PREFACE

Each year the Vice President for Research provides the Annual Report on the Status of University Research and Commercialization of Intellectual Property for the Board of Regents, summarizing the University of Minnesota’s research metrics for the past fiscal year, documenting the trends in research productivity, scholarship and commercialization of intellectual property as well as benchmarking the University’s performance and ranking among its peer group. In addition, the Vice President reports progress on a broad set of strategic priorities and principles that build upon the University’s historical research strengths and strategies to address barriers to research success.
The FY2016 Annual Report includes:

**Message from the Vice President for Research / 4**

**Research Statistics** (award data) / 8
- Externally sponsored research funding totals and comparison with previous year
- Year-to-year trends by source of funds and peer comparison

**National and Global Analysis** (R&D expenditure data) / 14
- Higher education research and development (R&D) expenditures and Top 20 performance
- National and global rankings among public research universities

**Technology Commercialization** / 16

**Economic Development** / 19

**Capacity Building** / 21
- Minnesota’s Discovery, Research and InnoVation Economy (MnDRIVE)
- Research Advancement Programs
- Increasing Informatics Capabilities
- Increasing Prominence of International Research
- Research Engagement
MESSAGE FROM THE
VICE PRESIDENT FOR RESEARCH

I arrived at the University of Minnesota nearly four years ago with the following guiding principles:

Produce **excellence**
Be **transformative, lead** not follow
Advance **transdisciplinary** work
**Focus** on critical global challenges
Present real, **measurable results**

A little over a year after my arriving, the Board of Regents approved the Five Years Forward: Through Collective Inspiration and Discovery system wide research strategic plan after input from close to 4,000 individuals from within and outside of the University. Guided by this plan, we have achieved much in the years since then. I am particularly proud of the significant advancements that we collectively achieved under the plan’s four cornerstones, many of which are elaborated on in this report.

I am happy to report that we have achieved all of the Maroon metrics in the University Progress Card well ahead of schedule, and are on our way to meet the Gold metric of exceeding the target of $900 million of overall Twin Cities research expenditures ahead of 2021 (FY2015 UMTC research expenditures of $880 million; all campuses expenditures of $910 million). We have maintained our top 10 ranking and we are exceeding our goal to grow MN-IP agreements by 10% per year, increasing from 41 agreements in FY2013 to 81 in FY2016.
In addition, we successfully launched MnDRIVE and Research Computing, are near completion of our institutional plan to strengthen our Human Research Protection Program (HRPP) to ensure that the welfare of research participants is our highest priority, and expanded state-wide economic development and external engagement through our new Office of University Economic Development (UED). We re-engineered public-private partnerships, contributing to a doubling of research funding from corporate partners, we saw the creation of our 100th startup company and we have increased success of University startups through the creation of the Discovery Capital program, providing a 7 fold ROI—$1.7 million of our capital matched by $12.1 million external matching capital in the first year, and the new Gener8tor partnership. We funded a new Driven to Discover (D2D) research facility at the Minnesota State Fair and created an environment that nurtures creative innovation and discovery through Convergence Colloquia and Serendipity Grant programs.

While these accomplishments are outstanding and speak to the capabilities of the University of Minnesota, I do see dark clouds on the horizon for the U.S. academic research engine. While the U.S. higher education research enterprise is still considered among the best in the world, it is increasingly hampered by a long-term trend of public disinvestment that continues to flatten and erode research funding. Our national competitiveness will inevitably suffer in this environment of decreased availability of funding. But competitiveness is not the only possible casualty: the talent and facilities on our research campuses, which cannot be utilized to full capacity due to lack of funding, could be helping to solve significant global challenges in the realms of food, health, the economy, governance, human rights and the environment.

Diversification of funding sources to support higher education research is widely touted as a solution to declining/flat federal investment. The potential sources to be tapped include business and industry (B&I), philanthropy, foundations, other non-profits and an institution’s own funds. Many institutions, including the University of Minnesota, are investing significant amounts of their own funds to make up for loss in federal support, but this is not a sustainable solution because these funds are limited and measuring the true impact of this funding source is difficult to do.

Industry-supported research often tends more toward the applied side, neglecting the “seed corn” of research and development—basic research. Despite this reality of B&I funding, I strongly believe in, and have pushed for during my tenure, a greater reliance on industry-supported research.
To be successful in this more diversified universe of funding, researchers will need to shed their traditional reluctance to work with the private sector in search of what Harvard economist Michael Porter calls shared value, where a significant social issue is addressed using a business model

Porter gives as an example of this shared value how businesses increasingly see cutting pollution not as a drag on their bottom line, but a chance to generate profits. The concept of shared value means that we could create social and economic value at the same time. And since business represents more than two-thirds of the total U.S. investment in research and development (R&D), and universities are focused on providing new innovative solutions to societal issues, a better alignment of these interests would incentivize more investment of business resources in higher education R&D to tap into what research universities do best: arrive at innovative solutions that are then transferred to B&I for scaling up and transformation into economic value.

