

Report of the Provost's Grand Challenges Research Strategies Team

Advancing the Research Goals of the Twin Cities Campus Strategic Plan

January 2016



DRIVING TOMORROW
Our ten-year plan to lead and innovate

January 2016

Office of the Senior Vice President for Academic Affairs and Provost
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Foreword

On behalf of the Grand Challenges Research Strategies Team, I am pleased to present to Provost Karen Hanson this report recommending steps for advancing the interdisciplinary research goals of the Twin Cities Campus Strategic Plan. Our recommendations are the product of an extensive deliberative process that drew directly on the expertise of faculty across the campus. We thank the hundreds of faculty members who contributed ideas suggesting Grand Challenge research strengths, and the faculty, students, and staff who participated in invigorating discussions about how those ideas might be developed and integrated. These discussions, as well as additional input from University leaders, were invaluable in the team's efforts to crystallize the conception of Grand Challenges on which the University could be especially well positioned for great impact.

Initially, our faculty team was daunted by the charge of identifying Grand Challenges for our large University. As our understanding of the breadth and depth of University research strengths deepened, our clarity of purpose grew. In tapping into the knowledge, energy, innovative thinking, and drive of our faculty, staff, and students, we felt exhilarated by the opportunities we saw to help advance the institutional transformation envisioned by the Strategic Plan by pushing the boundaries of research and discovery. I believe that, to a person, each member of our committee now holds this sentiment. This process of personal transformation for the members of the team gives us optimism that a similar excitement will take hold across the University community as faculty, students, and staff from our many colleges, disciplines, and programs collaborate to engage with these Grand Challenges.

It has been an honor and a privilege to work closely and intensively with the distinguished faculty colleagues who compose the team (listed on the following page). Each of them, along with our outstanding staff members, Carla Carlson and Kate Tyler, worked diligently and creatively for nearly a year to organize the collaborations that have broadly engaged the campus and to develop the recommendations outlined in this report.

I want personally to thank all the members of the Grand Challenges Research Strategies Team, as well as supporting staff. I know that my colleagues join me in expressing special thanks to Provost Hanson for turning to faculty for guidance about this crucial component of the Strategic Plan, and for actively supporting the work of the team throughout the year as we moved toward completion of this report. Finally, we appreciate the incisive input from several University leaders about the proposed Grand Challenges as they were taking shape.

My colleagues on the Grand Challenges Research Strategies Team and I look forward with great anticipation to the implementation of these recommendations.

Raymond Duvall
Chair, Provost's Grand Challenges Research Strategies Team

Provost's Grand Challenges Research Strategies Team

Provost Karen Hanson convened a team of 30 distinguished faculty members early in 2015 to recommend potential Grand Challenges areas and related interdisciplinary research strategies that would best align with the goals of the Twin Cities Campus Strategic Plan.

Raymond Duvall, Distinguished University Teaching Professor of Political Science and former interim Dean of the College of Liberal Arts; *chair*

Bruce Blazar, Regents Professor of Pediatrics and CCRF Land-Grant Chair in Pediatric Oncology, Director of Clinical and Translational Science Institute, Chief of Blood and Marrow Transplantation Program, Medical School

James Bradeen, Professor and Head of Plant Pathology, College of Food, Agricultural and Natural Resource Sciences; Co-director of the Stakman-Borlaug Center for Sustainable Plant Health

Tom Clayton, Regents Professor Emeritus of English Language and Literature, CLA

Marilyn DeLong, Professor of Design, Housing, and Apparel, College of Design

Efi Foufoula-Georgiou, Distinguished McKnight University Professor of Civil Engineering, Joseph T. and Rose S. Ling Chair in Environmental Engineering, College of Science and Engineering

Gunda Georg, Professor and McKnight Presidential Chair in Medicinal Chemistry, Robert Vince Endowed Chair, Director of the Institute for Therapeutics Discovery and Development, College of Pharmacy

Apostolos Georgopoulos, Regents Professor of Neuroscience, McKnight Presidential Chair in Cognitive Neuroscience, American Legion Brain Sciences Chair, Medical School

Marc Hillmyer, Distinguished McKnight University Professor and McKnight Presidential Chair of Chemistry, Director of the Center for Sustainable Polymers, CSE

Sarah Hobbie, Distinguished University Teaching Professor of Ecology, Evolution, and Behavior, College of Biological Sciences

Deborah John, Professor and Curtis L. Carlson Chair in Marketing, Carlson School of Management

Sonja Kuftinec, Professor of Theatre Arts and Dance, CLA

Richard Leppert, Regents Professor of Cultural Studies and Comparative Literature, CLA

