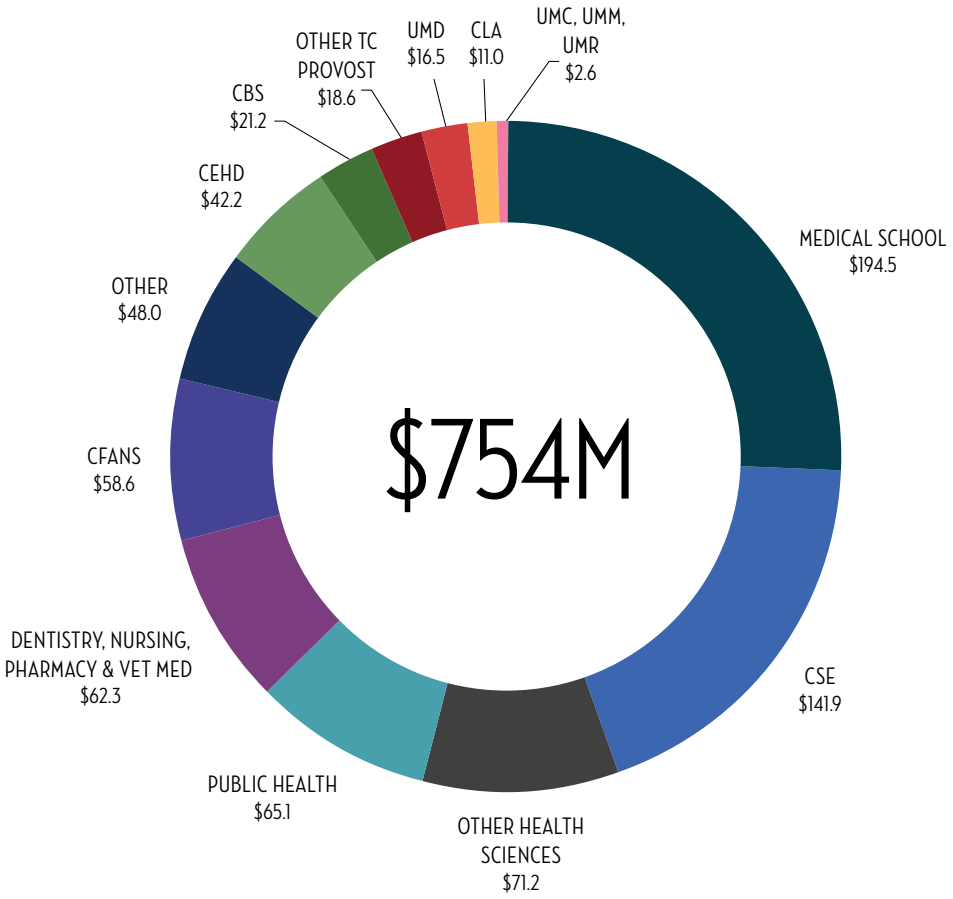
FIGURE 1 | *AWARDS BY SOURCE, FISCAL 2015*



Dollar amounts represented in millions
Office of the Vice President for Research Data Services

Figure 2 illustrates how the $754 million of externally sponsored research funding is distributed within the University by college and campus. Those with the largest annual increases include the College of Veterinary Medicine, up $26.7 million (180.4%), and the Other group, which was up $15.3 million (46.8%), primarily because of the aforementioned SNAP-ED awards to University of Minnesota Extension. Other Health Sciences was up $6.8 million (10.6%). Those with the largest decreases included the School of Public Health (SPH), down $29.4 million (31.2%) due to the previously referenced delay of a $30.3 million award, the Medical School, down $6.9 million (3.4%), and the College of Liberal Arts, down $1 million (8.2%).

FIGURE 2 | *AWARDS BY COLLEGE & CAMPUS, FISCAL 2015*



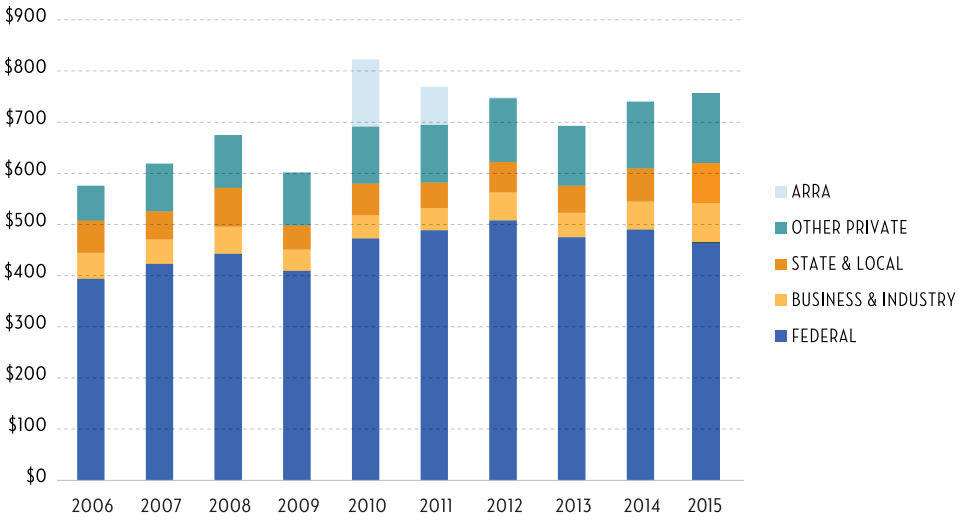
Dollar amounts represented in millions
Office of the Vice President for Research Data Services