Such collaboration requires serious rethinking of classical academic structures, organization, incentives and policies, and researchers’ roles, as well as careful avoidance of inappropriate conflicts of mission, but it could help universities continue to contribute to the public good in the face of declining public support.

The current funding situation for the U.S. higher education research enterprise demands a sense of urgency and a willingness to change. It also requires much greater accountability. With leadership and a bold vision, I feel encouraged that the University of Minnesota can meet the challenges of this changing funding landscape for higher education research and maintain its historically important societal changing contributions.

---

In FY2016, William Iacono and Monica Luciana in the COLLEGE OF LIBERAL ARTS, Department of Psychology, received $7.4 million of a five-year $21.7 million award from the National Institutes of Health (NIH) to support research at the University’s Adolescent Brain Cognitive Development (ABCD) study site. The U of M is one of 19 sites nationwide where they are collaborating with other universities to research how substance use affects youth brain function, behavior and health.
RESEARCH STATISTICS

FISCAL YEAR 2016

University of Minnesota faculty and staff competed successfully for $788 million in externally sponsored research awards in FY2016, up 4.5% from FY2015. This $34 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 $165,000 per award in FY2015 to $169,000 per award in FY2016.

Figures 1 and 2 display more detail about the $788 million awarded by external sponsors, aggregating these data by funding source, and by college or system-wide campus, respectively. Figure 1 shows the University’s total federal funding level at $465.8 million, which is up $2.6 million (0.6%) from the previous year; private funding (Business & Industry and Other Private) together totaled $231 million and was up $19.7 million (9.3%) compared to last year; and funding from State & Local sponsors was up $11.6 million (14.6%). The federal government continues to be the largest source of external research funding (59.1%) at the University of Minnesota, although funding from nonfederal sources continues to grow and is up $31.3 million (2.4%) from the previous year.

Awards from the National Institutes of Health (NIH), the largest single source within the University’s federal funding portfolio, rose by $37.2 million (16.9%). A delayed $30.3 million NIH award to James Neaton in the School of Public Health accounted for much of the year-to-year change, as was mentioned in the FY2015 Annual Report. Along with the funding increase, 611 NIH grants were awarded to University of Minnesota researchers, compared with 583 in FY2015.

For the National Science Foundation, the second largest federal sponsor of University research, funding was down $8.1 million (8.8%), although the number of awards remained steady – 302 in FY2016 compared to 306 in FY2015. The remaining Other Federal funding agencies are also showing a decrease, down $26.4 million (17.5%), although an unusually large $20 million FY2015 award from USAID contributed to the drop in FY2016.

State of Minnesota funding increased this year by $11.6 million (14.6%), primarily due to large single awards. These large awards to the University were distributed across broad areas of research, such as transportation studies, regenerative medicine and nutrition. And as was true last year, the state’s other large investment in MnDRIVE is accounted for separately.
Business & Industry (B&I) funding was up $2.8 million (3.6%) in FY2016. This funding category continues to grow and to account for more than 10% of all externally funded research. The increases in B&I funding can be attributed in part to University strategies focused on public-private partnerships. Both the funding levels and the number of such awards grew—1,361 this year compared with 1,239 in FY2015. Among the new funding highlights was another significant series of awards—$11.5 million in total—to James Neaton by Leidos Biomedical Research, Inc. for a flu study project. Semi-Conductor Research Corporation made another significant award, providing $5.6 million for Jian-Ping Wang and the Center for Spintronic Materials, Interfaces and Novel Architectures (C-SPIN).

**FIGURE 1: AWARDS BY SOURCE (FY2016)**

Dollar amounts represented in millions
Office of the Vice President for Research Data Services
Figure 2 illustrates how the $788 million of externally sponsored research funding is distributed within the University by college and campus. Those colleges with the largest annual percentage increases include the College of Liberal Arts, up $12.4 million (111.9%), the College of Pharmacy, up $11.7 million (107.2%), and the School of Public Health, up $39.8 million (61.2%), including the aforementioned NIH award to James Neaton. Those with the largest decreases included the Medical School, down $12.7 million (6.5%), and the College of Education and Human Development, down $5.8 million (13.8%). The College of Veterinary Medicine was down $14.8 million (35.8%), where the large drop was primarily attributable to a large one-time award from USAID in FY2015.