Ann Masten, Regents Professor, Distinguished McKnight University Professor, and Irving Harris Professor of Child Psychology, Institute of Child Development, College of Education and Human Development

Matt McGue, Regents Professor of Psychology, CLA

Phyllis Moen, Professor and McKnight Presidential Chair in Sociology, CLA

Thomas Molitor, Distinguished University Teaching Professor of Veterinary Population Medicine, College of Veterinary Medicine

Gary Muehlbauer, Distinguished McKnight University Professor and Endowed Chair in Molecular Genetics, Agronomy and Plant Genetics, CFANS, and Plant Biology, CBS

Fionnuala Ni Aoláin, Professor and Robina Chair in Law, Public Policy, and Society, Law School

Harry Orr, Professor of Laboratory Medicine and Pathology, Edmund Wallace Tulloch and Anna Marie Tulloch Chair in Genetics, Director of the Institute for Translational Neuroscience, Medical School

Mike Osterholm, McKnight Presidential Chair in Public Health, Director of the Center for Infectious Disease Research and Policy, School of Public Health

F. Abel Ponce de León, Professor of Molecular Genetics, Animal Science, CFANS

David Pui, Distinguished McKnight University Professor of Mechanical Engineering, CSE

Peter Reich, Regents Professor and Distinguished McKnight University Professor of Forest Resources, F.B. Hubachek Sr. Chair in Forest Ecology and Tree Physiology, CFANS

Steve Ruggles, Regents Professor of History, Director of the Minnesota Population Center; CLA

Karen Seashore, Regents Professor of Organizational Leadership, Policy and Development; Robert H. Beck Chair of Ideas in Education, CEHD

Donald Simone, Professor of Dentistry and Division Director/Basic Sciences, School of Dentistry

Joe Soss, Cowles Professor for the Study of Public Service, Humphrey School of Public Affairs

Ann Waltner, Professor of History, CLA

Jean Wyman, Professor and Cora Meidl Siehl Endowed Chair in Nursing Research, School of Nursing; Director, Minnesota Hartford Center of Gerontological Nursing Excellence; Co-Director, Powell Center of Women's Health, Medical School

Senior Staff to Committee: Carla Carlson, Kate Tyler
Office of the Senior Vice President for Academic Affairs and Provost

Report of the Provost's Grand Challenges Research Strategies Team

"Our institution has almost unparalleled breadth and depth to marshal toward the large collaborative efforts needed to solve complex and critical challenges, the difficult and pressing issues facing our region and the world. Leveraging our unique strengths in such collaborations is crucial to advancing the University of Minnesota as a land-grant research university with both global and local impact. Creating a more coherent and coordinated cross-disciplinary approach to these challenges will attract new recognition and new funding for the University and will provide invigorating new opportunities for faculty, students, and staff. It will enrich the education we provide to our students; and enhance our collaborations with external stakeholders for the good of our state and the world."

Twin Cities Campus Strategic Plan: Grand Challenges—Research

In early 2015, Provost Karen Hanson initiated a collaborative campus-wide effort to advance the research goals of the Strategic Plan for the Twin Cities campus. She convened a Provost's Grand Challenges Research Strategies Team, composed of 30 faculty members spanning many colleges and disciplines, to lead and steward this effort. Provost Hanson charged the committee with identifying areas in which the University was positioned to have major impact on critical societal challenges, as well as recommending strategies to realize the broader vision of a more integrative and engaged research campus.

This report presents the recommendations of the Grand Challenges Research Strategies Team in three key areas responsive to the provost's charge:

1. Grand Challenges areas of focus in which the University of Minnesota has exceptional interdisciplinary strengths—areas in which the University is positioned to have major impact on the most critical challenges of our state, nation, and world
2. Areas of interdisciplinary strength in which the University might productively invest beyond the recommended Grand Challenges
3. Institutional steps for further supporting interdisciplinary research of the kind envisioned by the Strategic Plan

These recommendations have been shaped through an extensive multi-stage process informed by contributions from and discussion among faculty, students, and staff across the campus.

Shaping the Grand Challenges

The development of Grand Challenges research is a key component of the Strategic Plan for the Twin Cities campus, a ten-year framework for strengthening the academic excellence and impact of the University. The plan envisions—as one part of an overarching project of institutional reinvigoration—that we will harness our research breadth and depth—and the advantages of our location—more powerfully to address some of the most complex and consequential problems of Minnesota, the nation, and the world.