Year-to-Year trends

Figure 3 and Table 1 below summarize a 10-year distribution trend of externally sponsored research for FY2006 to FY2015. When adjusted for inflation, annual award funding totals to the University over that period increased by 10.8%. Federal awards to the University for that same 10-year period fell by an inflation adjusted 0.4%. This small decline in federal awards is actually a success because national overall inflation adjusted federal R&D funding fell by a greater amount (22.6% in defense categories and 1.5% in non-defense categories) over that same period.

Despite some year-to-year variations in the proportions of funding (Figure 3), the $754 million funding total for FY2015 was roughly the same as FY2012 if funds from the one-time American Recovery and Reinvestment Act of 2009 (ARRA) are excluded. This is evidence of sustained funding levels for the University.

FIGURE 3 | *AWARDS BY MAJOR SOURCE CATEGORY, FISCAL YEARS 2006-2015*



Dollar amounts represented in millions
Office of the Vice President for Research Data Services

Table 1 demonstrates the reduction of Federal funding and how it is being replaced by Business & Industry and Other Private support. Adjusted for inflation, Business & Industry awards grew by 23.4% and awards from the Other Private category by 38.9%.

TABLE 1: *AWARDS BY MAJOR SOURCE CATEGORY, FISCAL YEARS 2006-2015*

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ARRA	–	–	–	–	$131.4	$74.2	$2.5	$0.8	$0.6	$0.2
OTHER PRIVATE	$68.8	$93.6	$103.2	$104.1	$111.3	$112.8	$123.9	$116.8	$130.1	$133.0
STATE & LOCAL	$62.8	$55.0	$75.9	$46.8	$61.8	$50.0	$59.7	$53.1	$64.6	$79.3
BUSINESS & INDUSTRY	$50.7	$47.8	$52.8	$41.7	$45.5	$43.6	$55.2	$47.6	$55.2	$78.0
FEDERAL	$393.8	$422.9	$442.9	$409.3	$472.7	$488.5	$507.7	$475.2	$490.0	$463.1
TOTAL	$576.1	$619.2	$674.8	$601.9	$822.7	$769.1	$749.1	$693.4	$740.6	$753.6

Dollar amounts represented in millions
Office of the Vice President for Research Data Services

Diversification is the key to a research university's ability to adequately support its research mission, as a recent qualitative survey of senior research officers at major research universities confirmed. "Our big push right now is to diversify our funding sources. We need to increase the share that comes from non-NIH and non-federal sources,"[1] read one representative quote. Combined, FY2015 totals for Business & Industry and Other Private funding now comprise 28.0% of new funding to the University, **underscoring the increasing importance of our public-private partnerships in a period of declining federal resources**.

As was noted in Table 1, new Business & Industry funding reached an all-time high of $78 million in FY2015. Even more important is the positive growth trend that Business & Industry funding has shown since FY2011's total of $43.6 million. This trend aligns with two significant public-private partnership strategies launched since FY2011: the MN-IP (Minnesota Innovation Partnerships) program and the Corporate Engagement Workgroup (CEW). As will be discussed later in the technology commercialization section, 69 new sponsored research MN-IP agreements were signed with industry partners in the past year and 175 have been signed since its inception.

[1] Education Advisory Board (2015, August 25). Growing Research Funding: Representative Comments from VPR Interviews [PowerPoint slides]. Presented at Charter Advisor Roundtable for Chief Research Officers at EAB Headquarters, Washington.

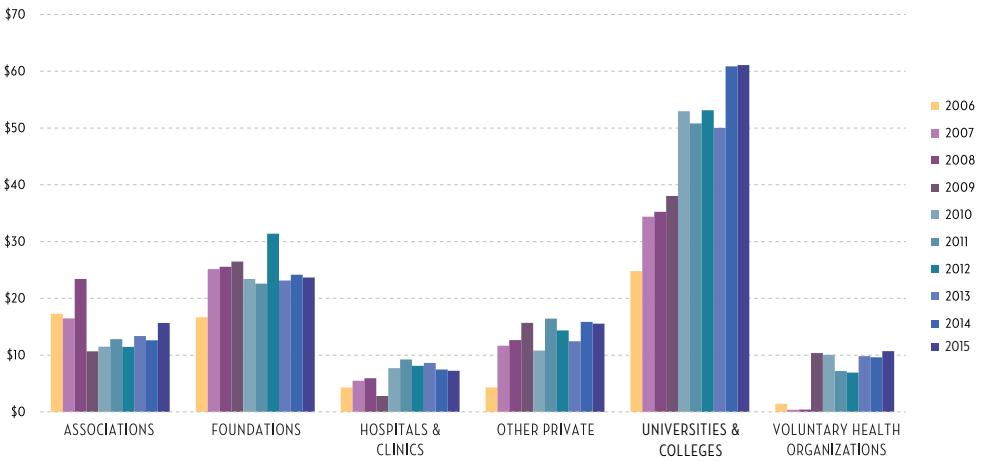
In FY2015, James Neaton in the School of Public Health received $17 million from

LEIDOS BIOMEDICAL

(with support from NIH) for several projects, including influenza studies, vaccine and treatment trials for Ebola and a study of Ebola survivors.