**FIGURE 2: AWARDS BY COLLEGE & CAMPUS (FY2016)**

![Pie chart showing distribution of research funding by college and campus.](image-url)

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 ten year distribution trend of externally sponsored research awards for FY2007 to FY2016. When adjusted for inflation, annual award funding totals to the University over that period increased by 9.0%. If funds from the one-time American Recovery and Reinvestment Act of 2009 (ARRA) are excluded, the $788 million funding total for FY2016 is the highest total in the past 10 years (Figure 3). This also continues the trend of increased funding since FY2013.

Table 1 also shows Federal awards for the same 10-year period fell by 5.6% and demonstrates the replacement of federal funds by nonfederal sources. Adjusted for inflation, nonfederal sources such as Business & Industry awards (up $33 million/44.8%) and awards from the Other Private category (up $56.3 million/37.2%) grew substantially.

**FIGURE 3: AWARDS BY MAJOR SOURCE (FY2007-2016)**

[Dollar amounts represented in millions
Office of the Vice President for Research Data Services]
Also of note, Business & Industry funding reached an all-time high of $80.8 million in FY2016. Even more important is the positive growth trend that Business & Industry funding has shown since FY2013’s total of $47.6 million. This trend aligns with several significant public-private partnership strategies launched since FY2011: MnDRIVE, Minnesota Innovation Partnerships (MN-IP) program and the Corporate Engagement Workgroup (CEW). MnDRIVE-supported researchers attracted $8.9 million in B&I funding in FY2016 ($16.4 million since FY2013). And as is discussed later in the technology commercialization section, 81 new sponsored research MN-IP agreements have been signed with industry partners in the past year and 256 have been signed since the program’s inception.

Figure 4 compares research award funding over ten years with selected members of the Big Ten Academic Alliance (BTAA, formerly the Committee on Institutional Cooperation). Within this elite group of universities, which occupy five of the top 12 spots for public universities by expenditures (Table 2), the U of M continued to rank third in new award funding.
The **CENTER FOR SPINTRONIC MATERIALS, INTERFACES AND NOVEL ARCHITECTURES (C-SPIN)** received $5.6 million as part of a five-year, $28 million award from the Semiconductor Research Corporation (a technology research consortium that includes seven industry sponsors) and the U.S. Department of Defense. C-SPIN, led by the College of Science and Engineering’s Jian-Ping Wang, brings together top researchers from across the nation to develop faster, smaller and more energy-efficient computing technologies.
FIGURE 4: AWARD FUNDING BY BIG TEN ACADEMIC ALLIANCE (BTAA) INSTITUTIONS (FY2007-2016)

Dollar amounts represented in millions
Big Ten-CIC database
The CIC changed its name to the Big Ten Academic Alliance (BTAA) as of the end of FY2016, and University of Chicago is no longer a formal member.