In a memo to the group in February 2015 (Appendix B) and more fully in an initial meeting, Provost Hanson charged our faculty-led research strategies team with the responsibility of advancing broad consultation with the faculty and campus community to recommend Grand Challenges areas in which the University could stake a special claim as a research university. The aim was to identify exceptional areas of interdisciplinary strength across the campus—areas where we could expand collaboration across multiple disciplines to broaden and deepen intellectual reach and to more powerfully address critical societal challenges. This work was to be guided by the Strategic Plan and particularly by its Research section outlining criteria for Grand Challenges (Appendix A). The plan noted that the priorities to be identified would be in addition to—or might broaden and elevate—existing interdisciplinary work aligned with Grand Challenge priorities (as examples, the plan mentioned MnDRIVE initiatives on food and the environment, and interdisciplinary collaborations to foster vibrant communities).

In addition, our charge extended to identifying strategies that would support the larger integrative research goals, thus advancing the transformational vision of a more ambitious, integrated, agile, and engaged land-grant research university for our students and state.

At its initial meeting, the Strategies Team established a subcommittee to develop a plan for information gathering, focused consultations, evaluation, and campus-wide discussion (Appendix C). Beginning in spring 2015, the committee organized and led a multiphase process aimed at drawing broadly and deeply on the expertise, ideas, and perspectives of the campus community, and particularly of faculty researchers. This process included:

1. A “Call for Ideas” enlisting faculty in the identification of ideas that could translate into interdisciplinary Grand Challenges research topics, guided by eight specific criteria outlined in the Strategic Plan (Appendices A and E);
2. Multiple campus forums—reflecting broad themes derived from faculty ideas—engaging faculty, students, and staff members in discussing priorities for research and institutional change that could support interdisciplinary research; and
3. Additional feedback via mechanisms that included website comments, follow-up with key groups, and suggestions from individuals.

In organizing a Call for Ideas process as the basis for broader campus discussion, the Strategies Team sought to tap the knowledge and networks of faculty from all corners of the campus. Faculty were asked to succinctly identify areas of scholarship “in which the University already has strength, in which it has the potential to have global impact and enhanced local relevance, and in which it also has potential to make a deeper connection with the land grant commitment

to engaged teaching and learning and reciprocal partnerships in the public and private sectors.” The goal was to engage faculty in an effort to take full account of the many strengths and innovative research that underpin the scholarly future of the University. Submissions were intended to be not discrete project proposals but rather descriptions of complex, multifaceted societal challenges—areas in which our breadth and depth is such that we are, or soon could be, a national and international leader.

Faculty response to the Call for Ideas, which was announced by Provost Hanson in mid-May (Appendix D), was exceptionally robust, drawing 130 ideas during two submission rounds between May and August 2015 (Appendix G). The submissions captured an impressive range of topics, with more than 350 faculty members named as leads and many more identified as potential contributors.

The Strategies Team carefully reviewed all submissions to assess the degree to which they fit the Grand Challenges criteria, with further consideration of potential connections among separate, but broadly related ideas. (Attentive to the potential for conflicts of interest among our team’s group of senior researchers, we adopted formal conflict-of-interest guidelines, with members recusing themselves from evaluation of ideas to which they were professionally connected.)

The framework in the Strategic Plan for defining and evaluating prospective Grand Challenges consistently remained in the forefront of the committee’s thinking and assessments. The eight criteria for Grand Challenges (described more fully in Appendix A) are:

- Global impact and local relevance
- Extent of existing faculty strength and leadership
- Disciplinary diversity
- Impact on the University and its reputation
- Suitability for a land-grant research university
- Interconnection with education
- Engagement of external constituencies
- Sustainability of research over a decade

The Call for Ideas process proved fruitful in highlighting not only well-recognized University research strengths, but also pockets of existing or potential strength that might be considered in relation to other areas. These assessments were aimed not at selecting “winning” ideas, but to inform the extent to which broadly related ideas might fruitfully be connected.

Prospective Grand Challenges topics were explored and developed further in five campus-wide forums in fall 2015 that were attended by faculty, staff, and students. The forums were organized around general themes reflecting broadly related ideas submitted by faculty.

Submitters themselves determined which of five “umbrella” themes best fit their idea:

- How will we ensure just and equitable societies? (Oct. 12)
- How will we foster human potential and well-being across the life course in a diverse and changing world? (Oct. 13)
- How will we advance human health? (Oct. 14)
- How will we develop sustainable cities and resilient communities in a world of climate change? (Oct. 16)
- How will we provide secure food, water, and energy today and for the future? (Oct. 22)

Overviews of these broad discussion themes were posted online in advance of the forums (Appendix I). The purpose of the forums was to cast prospective Grand Challenges in a clearer light and foster connections among distinct but potentially related disciplinary perspectives. More specifically, the team intended the forums to inform its work to identify potential Grand Challenges that take in a breadth of University strengths while being more sharply defined and focused than the broad forum themes; to deepen awareness of existing research strengths—disciplinary or interdisciplinary—that could be more effectively mobilized toward solutions to complex societal problems; and to foster connections among researchers and steps that could be taken to bring researchers together in new and productive ways.