The vision for CEW, a partnership between OVPR and the University of Minnesota Foundation, is to connect the University's extensive innovation and talent resources with the needs and goals of private sector partners. CEW helped facilitate a master agreement with PepsiCo ($2.3 million) and sponsored research funding with St. Jude Medical, Target Corp. and Boston Scientific, to name just a few successful projects.

FIGURE 4: *OTHER PRIVATE AWARDS BY SOURCE CATEGORY*



Dollar amounts represented in millions and current dollars
Big Ten-CIC database

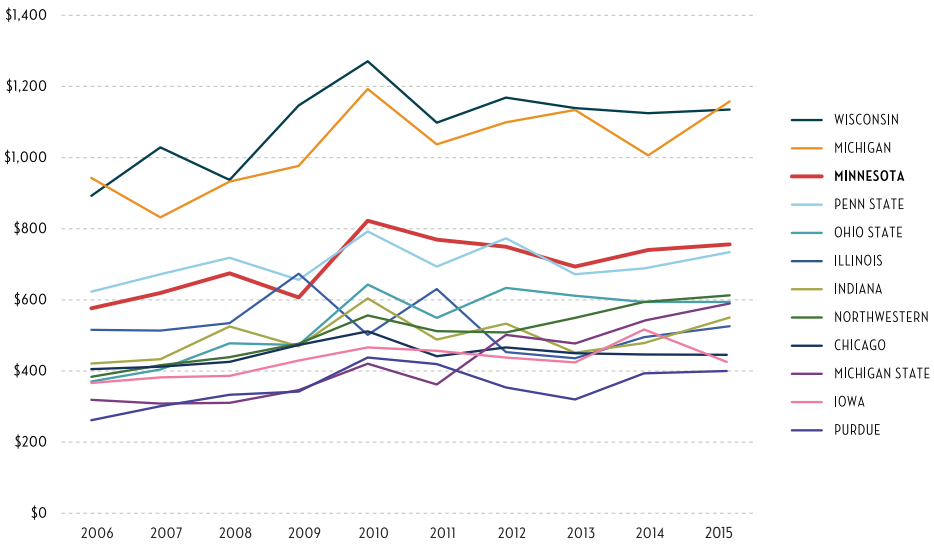
Growth in the Other Private category grew the most dramatically over the ten year period, with **the largest portion of that growth due to collaborations with other Universities and Colleges** (Figure 4). Collaborations with other Universities & Colleges represent 46% of the FY2015 Other Private category, its largest share.

One current example of multi-university collaboration is a new study led by Dorothy Hatsukami, professor in the U's Department of Psychiatry and associate director of Cancer Prevention and Control for the Masonic Cancer Center, evaluating nicotine standards for cigarettes. Working with researchers from the University of Pittsburgh, the study has found that cigarettes with lower nicotine levels could lead to lower levels of dependence and help more smokers quit. The study is funded by NIH.

These multi-university relationships underscore the words of Herman B. Wells, former chancellor of Indiana University and a founder of the Committee on Institutional Cooperation (CIC): "Academic isolation has long been impractical; in today's world, it is impossible…no single institution has the resources in faculty or facilities to go it alone."[2]

Figure 5 expands the 10-year research award funding analysis with selected members of the CIC (or more commonly referred to as the "Big Ten" plus Chicago). Within this elite group of universities, which occupy five of the top 12 spots for public universities by expenditures (Table 3), the U of M continued to rank third in new award funding.

FIGURE 5: *AWARD FUNDING BY SELECTED CIC ("BIG TEN") INSTITUTION*



Dollar amounts represented in millions
Big Ten-CIC database
Note: Maryland, Rutgers and Nebraska were omitted due to non-reporting of data to the CIC

[2] Wells, H.B. A Case Study on Interinstitutional Cooperation, Educational Record, Fall 1967. Retrieved from https://www.cic.net/docs/default-source/news-pub/historyofcic.pdf?sfvrsn=0

NATIONAL AND GLOBAL ANALYSIS

PEER COMPARISON

Analysis of FY2014 Research Expenditures

According to the National Science Foundation's Higher Education Research and Development (HERD) Survey data for FY2014, the University maintained its top 10 ranking and moved up in ranking from the ninth to the eighth position among public research universities, posting over $877 million in research expenditures (Table 3). The HERD survey is the primary source of comparative information on R&D expenditures at U.S. colleges and universities. It is completed by over 900 universities and colleges every year, producing the most accurate statistics possible on U.S. higher education R&D spending. Because of survey reporting requirements, the University's $877 million represented research expenditures for the Twin Cities campus only. **If all U of M campuses were reported together, the total would grow to $901 million**.