NATIONAL AND GLOBAL ANALYSIS

PEER COMPARISON

According to the FY2015 National Science Foundation’s Higher Education Research and Development (HERD) Survey data (most recent available), the University maintained its top 10 status, holding its rank in the eighth position among public research universities and posting over $880 million in research expenditures (Table 2).
### TABLE 2: TOP 20 U.S. PUBLIC RESEARCH INSTITUTIONS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MICHIGAN</td>
<td>1</td>
<td>$1,369,278</td>
<td>9 of 9</td>
</tr>
<tr>
<td>WASHINGTON</td>
<td>2</td>
<td>$1,180,563</td>
<td>8 of 9</td>
</tr>
<tr>
<td>UC SAN FRANCISCO†</td>
<td>3</td>
<td>$1,126,620</td>
<td>7 of 9</td>
</tr>
<tr>
<td>UC SAN DIEGO</td>
<td>4</td>
<td>$1,010,466</td>
<td>8 of 9</td>
</tr>
<tr>
<td>WISCONSIN</td>
<td>5</td>
<td>$1,069,077</td>
<td>9 of 9</td>
</tr>
<tr>
<td>UCLA</td>
<td>6</td>
<td>$1,021,227</td>
<td>9 of 9</td>
</tr>
<tr>
<td>NORTH CAROLINA</td>
<td>7</td>
<td>$966,781</td>
<td>9 of 9</td>
</tr>
<tr>
<td>MINNESOTA—TWIN CITIES</td>
<td>8</td>
<td>$880,618</td>
<td>9 of 9</td>
</tr>
<tr>
<td>TEXAS A&amp;M</td>
<td>9</td>
<td>$866,678</td>
<td>5 of 9</td>
</tr>
<tr>
<td>PITTSBURGH</td>
<td>10</td>
<td>$861,205</td>
<td>7 of 9</td>
</tr>
<tr>
<td>TEXAS M.D. ANDERSON CANCER CENTER†</td>
<td>11</td>
<td>$833,406</td>
<td>4 of 9</td>
</tr>
<tr>
<td>OHIO STATE</td>
<td>12</td>
<td>$817,881</td>
<td>9 of 9</td>
</tr>
<tr>
<td>PENN STATE</td>
<td>13</td>
<td>$791,031</td>
<td>8 of 9</td>
</tr>
<tr>
<td>UC BERKELEY</td>
<td>14</td>
<td>$788,505</td>
<td>9 of 9</td>
</tr>
<tr>
<td>GEORGIA TECH</td>
<td>15</td>
<td>$765,370</td>
<td>8 of 9</td>
</tr>
<tr>
<td>FLORIDA</td>
<td>16</td>
<td>$739,522</td>
<td>9 of 9</td>
</tr>
<tr>
<td>UC DAVIS</td>
<td>17</td>
<td>$721,077</td>
<td>5 of 9</td>
</tr>
<tr>
<td>TEXAS (AUSTIN)</td>
<td>18</td>
<td>$650,608</td>
<td>9 of 9</td>
</tr>
<tr>
<td>ILLINOIS</td>
<td>19</td>
<td>$639,817</td>
<td>9 of 9</td>
</tr>
<tr>
<td>RUTGERS</td>
<td>20</td>
<td>$628,613</td>
<td>3 of 9</td>
</tr>
<tr>
<td>ARIZONA</td>
<td>21</td>
<td>$606,219</td>
<td>4 of 9</td>
</tr>
</tbody>
</table>

†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 the printing of this report, the 2015 CMUP data is the latest available.
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 on U.S. higher education R&D spending. Because of survey reporting requirements, the University’s $880.6 million represented research expenditures for the Twin Cities campus only. When all U of M campuses are reported together, the total is $910 million.

As is evidenced in Table 2, 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 2% of colleges and universities reporting in the HERD survey.

In addition, Table 2 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.

TECHNOLOGY COMMERCIALIZATION

The Office for Technology Commercialization (OTC) continued its strong performance and productivity in FY2016 with many performance measures showing growth over the previous fiscal year (see Table 3). One of those, invention disclosures, is one of five accountability measures the University tracked in FY2016 as a condition to receive its full biennial appropriation from the State of Minnesota. The increase in this measure means that the University has met the State’s biennial appropriations performance goal of a 3% increase on invention disclosures between FY2015 and FY2016.

Other significant technology commercialization highlights are included in the attached insert.
## TABLE 3: TECHNOLOGY COMMERCIALIZATION DATA (FY2012-2016)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENERAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INVENTION DISCLOSURES</td>
<td>321</td>
<td>331</td>
<td>343</td>
<td>354</td>
<td>402</td>
</tr>
<tr>
<td>NEW LICENSES*</td>
<td>71</td>
<td>91</td>
<td>154</td>
<td>268</td>
<td>194</td>
</tr>
<tr>
<td>CURRENT REVENUE GENERATING AGREEMENTS*</td>
<td>426</td>
<td>331</td>
<td>429</td>
<td>544</td>
<td>528</td>
</tr>
<tr>
<td>GROSS REVENUES</td>
<td>$45.7</td>
<td>$39.5</td>
<td>$27.4</td>
<td>$20.2</td>
<td>$46.9</td>
</tr>
<tr>
<td>OUTGOING MATERIAL TRANSFER AGREEMENTS</td>
<td>313</td>
<td>281</td>
<td>288</td>
<td>297</td>
<td>273</td>
</tr>
<tr>
<td><strong>PATENTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISSUED PATENTS (U.S. AND FOREIGN)</td>
<td>153</td>
<td>129</td>
<td>104</td>
<td>136</td>
<td>168</td>
</tr>
<tr>
<td>NEW PATENT FILINGS‡</td>
<td>115</td>
<td>148</td>
<td>138</td>
<td>146</td>
<td>202</td>
</tr>
<tr>
<td><strong>MN-IP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN-IP RESEARCH AGREEMENTS</td>
<td>14</td>
<td>41</td>
<td>51</td>
<td>69</td>
<td>81</td>
</tr>
<tr>
<td>COMPANIES W/ MN-IP RESEARCH AGREEMENTS</td>
<td>15</td>
<td>38</td>
<td>44</td>
<td>54</td>
<td>62</td>
</tr>
<tr>
<td>SPONSORED RESEARCH COMMITMENTS</td>
<td>$2.6</td>
<td>$3.8</td>
<td>$4.3</td>
<td>$10.8</td>
<td>$12.2</td>
</tr>
<tr>
<td><strong>STARTUPS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STARTUP COMPANIES</td>
<td>12</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

Dollar amounts represented in millions
Office for Technology Commercialization, InfoEd System; U of M Enterprise Financial System

*New Licenses and Current Revenue Generating Agreements: Updated in FY2014 to include express licenses with revenue greater than $1,000; FY2015 includes 94 licenses for the FAST technology, spun out that year as FastBridge Learning.