Provost Hanson briefly introduced each forum. She emphasized the University’s commitment to making investments in priority Grand Challenges areas embraced by the campus in ways that will leverage opportunities specific to those areas, guided by the various elements of the campus strategic plan and advanced through collaborations with deans, the Office of the Vice President for Research, and the University of Minnesota Foundation.

Each forum included a short presentation, table discussions of about 40 minutes, and a concluding comment period. Teams of faculty provided a brief overview and moderated discussions. Recorders were on hand to capture essential elements, with summary notes made available online (Appendix J). Overall, the forums drew nearly 600 participants, nearly three-fourths of whom were members of the faculty.

The information and insights from the forums, as well as post-forum feedback from students, faculty, and staff members and close consideration of the ideas suggested by faculty, informed the identification of five Grand Challenges recommended in this report. The committee based its recommendations on strong consideration of all that had been learned from its multipronged process of campus consultation. Following the forums, subgroups of committee members focused intensively on each of the broad thematic areas to identify potential Grand Challenges warranting closer consideration. This led to the evaluation of more than a dozen possible challenges. The committee weighed possibilities in relation to the evaluative criteria for Grand Challenges and undertook consultations with the provost, deans, the vice president for research, and the vice president for health sciences. Through deliberation and vigorous

discussion, the committee arrived at a final slate of five interrelated Grand Challenges where the University clearly is singularly well positioned for great impact.

It is important to note that the process highlighted multiple research strengths at the University of Minnesota, in addition to the five Grand Challenges that have been identified. Additional priority areas of interdisciplinary research are identified in this report (*Additional Interdisciplinary Research Priority Areas and Institutional Recommendations, page 28*).

Alongside boundary-breaking Grand Challenges research, the campus will continue to nourish and celebrate basic research and focused disciplinary scholarship and creative activity. This is a point of emphasis in the Strategic Plan. Grand Challenges research is central to the University's aim of marshaling its breadth and depth more powerfully, but the larger goal is excellence. A focus on Grand Challenges is not to come at the expense of continued support for excellence in core disciplinary research and education.

It is also important to underscore that the recommended Grand Challenges are not a slate of specific research ideas selected from among those suggested by faculty during the open Call for Ideas. Each Grand Challenge represents a distillation of topics reflected in multiple idea submissions—again emphasizing the intent to focus not on specific existing research teams but toward broad themes that integrate multiple disciplinary perspectives and approaches.