As is evidenced in Table 3, the University remains among an elite group of U.S. public research universities. While there is no single indicator or composite number that accurately represents what an individual institution has done, can do, or will do, the HERD survey data does provide a credible and nationally accepted basis for comparison. The University of Minnesota is among the top 1% of all universities reporting in the HERD survey.

In addition, Table 3 also includes two other widely accepted and cited ranking systems, the Center for Measuring University Performance (CMUP) and the Academic Ranking of World Universities (ARWU). These systems rely on a number of indicators that serve as a proxy for accomplishments and strength relative to the best performing research institutions in the country and the world. By both these additional measures, the University remains highly competitive with its peers.

TABLE 3: *TOP 20 INSTITUTIONS*

	NSF/HERD - 2014		CMUP - 2013‡	ARWU (SHANGHAI) RANKINGS 2015		
	PUBLIC	EXPENDITURES	PUBLIC	WORLD	U.S.	U.S. PUBLIC
MICHIGAN	1	$1,349,262	9 of 9	22	17	7
WASHINGTON	2	$1,176,340	8 of 9	15	13	4
WISCONSIN	3	$1,108,564	9 of 9	24	18	8
UC SAN FRANCISCO†	4	$1,084,031	7 of 9	18	16	6
UC SAN DIEGO	5	$1,067,388	8 of 9	14	12	3
NORTH CAROLINA	6	$989,766	9 of 9	39	29	14
UCLA	7	$948,197	9 of 9	12	10	2
MINNESOTA–TWIN CITIES	**8**	**$876,870**	**9 of 9**	**30**	**22**	**10**
PITTSBURGH	9	$856,806	8 of 9	70	41	24
TEXAS A&M	10	$854,214	6 of 9	100	51	31
OHIO STATE	11	$815,075	8 of 9	67	40	23
PENN STATE	12	$800,773	8 of 9	60	36	20
TEXAS M.D. ANDERSON CANCER CENTER†	13	$794,980	4 of 9	101-150	52-65	59
UC BERKELEY	14	$744,343	9 of 9	4	4	1
GEORGIA TECH	15	$725,550	7 of 9	101-150	52-65	55
UC DAVIS	16	$711,721	5 of 9	57	35	19
FLORIDA	17	$708,526	9 of 9	83	44	25
RUTGERS	18	$644,116		64	39	22
ILLINOIS	19	$621,733	9 of 9	29	21	9
ARIZONA	20	$588,088	5 of 9	90	46	26
TEXAS	21	$585,251	9 of 9	37	27	12

Dollar amounts represented in thousands

National Science Foundation's HERD Survey

† *The University of California - San Francisco and University of Texas M.D. Anderson Cancer Center are stand-alone medical schools without undergraduate education programs. Therefore, the highest CMUP ranking they can obtain is 8 rather than 9 as they do not have SAT scores for ranking purposes.*

‡ *As of 10/13/2015 the 2013 CMUP data is the latest available.*

TECHNOLOGY COMMERCIALIZATION

The Office for Technology Commercialization continued its strong performance and productivity in FY2015. With a few exceptions, all metrics showed growth over the previous fiscal year (Table 2). A record 16 startup companies were launched in FY2015, topping the previous year's high performance.

TABLE 2: *UNIVERSITY TECHNOLOGY COMMERCIALIZATION DATA*

	2011	2012	2013	2014	2015
GENERAL					
INVENTION DISCLOSURES	250	321	331	343	354
NEW LICENSES†	76	71	91	154	268
CURRENT REVENUE GENERATING AGREEMENTS†	457	426	331	429	544
GROSS REVENUES	$10.1	$45.7	$39.5	$27.4	$20.2
OUTGOING MATERIAL TRANSFER AGREEMENTS	271	313	281	288	297
PATENTS					
ISSUED PATENTS (U.S. AND FOREIGN)	100	153	129	104	136
NEW U.S. PATENT FILINGS	78	115	148	138	146
MN-IP					
MN-IP RESEARCH AGREEMENTS	-	14	41	51	69
COMPANIES W/ MN-IP RESEARCH AGREEMENTS	-	15	38	44	54
SPONSORED RESEARCH COMMITMENTS	-	$2.6	$3.8	$4.3	$10.8
STARTUPS					
STARTUP COMPANIES	9	12	14	15	16

Dollar amount represented in millions

Office for Technology Commercialization, InfoEd System; Enterprise Financial System

† *Starting in FY2014, New Licenses and Current Revenue Generating Agreements include Express Licenses with revenue greater than $1,000. This accounts for an increase of 56 agreements over FY2013. Starting in FY2015, New Licenses and Current Revenue Generating Agreements include 94 FAST IBU licenses.*

Table 2 also reflects the University meeting the state's biennial appropriations performance goal of a 3% increase on invention disclosures between FY2014 and FY2015. This metric is one of the five accountability measures the University tracked in FY2015 as a condition to receive its full biennial appropriation from the state of Minnesota.