‡New Patent Filings: Updated in FY2015 to include both U.S. and foreign filings. Pre-FY2015 data include only U.S. filings.
ECONOMIC DEVELOPMENT

The Office of University Economic Development (UED) was established in 2014 in response to feedback from industry and economic development leaders who sought strengthened engagement with the University and connection to resources and capabilities across the University system. The office serves as the University’s “Front Door & More” and promotes a vision that Minnesota’s economy can grow, diversify and yield benefit to the state’s citizens when the University of Minnesota pursues innovative strategies to stimulate and contribute to shared economic success.

After spending significant time in FY2015 meeting with individuals around the state and faculty and staff across the University system, UED approved in FY2016 a three-year strategic action plan. The plan creates a three-part framework to expedite access, act statewide and catalyze economic development. It was presented to internal and external stakeholders and linked to government, industry, community, campus, collegiate and other unit level plans and initiatives.

Expedite Access

In FY2016, UED worked to improve access to the University’s resources for the drivers of statewide economic development—businesses, associations, governments and communities.

- UED responded to 166 “Front Door” requests through its on-line customer relations management system, a 70 percent increase over FY2015. Sixteen percent of requests from industry were from Fortune 500 (or FT Global 500) companies, including Boston Scientific, Cargill and Medtronic.

- UED continued collaboration with the University of Minnesota Foundation on the Corporate Engagement Workgroup (CEW). The portfolio of companies managed by CEW represented 16% ($13 million) of the University’s B&I research awards. CEW nurtures this investment by coordinating a company’s broader engagement with the University in areas of technology and innovation, workforce development, executive and employment engagement, and outreach and visibility. The CEW model is now being adopted by other universities.
FIGURE 5: UED MN EXTERNAL VISITS, CONFERENCES & EVENTS (FY2016)

**Act Statewide**
UED advanced economic development in both greater Minnesota and the Minneapolis-St. Paul region, building upon work in progress across the University system and pursuing opportunities to tell the University’s story:

- UED hosted 63 business and community partner visits to the University and made 70 on-site visits to business and community partners.
- Over a quarter of these visits were to Greater Minnesota.

UED represented the University’s innovation and talent resources at 66 conferences and events—presenting, hosting, sponsoring or exhibiting at 22 of them (Figure 5).

**Catalyze Economic Development**
UED actively connected the University’s talent resources with the needs of local businesses by creating the Economic Development Fellows Consulting Program. This partnership with the Graduate School offers graduate and professional students the opportunity to consult for businesses for academic credit. During the spring and summer of 2016, the UED Economic Development Fellows Consulting Program oversaw nine projects with Minnesota companies, involving 64 graduate students. The students provided roughly $60,000 in consulting value to the companies. Company satisfaction with the program resulted in internship offers for 12 students and full time job offers for three students.

UED represented the University of Minnesota in applying for and receiving the Association of Public and Land-grant Universities (APLU) award for the most innovative public research university in the
nation. The University received the honor as part of APLU’s fourth annual Innovation and Economic Prosperity University Awards. The awards honor public universities that are actively engaged in promoting regional economic development.

CAPACITY BUILDING

The University’s research strategic priorities target both sustainability and capacity building programs. Programs like MnDRIVE and Research Advancement are designed to support and nurture a diverse research portfolio with investments aimed toward growth and innovation.

MnDRIVE

800 researchers • 511 people hired • 116 departments
29 colleges • 3 campuses • $167M external funding
184 invention disclosures • 30 supported students graduated

MnDRIVE (Minnesota's Discovery, Research and InnoVation Economy) is a partnership between the University and the State of Minnesota that aligns areas of University strength with the state’s key and emerging industries to produce breakthrough research that addresses our state and society’s greatest challenges. Since inception, more than $71 million has been authorized for MnDRIVE research across its four research areas (robotics, sensors and advanced manufacturing; global food ventures; advancing industry, conserving our environment; and discoveries and treatments for brain conditions), involving more than 800 researchers in 116 departments, 29 colleges and three campuses (Twin Cities, Duluth and Morris).