Recommended Grand Challenges

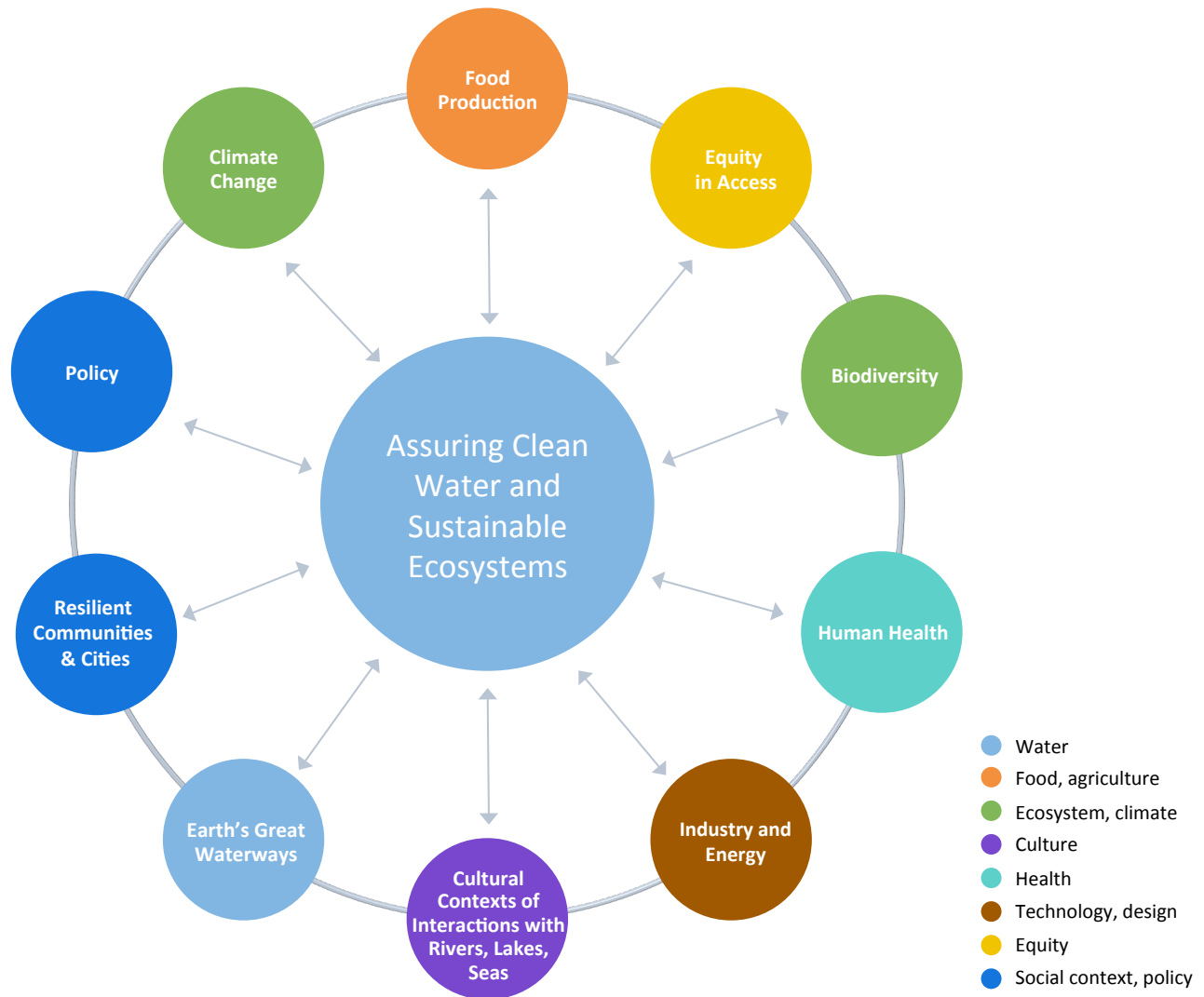
The five interrelated Grand Challenges recommended by the Provost's Grand Challenges Research Strategies Team are described in the following sections. They are:

- **Assuring Clean Water and Sustainable Ecosystems**
- **Fostering Just and Equitable Communities**
- **Advancing Health through Tailored Solutions**
- **Enhancing Individual and Community Capacity for a Changing World**
- **Feeding the World Sustainably**



Assuring Clean Water and Sustainable Ecosystems

Achieve adequate supplies of safe and clean water to sustain people, agriculture, and industry, while protecting water resources and ensuring the sustainability of environmental systems and the vitality of communities on rivers, lakes, and seas



Assuring sufficient clean water and the sustainability of water resources is a complex Grand Challenge with far-reaching implications for human health, agriculture, energy production, the vitality of communities, the health of ecosystems, and the environment at large. The World Economic Forum recently identified shortage of clean water as the No. 1 global threat. By 2030 most of the world's population is expected to live under conditions of water stress. Having sufficient supplies of safe water—the lifeblood of all societies—is particularly critical for providing food and improving public health worldwide. Every year, tens of millions of people become ill and millions die from water-related diseases. In addition to being essential to life,

water resources are crucial for providing energy, enabling economic development, and supporting multiple aspects of quality of life in the places people live and work. For all of these reasons, demand for water—both quality and quantity—continues to increase, in some parts of the world at accelerating rates, and increasing water consumption to meet these demands threatens supplies of freshwater from both surface and ground water sources.

The challenges of meeting growing demand for water without depleting freshwater sources are compounded by concomitant threats to the environment and human welfare. Climate change will affect almost all aspects of sustainability and likely will result in major disruptions of human societies and their water systems. Water stress and its intimate connection to food and energy insecurities disproportionately affect poor populations and contribute to social and political conflicts throughout the world. Social conflict, in turn, can degrade ecosystems, including water resources, and exacerbate inequities in access to clean water. There is no simple or readily available path to meet future needs for clean water while sustaining the vitality of ecosystems. Although a Grand Challenge with no easy solution, achieving water and related ecosystem sustainability is critical for the state, the nation, and the world.

Meeting this Grand Challenge will require a systems approach that considers interconnections with food and energy production, and other human uses of water resources. Given the complexity and multitude of issues involved (e.g., technological, institutional, behavioral) and the variety of actors (e.g., industry, agriculture, government, citizenry), crosscutting research collaborations are imperative. At the University of Minnesota, innovative research will identify effective strategies for producing and delivering clean water and renewable energy, including through creative harnessing of biodiversity and other novel technologies. Other work will identify new approaches to designing water policy, as well as proactive and innovative models to address intersections between water availability, environmental quality, food production, energy use/production, and resource recovery.