In FY2015, 69 new sponsored research agreements were signed through the MN-IP program, a program recognized nationally for its innovative approach, bringing the total number of MN-IP agreements signed since the inception of the program to 175.

The Discovery Capital investment program, which provides seed investments for the most promising University startups, has had notable success in its first year. Launched in 2014, the program offers $350,000 in seed funding with a requirement that the investment be matched by an external partner. To date, three startup companies have been approved for funding. In addition to the University investment, aggregate outside capital in the amount of $3 million has been identified by these companies.

INSTITUTIONAL FUNDS FINANCING RESEARCH

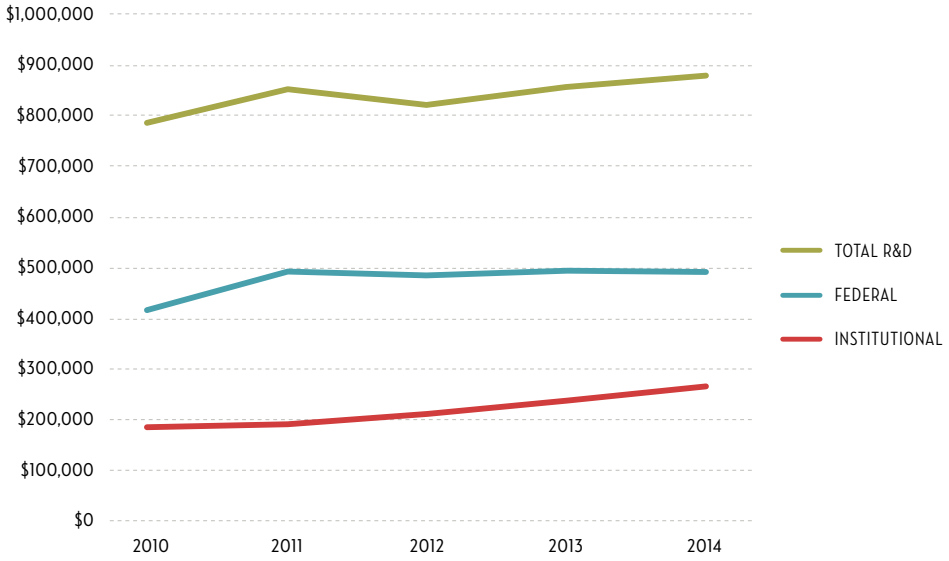
A growing and significant portion of the University of Minnesota's $877 million total R&D spending in FY2014 is the institution's $256 million spending of its own funds on research. The $256 million is a 7.9% increase from the previous year's $237 million. Institutional funds, which now account for 29% of the University's total R&D spending, can when invested strategically catalyze additional research with high return, as seen in the Grant-in-Aid and Minnesota Futures sections below. However the increased magnitude of this investment over the past five years is a different story and depicts an R&D funding shift that is mirrored nationally and is not sustainable long term.

Figure 6 shows a five-year comparison between federal and institutional sources at the University and when combined, federal and institutional sources of R&D spending represent 85% of total R&D for the University. The remaining 15% represents all other external sources of R&D revenue. Figure 6 demonstrates that unadjusted federally funded expenditures at the University have been flat since 2011. (When adjusted for inflation, federal expenditures have delined.)

Increased use of institutional funding for research is a national trend and largely a result of decreased federal investment in research, including federal rules governing the amount and uses of indirect costs. For FY2014, the National Center for Science and Engineering Statistics[3] reported a 5.3% increase in universities' use of their own funds for research. Similarly, this same report stated that federally funded expenditures have dropped 6% since FY2011, the greatest multi-year drop since statistics began to be compiled in 1972.

[3] National Center for Science and Engineering Statistics. 2014. Universities Report Continuing Decline in Federal R&D Funding in FY 2014. Retrieved from http://www.nsf.gov/statistics/2016/nsf16302/

FIGURE 6: *UMN R&D EXPENDITURES BY SOURCE OF FUNDS (FY2010 - FY2014)*



Dollar amounts represented in thousands
National Science Foundation's HERD Survey

There are three components to institutional funds and in FY2014 they were represented as follows: direct funding of R&D, $183 million (71.6%), cost sharing on externally sponsored projects, $23.8 million (9.2%) and Facilities and Administrative (F&A, also referred to as indirect) costs on external projects that are not reimbursed by sponsors, $49.2 million (19.2%).

The largest component, $183 million of direct funding, represents the discretionary portion of institutional R&D spending. While the University can identify where this funding occurs within the institution, little analysis has been done on how these direct funds are invested in research. The University has an opportunity going forward to look systematically at direct institutional funding to determine if these resources are allocated optimally, providing the best return on investment.

Cost sharing and under-recovered F&A costs ($73 million in total) represent the mandatory institutional cost of doing externally sponsored research. All F&A costs that are recovered from externally sponsored research go back to a researcher's college, which has the authority to determine how those funds are dispersed; colleges also have the responsibility to pay their proportionate share of centrally provided services such as heating and cooling, libraries and administrative staff, and F&A dollars provide funds to help cover them. Under-recovered F&A costs ($49.2 million) therefore represent the lack of funding provided by the research sponsor to fully support the cost of that research, which the institution then has to provide.