With these funds and others leveraged, the four MnDRIVE areas have hired 511 people, including 31 new faculty, 246 graduate and undergraduate students, and 63 post-docs and have conducted some substantial outreach: more than 900 meetings, symposia, workshops, and conferences with more than 77,000 attendees ranging from researchers to industry partners.

MnDRIVE researchers have leveraged $167 million in additional state, federal and private funding from major companies and agencies such as Boston Scientific, NSF, USDA and NIH. The groups have also submitted 184 disclosures for inventions and helped launch 13 startup companies.
MnDRIVE students have also been an area of success. Thus far, more than 30 MnDRIVE supported students have graduated, and 12 of those students have gone on to work in industry at places like Medtronic, Seagate and Toro.

The MnDRIVE Transdisciplinary Research program was a related, one-time grant opportunity to promote cross-disciplinary, collaborative research addressing at least three of the four MnDRIVE research areas. In 2014, nearly $6 million was awarded to twelve transdisciplinary research projects, including a precision agriculture project headed by Demoz Gebre-Egziabher, who has partnered with a private corporation, Sentera, to develop a next generation pest control for research and agricultural use. Another transdisciplinary success includes launching a major clinical trial by Dr. Alexander Khoruts to study bioremediation of gut microbiota.

Research Advancement Programs

Over the past five years, the Office of the Vice President for Research (OVPR) has provided more than $36 million to researchers through several funding programs. The aims of these programs are to advance disciplinary and interdisciplinary initiatives and guide research infrastructure planning activities.

Minnesota Futures

The Minnesota Futures program supports extraordinary research by nurturing interdisciplinary ideas. The two, two-year $500,000 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 and whose innovations reach the market to potentially improve the lives of millions. For every dollar invested, $6.79 in external funding was generated in FY2010-2014.

The 2016 Minnesota Futures grants went to two projects: one to develop new therapies to fight life-threatening fungal infections and one to explore genetic control of invasive fish species.
Grant Match/Grant-in-Aid

The Grant-in-Aid 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. Grant-in-Aid (GIA) projects represent the breadth and depth of University research in all disciplines and fields. While any faculty 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. In the past five years, $14.5 million has been awarded through the GIA program. For every dollar invested, $4.19 in external funding was generated in FY2011-15.

Research Infrastructure Investment Program

The Research Infrastructure Investment Program is one way the University maintains robust, state-of-the-art equipment to support research and academic endeavors, even as federal funding for research declines. These infrastructure improvements are key to catalyzing research and innovation, and support the University’s talented researchers as they explore new ideas, form interdisciplinary partnerships, and make groundbreaking discoveries. In 2016, over $1.2 million dollars were matched one-to-one by funds from supporting colleges or centers, yielding over $2.5 million in total. Twelve proposals in nine colleges and eight centers and institutes across the University’s colleges and campuses were chosen for funding, ranging from an asphalt performance tester at University of Minnesota Duluth to expanded 3D bioprinting capacity to the Driven to Discover (D2D) research facility at the Minnesota State Fair.

Increasing Informatics Capabilities

In 2016, OVPR established Research Computing as an umbrella to consolidate management of research computing services provided by the Minnesota Supercomputing Institute (MSI), the University of Minnesota Informatics Institute (UMII) and U-Spatial. These three units offer increasingly customized resources for computer- and data-intensive research to the U of M research community.

The Minnesota Supercomputing Institute (MSI) is a 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 across the life, health and social sciences and the more traditional high-performance computing tasks common to the engineering and physical
The **Natural Resources Research Institute** received $300,000 from the state Iron Range Resources and Rehabilitation Board, matched by additional funds from OVPR and U of M Duluth, to test a new technology for refining high-purity titanium dioxide from mineral deposits in northeastern Minnesota and to evaluate its potential economic impact. Titanium can be alloyed to produce strong lightweight materials for jet engines, mobile phones and more.
sciences. Some recent publications generated by MSI researchers include an analysis of how the change from a prairie landscape to crop fields has affected Minnesota weather and a study indicating that mice from “dirtier” environments replicated human immune systems more closely than their “cleaner” counterparts.

The University of Minnesota Informatics Institute (UMII) was founded in 2014 to foster and accelerate research across the University system in agriculture, arts, design, engineering, environment, health, humanities and social sciences through informatics services, competitive grants and consultation. Funding from UMII supports undergraduate research through the Undergraduate Research Opportunities Program (UROP) and provides graduate fellowships for MnDRIVE-related research that has a strong informatics component. One project is developing a high-throughput sensor technology together with real-time analysis to provide a rapid, automated diagnostic approach to pathogen or toxin screening in foods and food products.