Research will also deepen understanding of how human communities interact with water, from water resource management to the ways in which rivers and coasts figure prominently in the history, economic vitality, and culture of communities and groups within communities. Addressing this Grand Challenge requires balancing the needs of human activities and ecosystem functions, recognizing that solutions need to be framed within specific cultural, historical, and political contexts, and acknowledging that the poor are disproportionately burdened by lack of access to adequate and clean water and by threats associated with climate change.

Interdisciplinary research engaged with communities and many public and private partners will help to foster an inclusive mode of thinking about water as a resource and how rivers, lakes and seas figure into efforts to plan and design inclusive, vibrant, and sustainable communities. Further research into human values and psychology will help to support behavioral and social change, including the changes in consumption patterns that will be important to address this Grand Challenge. University of Minnesota interdisciplinary research will advance not only the development of technological innovations, but also the tools and models to strengthen how communities approach water-related policymaking as part of the broad human and environmental ecosystem of communities.

The University of Minnesota is especially well positioned to meet the Grand Challenge of assuring clean water and sustainable ecosystems. Minnesota is a water state; we have the headwaters of two major rivers, more than 10,000 lakes, one of the Great Lakes, and nearly 100,000 miles of rivers and streams. (The University campus straddles one of the great rivers of the world and is located in the Mississippi National River and Recreation Area). Water is integral not only to the state's complex biological and physical systems, including its many farms and fields, but throughout the Minnesota economy and the social and cultural fabric of rural and urban communities alike. With ample water supply, Minnesota houses global leaders in the water-technology business; but unsustainable water-use patterns are also evident here.

The University has internationally recognized experts in the variety of research areas that will be critical to understanding the causes and consequences of impaired water quality and in engineering solutions to achieving clean water. Over a hundred faculty members are actively teaching and researching water issues in multiple fields of study, including interdisciplinary work connecting the humanities, arts, and sciences. The University is home to crosscutting units and initiatives that bring water-related experts together, and connect university faculty and students with outside partners.

The University's comprehensive research, educational, and outreach opportunities related to water reflect intersecting strengths of its statewide system, including Extension water resources activities statewide; relevant work of the University of Minnesota Duluth, a sea grant campus on the shore of Lake Superior; and an interdisciplinary graduate program that includes faculty and students from the Twin Cities and Duluth campuses, providing further connections to partners throughout Minnesota. In addition, this Grand Challenge builds on and expands the reach of MnDRIVE, particularly the core area focused on issues including climate change, ground and water pollution, and other environmental degradation, by linking this work explicitly to research on social-cultural relations to water and its uses. A broad array of talented researchers at the University of Minnesota is in place to tackle this Grand Challenge through an integrated, interdisciplinary, and systems approaches.

Fostering Just and Equitable Communities

Assure quality of life and equality of opportunity for all members of diverse communities—including educational and health equity, economic opportunity, personal security, and cultural experience



Persistent inequalities that are rooted in barriers—whether institutionalized or informal—to equal and fair opportunities undermine individual dignity and well-being and harm the vitality and stability of communities. Such enduring inequalities are becoming increasingly pronounced in Minnesota and across the nation and globe. They are expressed in growing disparities in economic and social well-being, environmental quality, community and cultural vitality, health, education, political participation, and human rights. In some instances, these gaps reflect regional or urban-rural differences in economic development processes, or uneven rewards across employment categories. In other circumstances, the disparities are rooted in deeply embedded social

inequalities—racism as well as structural inequality related to ethnicity, religious identity, gender, age, or sexual orientation (among many forms of deep-seated bigotry and bias).

Some of these inequalities and their harmful outcomes are legacies of colonialism and historical injustices against indigenous populations and immigrants, voluntary and involuntary. Their contemporary manifestations include human trafficking, sexual exploitation, and hate crimes, and the “structural violence” of unequal opportunities to survive or thrive related to poverty, discrimination, and other forms of social disadvantage or oppression.

Global inequities are fueling instability, political conflict, fragile states, and a rising tide of migration that is threatening the lives and future of people around the world. Closer to home, while Minnesota generally is economically advantaged, healthy, and educated, major disparities in education, health, and economic well-being—primarily racial, ethnic, and urban-rural disparities—leave many behind and threaten the state’s future to the detriment of all of the state’s residents. To dismantle the barriers to equal and fair opportunities for all by fostering just and equitable communities is an imperative Grand Challenge of paramount importance.