Nationally, institutional research funding is the fastest growing source in the last five years, and it has become an increasingly important part of University's research enterprise (Figure 6). For most universities, including our own, the growth in institutional funding of research is not sustainable. According to Meranze and Newfield (2014), it is critical that institutions report on and discuss the cost of research and their own institutional costs and point out that the federal government's "freezing public funding to hundreds of research universities is undermining the country's research ecosystem."[4]

[4] Meranze and Newfield. 2014. How Can Public Research Universities Pay for Research? Retrieved from http://utotherescue.blogspot.com/2014/08/how-can-public-research-universities.html

FIVE YEARS FORWARD

Results and Opportunities

FY2015 was the first full year of implementing the University's system-wide research strategic plan, Five Years Forward through Collective Inspiration and Discovery, and it unfolded through both short-term and long-term initiatives. The work continues to be faculty driven, highly collaborative and dynamic based on the changing research environment. The fundamental vision that drives the University's research enterprise is bringing people together in new ways, fostering discoveries and making our world a better place. Realization of this vision is organized around four thematic areas, or cornerstones, where the University will forge its path forward.

Enhance Research Excellence

Advance Transdisciplinary Partnerships

Accelerate Transfer of Knowledge for the Public Good

Promote a Culture of Serendipity

Included below for each cornerstone of the plan are the accomplishments to date and planned work for the upcoming year.

Enhancing Excellence and Advancing Partnerships

Advancing Human Research Protections

In the past year, the University has undergone a rigorous review and assessment of its human research policies and practices, and is now implementing major enhancements to its human research protection program. Some key areas of enhancement include: reinforcing an ethical culture, more education and training for investigators and staff, changes to Institutional Review Board processes and policies, new approaches for managing conflicts of interest, and increased community participation and oversight. Once fully implemented, these improvements will ensure that the well-being of research participants remains at the center of all University research activities and will establish a program that will serve as a national model.

The timeline for implementation is July 2015 - June 2016. Monthly progress updates are being posted to http://advance-hsr-alerts.umn.edu/

MnDRIVE

MnDRIVE (Minnesota's Discovery, Research and InnoVation Economy) is a groundbreaking partnership between the University of Minnesota and the state that aligns areas of University strength with the state's key and emerging industries to produce breakthrough research that addresses our greatest challenges. The four primary research areas are: Robotics, Sensors and Advanced Manufacturing; Global Food Ventures; Advancing Industry, Conserving our Environment; and Discoveries and Treatments for Brain Conditions.

Since inception in 2013, $34.5 million has been authorized for more than 210 projects across the four research areas involving 629 researchers in 103 departments, 21 colleges and three campuses (Twin Cities, Duluth and Morris) (Table 4). Because of this work and collaboration, MnDRIVE researchers in total leveraged $57 million in state, federal and private funding from major companies such as Boston Scientific, and federal agencies including National Science Foundation, U.S. Department of Agriculture and the National Institutes of Health. MnDRIVE collaborators have also submitted 41 disclosures for inventions.

TABLE 4: *MNDRIVE BY THE NUMBERS: SINCE INCEPTION*

MNDRIVE PROJECTS	210
RELATED PUBLICATIONS	638
INVENTION DISCLOSURES	41
SUCCESSFUL EXTERNAL PROPOSALS	$57M
OUTREACH, MEETINGS, CONFERENCES	500
PEOPLE REACHED	30,000
STUDENTS GRADUATED	11

MnDRIVE's Transdisciplinary Research Program supports cross-disciplinary, collaborative research that addresses at least three of the four MnDRIVE research areas. In 2014, nearly $6 million was awarded to 12 transdisciplinary research projects spanning three U of M campuses and involving researchers from across 10 colleges and 24 departments. The Transdisciplinary Research Program projects have already resulted in at least three new inventions.

One representative project involves using precision agriculture systems to help farmers curb the harmful effects of soybean aphids. It brings together experts not only in entomology but also in industrial design, applied economics and aerospace engineering and mechanics.

International Research

The Five Years Forward plan has a goal of increasing the prominence of international research. University researchers collaborate in 152 countries across the globe, with over 30 percent of their publications including international co-authors, and, over the last 10 years, that collaborative international work grew twice as fast as U of M publications without an international author.

In February 2014, Vice President Herman appointed a faculty and staff committee to identify short- and long-term objectives and priorities to enhance the University's reputation as a leader of global research. The committee came up with several recommendations, which included a need to identify the greatest areas of opportunity for international research. By the end of FY2015, it was determined that existing data sources could provide enough information so that the areas of greatest geographical opportunity could be analyzed and discussed.

In FY2016, OVPR will bring together U of M researchers who currently collaborate in or are interested in high-potential geographic regions. To catalyze promising collaborations, OVPR will provide seed funding to facilitate these partnerships, such as covering expenses for face-to-face meetings with international collaborators or making core research infrastructure, such as supercomputing resources, accessible to researchers from developing countries. OVPR will also bring together academic and business leaders from high-priority geographic regions along with Minnesota industry, funding agencies and philanthropy to develop new relationships that University researchers can build upon.