U-Spatial, which joined Research Computing in June 2016, serves and drives a fast-growing need for expertise in geographic information systems (GIS), remote sensing and spatial computing across the University. U-Spatial collaborates with departments and centers across the University, meeting the fast-growing demand for core services, such as help desk and training, while creating new opportunities and synergies around spatial research. One recent project allowed the Institute on the Environment’s Natural Capital Project researchers to learn more about the value recreational lake users place on water quality, and another mapped the age of sewers and water infrastructure across Minnesota towns and cities to help inform policymakers’ choices and investments.

**Increasing Prominence of International Research**

In 2015, an International Research Committee of faculty and staff reviewed the breadth of international research across the University and made recommendations to increase the prominence of international research to advance transdisciplinary partnerships. As a result, in 2016 OVPR announced two funding opportunities that primarily target three geographic areas: 1) Sub-Saharan Africa: Kenya, Tanzania, Uganda, South Africa and Nigeria; 2) South-East Asia: Indonesia, Hong Kong, Singapore and Thailand; and 3) South America: Argentina, Chile and Peru. Projects in other countries may be considered.

One funding opportunity, the International Visitor Fellowship program, supports visits of international visitors from high-potential geographic regions who hold faculty or senior research positions at a university or research organization in their home country. Additional funding is provided
to the hosting academic unit for networking events.

The second opportunity, Capacity Building: Developing Sustainable International Collaborations, targets capacity building in centers and institutes to develop international research collaborations that will result in broad institutional capacity building. This funding opportunity was established recognizing the substantial coordination that is required for the development of international collaborations and grant proposals with international partners.

**Research Engagement**

**External Stakeholder Engagement Partnerships**

Public universities play a well-known role in creating new knowledge, but they must also bring that knowledge beyond the ivory tower and into the community.

A new pilot program at the University of Minnesota focuses on working with partners outside the U to create new knowledge and put it into play benefiting the community. External Stakeholder Engagement, launched in Spring 2016 by OVPR, combines University research talent with one or more partners from community organizations, government agencies, industry and nonprofits to promote innovation across a range of disciplines.

The stakeholder partnerships are designed to catalyze and sustain research between the University and external partners to accelerate the transfer of new knowledge for the public good—a cornerstone of the research strategic plan, Five Years Forward.

**Convergence Colloquia**

Convergence Colloquia are multi-disciplinary gatherings that advance cutting-edge research to develop innovative solutions and build long term partnerships that improve the world. The idea behind the gatherings is to bring together University researchers with private, public and nonprofit stakeholders to identify strategic collaboration opportunities that can lead to significant impact at the local, state, national and global scales.

Seven highly successful Convergence Colloquia were held between February 2015 and May 2016 on the topics of smart cities and infrastructure, aging, health equity, renewable energy, sustainable
food systems, water supply and citizen science. More than 600 people, with roughly half from the University and half from outside, participated in these action-oriented “think tanks.” Internal participants from all five University campuses and 15 colleges, and external participants represented the nonprofit sector (41%), the public sector (39%) and the private sector (25.8%).

Surveys of participants indicated a high level of satisfaction with the colloquia, with more than half reporting that they met more than five new people at their event and 95% or more of respondents saying they had productive opportunities for interaction and the chance to meet people outside their discipline.

The colloquia have been followed by the opportunity to build new collaborative research teams with funding from dedicated Serendipity Grants. For the first six Convergence Colloquia (smart cities and infrastructure, aging, health equity, renewable energy, sustainable food systems, and water supply), 21 Serendipity Grants (out of 49 proposals) were awarded for a total of $452,360, with $130,123 supported by the McKnight Foundation.

Serendipity Grants included projects to map the age of infrastructure across Minnesota’s towns and cities in order to help inform policymakers’ decisions, to benchmark the growing sector of urban agriculture for environmental sustainability and production efficiency, and to examine the opportunities and barriers to the use of renewable energies by municipal and cooperative utilities in Greater Minnesota.

**Serendipity Team and Connectors Network**

OVPR has formed two committees to identify, network and empower the administrators, faculty and staff that play an essential role in bringing together seemingly unrelated disciplines to foster creativity and innovation. The Connectors Network is working to foster networking among collegiate and research center staff who are involved in research advancement activities and who play an important role in spurring cross-disciplinary research within their colleges and across the University. The related Serendipity Team has been formed to draw on the expertise of administrators and faculty from across the U of M who are leaders in advancing cross-disciplinary connections. Both the Serendipity Team and Connectors Network are creating plans for events, meetings and tools that will help the University of Minnesota leverage interdisciplinary work across the breadth of its many disciplines.
Participating in Research and Human Research Protections

Research has significantly contributed to improvements for many people from every walk of life. Many advances in knowledge would not have been possible without individuals willing to participate. The U of M is dedicated to meeting, upholding and exceeding the highest ethical standards in research practices involving human participants.