At the University of Minnesota, research will deepen understanding of the causes, contexts, and consequences of inequality in its many forms. Interdisciplinary research and policy analysis will probe the complex ways in which racism and other structural inequalities take shape and are sustained in local and global communities, from inequitable access to health, education, and legal justice to mass incarceration and pervasive poverty. Community-engaged research collaborations also will develop cross-cutting methodologies and models to build and sustain just and equitable communities: Interdisciplinary solutions are needed to reform systems and build strategies and partnerships in ways that will effectively attack income and employment inequalities; reduce intolerance and violence at all levels of society, from intimate violence to political conflict; promote human and civil rights, structural justice, and reconciliation; build just and equitable cities and institutions; and foster safe households, schools, and neighborhoods.

Our work also will seek to yield innovative solutions to complex issues such as pronounced inequities involving access to food and water resources, food insecurity, environmental degradation, and adverse effects of climate change. Our research will additionally contribute to new ways of approaching technology, community infrastructure, organizational design, and city planning to enhance diversity and inclusion, civic engagement, cultural vitality, and fair and just access to opportunities and resources.

The University of Minnesota is singularly well positioned to address this critical Grand Challenge. Across multiple disciplines and levels of inquiry, the University has both broad and deep expertise in issues of equity and justice and their attendant disparities. University research draws on an expansive array of disciplinary strengths to interrogate the historical and contemporary roots of inequality. The University also has exceptional capacity in health and human development, expertise in transforming justice systems or access to justice, and strengths across multiple additional fields addressing challenges related to equitable access to resources, particularly water and food. The depth of our expertise in key areas is striking. For example, strengths related to assessing and intervening in socioeconomic and racial disparities, particularly for children, range from epigenetics and neuroscience to economics and public policy, including health policy. Other notable strengths include deep expertise on human rights, law, incarceration, indigenous and

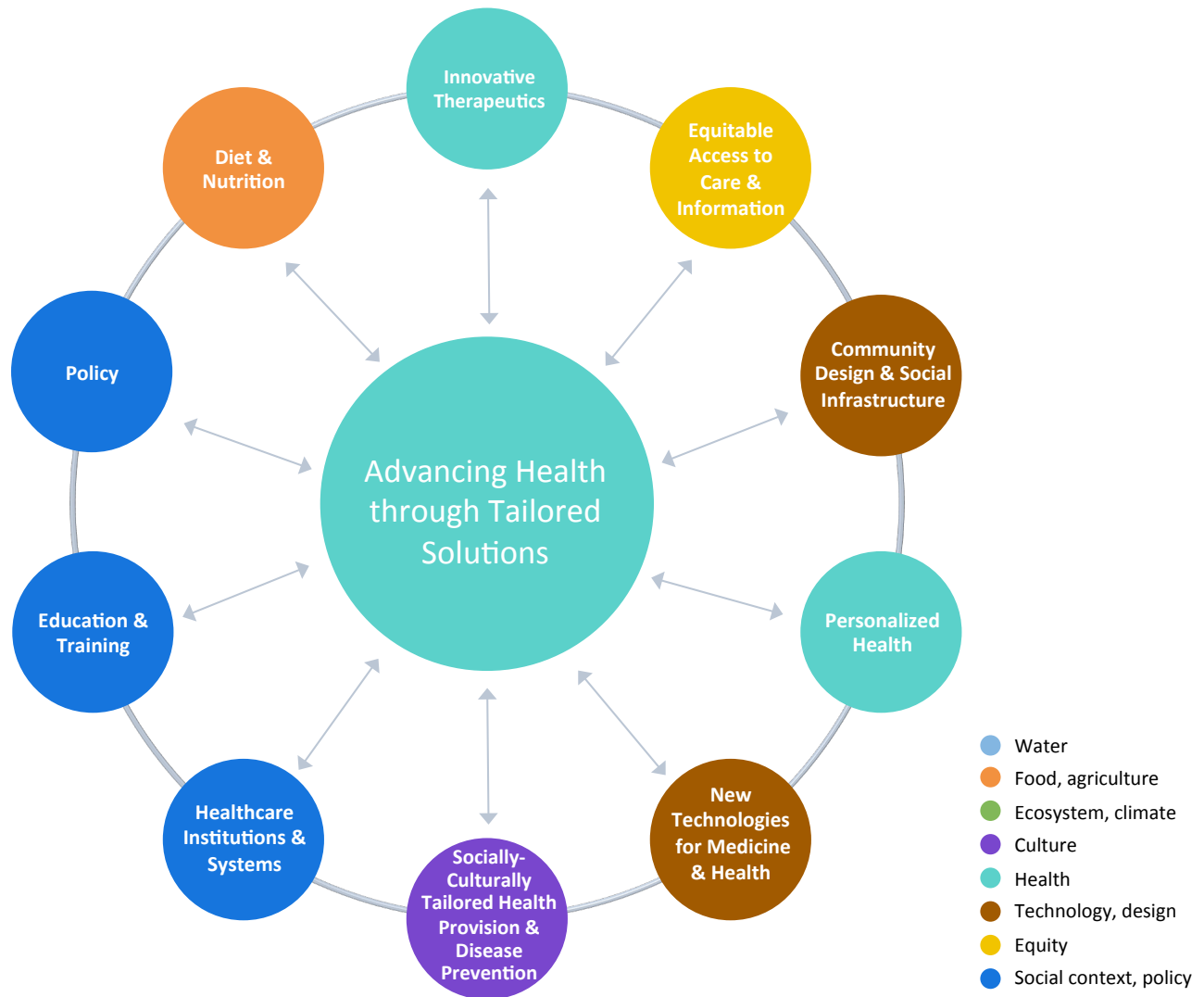
immigrant peoples and cultures, religion, reconciliation and restorative justice, and violence and peacemaking.