Research Computing

In FY2015, OVPR continued to shape research computing services in order to best serve University of Minnesota faculty across many disciplines and the broader research community.

The University of Minnesota Informatics Institute (UMII), founded in January 2014, has fostered and accelerated research across the University through informatics services, competitive grants and consultation. UMII helps researchers manage information across the data life cycle and is working directly with high-throughput facilities to provide data analytics services to their users.

The Minnesota Supercomputing Institute (MSI) is a longstanding nexus for leading edge research in scientific computing, for fostering interdisciplinary research on campus and for enabling public-private collaborations. With approximately 600 research groups, MSI plays a key role in enabling high-impact research. MSI recently acquired a world-class supercomputing system, called Mesabi. Mesabi means "immense mountain" in Ojibwe and is the name of the chief iron ore deposit in the U.S., located in the Iron Range in northern Minnesota. Not only is this name steeped in Minnesota natural history, but it is also tied to an informal term for supercomputers, "Big Iron." Mesabi is among the top 10 fastest academic supercomputers in the U.S.

In early FY2016, the management of UMII and MSI was consolidated under a new umbrella, Research Computing, housed in OVPR. Research Computing is creating a user-centric environment where solutions can be tailor-made to a researcher's needs in a wide variety of large, computationally intensive research projects in the life, health and social sciences.

With funding from the

MnDRIVE

Transdisciplinary Research Program, a multi-disciplinary team of researchers is developing uninhabited aerial vehicles (UAVs) and computer monitoring technology to help farmers better detect and manage the threat of pests and decrease the environmental impact of pesticide use.

Research Advancement

OVPR Research Advancement programs strive to support pre-award aspects of the proposal development process with tips, toolkits and other resources. In the past five years, OVPR has invested $108 million in research funding across the University's colleges and campuses, providing approximately $20 million annually to research and supporting resources. These seed funds are designed to leverage other investments and promote collaborations across the University and with business and industry partners. Examples of programs being leveraged are:

Grant-in-Aid

The Grant-in-Aid (GIA) of Research, Artistry and Scholarship Program provides grants to support scholarly and artistic activities of faculty and their graduate students to foster excellence throughout the University. GIA projects represent the breadth and depth of University research in all disciplines and fields. While any faculty member can apply for GIA funding, it plays an especially important role by providing new professors and emerging researchers' opportunities to pursue research and scholarship that may not yet have received external funding. University return on investment (ROI) for this program is for every $1 GIA funding awarded, $5.50 of extramural funds is received.

In the past five years, $15 million has been awarded through the GIA program that benefited:

- 528 research projects
- All 5 U of M campuses
- 29 colleges/units

Research Infrastructure

The Research Infrastructure Investment awards are one way the University ensures it maintains robust, state-of-the-art equipment to support research and academic endeavors. These improvements to research infrastructure support the University's talented researchers as they explore new ideas, form new partnerships and make groundbreaking discoveries.

This year's program impacted researchers in at least five colleges and 12 centers and institutes, supported transdisciplinary research and encouraged collaboration across the U's colleges and campuses. Thirteen proposals were chosen for funding, ranging from a new 3D bioprinting facility to an expansion of the Multisensory Perception Laboratory where researchers can measure audio-visual perception in a variety of simulated environments.

In the past five years, over $33 million in infrastructure awards have been provided, benefiting:

- 46 research projects
- 2 campuses
- 29 colleges/units; 58 including departments
- 2,027 infrastructure users

Minnesota Futures Program

The Minnesota Futures program nurtures extraordinary interdisciplinary research ideas. The two-year grants, which are supported by technology commercialization revenue, fund research opportunities that cross disciplinary and professional boundaries and support in-depth research that aims to address society's grand challenges. Since 2008, the Minnesota Futures grants have supported research by faculty who go on to win substantial grants with the potential for life changing innovation. University ROI for this program is for every $1 Minnesota Futures has awarded, $7.50 of extramural funds was received.

The 2015 Minnesota Futures grants include two projects that advance new approaches to disease treatment. One project combines the University's strengths in genome engineering and biotechnology to explore new methods to generate cells used in drug development. The other project explores an overlooked bacterial process that may play a crucial role in blocking beneficial phosphates, found in tooth paste and other topical therapies, from reaching the tooth.

Accelerating Transfer of Knowledge for the Public Good

Economic Development

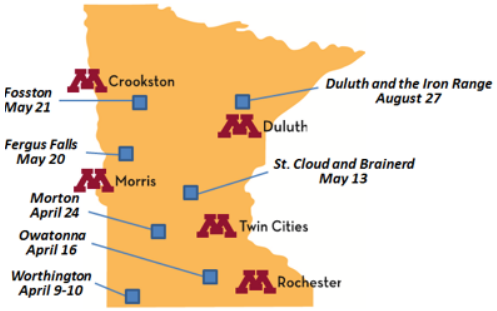
The University of Minnesota is among the top research institutions in the nation and is a powerful economic engine for the state, creating $8.6 billion in total economic impact annually. The Office of University Economic Development (UED) was established in 2014 as part of the research strategic plan, which identified an increasing need for public-private partnerships in economic development. The office's mission is to strengthen the University's ties to business and community partners and help grow and diversify Minnesota's economy. Today UED serves as a public face for economic development at the U, helping external partners connect with resources, services and expertise at the University and its system campuses, and promoting internal collaboration across the breadth of its economic development activities.