Following a rigorous review and assessment of its human research policies and practices in 2015, the University is now implementing major changes to enhance its human research protection program. The Advancing Human Research Protections initiative aims to strengthen protections for human research participants and establish a program that will serve as a national model.

Key enhancement areas include renewing our commitment to research ethics, more education and training for investigators and staff, changes to Institutional Research Board (IRB) processes and policies, new approaches for managing conflicts of interest, and increased community participation and oversight.

The close of FY2016 marked the end of a busy phase for Advancing Human Research Protections, with 16 work teams of University faculty and staff completing final reports and putting their findings into operation. Specific examples of progress include:

- Restructuring the IRB with more panels involving more members to ensure timely and rigorous review and that the relevant expertise is available to effectively evaluate the diverse and complex portfolio of research conducted by our investigators.

- Adopting new policies for research participants who have impaired or fluctuating capacity to consent. These policies were developed in consultation with the Center for Bioethics, the Research Compliance Advisory Committee, and the Community Oversight Board.

- Creating the Fairview-University Research Oversight Committee (FUROC) in order to improve communication and partnership between researchers and nursing staff.

- Launching a Research Ethics campaign to build awareness of the University’s principles, policies and processes that uphold ethical research practices.

THE ACCESSIBILITY OBSERVATORY, a joint project of the Center for Transportation Studies and the Department of Civil, Environmental, and Geotechnical Engineering, received a five-year, $1.6 million award from Minnesota Department of Transportation and 11 other transportation agencies across the nation to calculate and map data on city residents’ access to jobs by car, public transit, bicycle and walking. The data will help transportation agencies nationwide plan and evaluate more effective transportation systems.
CONCLUSION

The University’s size, diversity, intellectual and physical capital and its financial resources position it well for competing as a leader in the future generation of new knowledge that will benefit our society. However, as aptly described in the 2007 National Academies report, Rising Above the Gathering Storm\(^2\), “[t]oday, Americans are feeling the gradual and subtle effects of globalization that challenge the economic and strategic leadership that the United States has enjoyed since World War II.” Today, the effects of globalization are no longer “gradual and subtle.” Instead, Americans experience fierce global competition, as, and the quote continues, “[a] substantial portion of our workforce finds itself in direct competition for jobs with lower-wage workers around the globe, and leading-edge scientific and engineering work is being accomplished in many parts of the world. Thanks to globalization, driven by modern communications and other advances, workers in virtually every sector must now face competitors who live just a mouse-click away in Ireland, Finland, China, India or dozens of other nations whose economies are growing.”

Our recent national and state elections brought these economic anxieties to the surface, and polling indicates that Americans’ faith in their institutions declined by 10 percentage points in 2007, the start of the Great Recession, and has not rebounded significantly since\(^3\). Higher education is not immune from the new skepticism; a recent study by the firm Edelman found a “fraying belief in the state of higher education,” and that the “[t]he public and academics are deeply disconnected on the role of universities,” with six in ten public respondents agreeing that the traditional role of universities in society must evolve versus four in ten academic respondents. The study warns that universities are “at risk” of losing public support if they fail to demonstrate real-world impact and return on investment.\(^4\)  As faculty, as staff, and as students we must engage the world around us all the more and actively work to disprove the notion that “[i]nstitutions of higher education are awash with hysteria, authoritarianism, obscurantism, philistinism and charlatantry,” as one national columnist colorfully asserted.\(^5\)

---


To be successful, higher education, like many of our institutions and elements of our infrastructure, will need to take a hard look at its business models and the value proposition it provides to its communities. If we believe that our research enterprise remains vital to our success as a society and a nation, we need to continue to make the case for public investment. But that cannot be the whole of it; in era of public disinvestment in research universities, we cannot plan on either federal investment or our own finite institutional resources. We have to change our structures, processes and incentives, and look carefully at where more than two-thirds of research and development resources are today—in business and industry. We need to take the latter path carefully, with appropriate oversight and management of conflictual issues, as well as a constant eye toward accountability in terms of return on investment for our own institution.

The University of Minnesota has many assets, in its people and in its infrastructure. If it can shift from “the way we’ve always done it” toward a more nimble and innovative culture, it can be a leader in adapting to the new research reality.