UED has had three primary focus areas during this past year:

- Providing a portal ("Front Door and More") for potential collaborators to connect with University resources and capabilities and helping University faculty and staff connect with external resources (e.g., industry). Over a 12-month period, UED received and dispatched over 200 requests for connectivity support and hosted events on campus that included local, national and international businesses and economic development groups.

- Co-leading the Corporate Engagement Workgroup (CEW) with the University of Minnesota Foundation. The vision of CEW is to connect the University's extensive innovation and talent resources with the needs and goals of private sector partners. The group includes representatives of each U of M college and system campus and meets regularly to strategically manage a portfolio of active corporate partners and a discovery portfolio. CEW's work to date has resulted in new public-private partnerships as well as a broadening of economic engagement with existing industry partners.

- Engaging in a series of economic development meetings around the state. UED has organized and made nine Greater Minnesota community visits to publicize the office's goals and resources, discuss current community needs identified by local business and economic development leaders, and explore possible areas of partnership with the University. The visits allowed UED and OVPR to renew and strengthen connections with University campuses in Crookston, Duluth, Morris and Rochester and several Research and Outreach Centers, and Extension leaders across the state. Logging over 2,000 miles within the state, UED visited 16 communities representing 14 counties, including Owatonna, Austin, Morton, St. Cloud, Brainerd, Fergus Falls and Fosston, and engaged with approximately 250 people. In early FY2016, destinations included Duluth and Eveleth.



Technology Commercialization *(see p. 16)*

Promoting a Culture of Serendipity

Promoting a culture of serendipity is central to connecting researchers across departments, colleges and disciplines—and with colleagues and communities outside of the University—to think creatively and cultivate new ideas. Connectors, individuals across and at all levels within the U of M, play essential roles in bringing together seemingly unrelated disciplines and ideas to foster creativity and innovation.

OVPR is pursuing a number of efforts intended to promote a culture of serendipity, including the new Convergence Colloquia series and Serendipity Grants. In addition, OVPR is working to identify, network and empower people at the University who are connectors, so that they can be even more effective.

Convergence Colloquia

Convergence Colloquia are a new series of day-long, multi-disciplinary gatherings that convene internal and external expertise around emerging research opportunities and societal challenges. According to a National Academy of Sciences report: "[C]onvergence is meant to capture two closely related but distinct properties: the convergence of expertise necessary to address a set of research problems and the formation of the webs of partnerships involved in supporting such scientific investigations and enabling the resulting advances to be translated into new forms of innovation and new products."[5]

Based on this model of convergence, the University's colloquia are action-oriented think tanks that bring together U of M researchers with private, public and nonprofit stakeholders in focused, facilitated discussions. Two colloquia, on smart cities and infrastructure, and aging, took place in FY2015, two more, on health equity and renewable energy, have happened thus far in FY2016, and two more are planned for sustainable food systems and water supply.

The four colloquia held thus far have had more than 340 participants, representation from 14 Twin Cities colleges, UMD and UMM, as well as the Metropolitan Council and several state agencies, 40 nonprofit organizations, and 25 private companies. Already, 29 proposals have been submitted to OVPR for new projects growing out of the colloquia. The proposals are eligible for follow-on Serendipity Grants of up to $30,000 to kick start ideas and new collaborations that connect across disciplines and with organizations outside the U of M.

Connectors Network

In FY2016 OVPR will initiate and support two new committees. The Connectors Network will engage collegiate and research center staff involved in research advancement activities to explore capacity building needs and collaboration opportunities. The Serendipity team will draw on administrators and faculty who have demonstrated leadership advancing cross-disciplinary connections and who are motivated to play a strategic role in advancing serendipity at the U of M. The idea is for the two committees to engage different participants, but to come together occasionally to advance key initiatives.

[5] National Research Council 2014. Convergence: Facilitating Transdisciplinary Integration of Life Sciences, Physical Sciences, Engineering, and Beyond. Washington, D.C., The National Academies Press.

CONCLUSION

In the face of a declining federal investment in research, the University of Minnesota continues to make steady progress in growing its research enterprise across a broad array of disciplines and ideas. That progress is a tribute to the creative and dedicated people of our research community, who have continued to advance academic scholarship, address global challenges and develop breakthrough research in an increasingly competitive research environment.

Despite the real challenges research institutions face in this funding climate, the University's research engine continues to thrive and be highly competitive and successful. The data presented here show the increasing importance of collaboration with other universities and public-private partnerships. Not only do those new partnerships hold the potential for additional research resources, they will also help connect our researchers' knowledge and creativity with the challenges our world faces.

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