The University also has been actively engaged in public-private collaborations to strengthen community vitality and close educational and health gaps, among other efforts. These collaborations highlight the exceptional opportunities the University has as an anchor institution in a large and diverse metropolitan area and dynamic state. Importantly, expanded interdisciplinary collaborations and partnerships will build on the extraordinary cultural diversity of the region and state, including indigenous American Indian cultures, African American communities, refugees from conflicts around the globe, and generations of immigrants. The location of our flagship campus in a major metropolitan area is rare for a land-grant public research university, and—along with our system campuses around the state—presents opportunities for innovative work embedded in the fabric of diverse communities and drawing deeply on community knowledge and strengths.

In addition to a long history of statewide outreach, extension, and engagement rooted in its land-grant mission, the University has many ties to research, governmental, and community-based organizations relevant to issues of equity and justice locally, nationally, and globally. In marshaling its strengths and resources more powerfully to address persistent inequality, the University will expand collaborations with many partners in government, business and industry, a strong nonprofit sector, and a thriving arts community to strengthen crosscultural understanding and engagement, develop human potential, and to foster inclusion and success of diverse residents.

Advancing Health Through Tailored Solutions

Foster community and population health—together with individual physical, mental and psychosocial well-being—by tailoring health care services and interventions to biological, social, and cultural circumstances



Rapidly unfolding scientific and technological developments make possible a profound change in the means for fostering health, such that health care interventions and regimens can be tailored to the unique characteristics of each individual, including his or her specific genetic background, pathology, and microenvironment. Moreover, growing evidence suggests that health and well-being are conditioned not only by individual biological factors but also by social and cultural environments. Future success in reducing health disparities and raising overall levels of health in all of its dimensions—physical, mental, and psychosocial—will require more systematic commitment to tailor individualized health care, as well as to bridge cultural differences, and

address diverse social needs through designed environments. Prevention, treatment, and health-promoting services will be rooted in knowledge of the individual's genetics, microbiota, and lifestyle and in a better understanding of diverse populations and their environments. This exciting Grand Challenge of fostering innovative advances in more precisely tailored health will guide research at the University of Minnesota.

The research addressing this Grand Challenge will promote innovations in the areas of genomics, pathology, and microenvironments. Innovations will also result in point-of-care diagnostic devices and therapeutic modes, including nanomedicine and ultra-high sensitivity imaging for critical diseases—innovations that can enhance prevention and personalized treatments. The work integrates engineering with biology and medicine to achieve improved quality of life while also reducing health care costs. Interdisciplinary research addressing this Grand Challenge will further examine how to deliver the highest quality, most effective personalized health care across diverse communities. Our research will develop new educational and training models that provide important foundational skills for future researchers and professionals (mining large datasets and working effectively with differing social and cultural populations, for example).

Research will also contribute to new knowledge about crucial lifestyle factors, such as diet and nutrition and environmental influences; health care systems and health-related policy; community support mechanisms; and access to information about health. Also essential for meeting this Grand Challenge is research that contributes to improved and equitable access to health care and health information in both urban and rural areas—addressing the serious and persistent problems of equity in the distribution, organization, and delivery of health care and the disparate outcomes that result. Research on the design of livable communities that are envisioned to meet specific health care needs, including disease prevention respectful of social and cultural differences, is especially important. Work in history of medicine and medical anthropology, among other social sciences and humanities, can provide context and insights into diverse understandings of what constitutes health, and how it is achieved in a variety of settings.

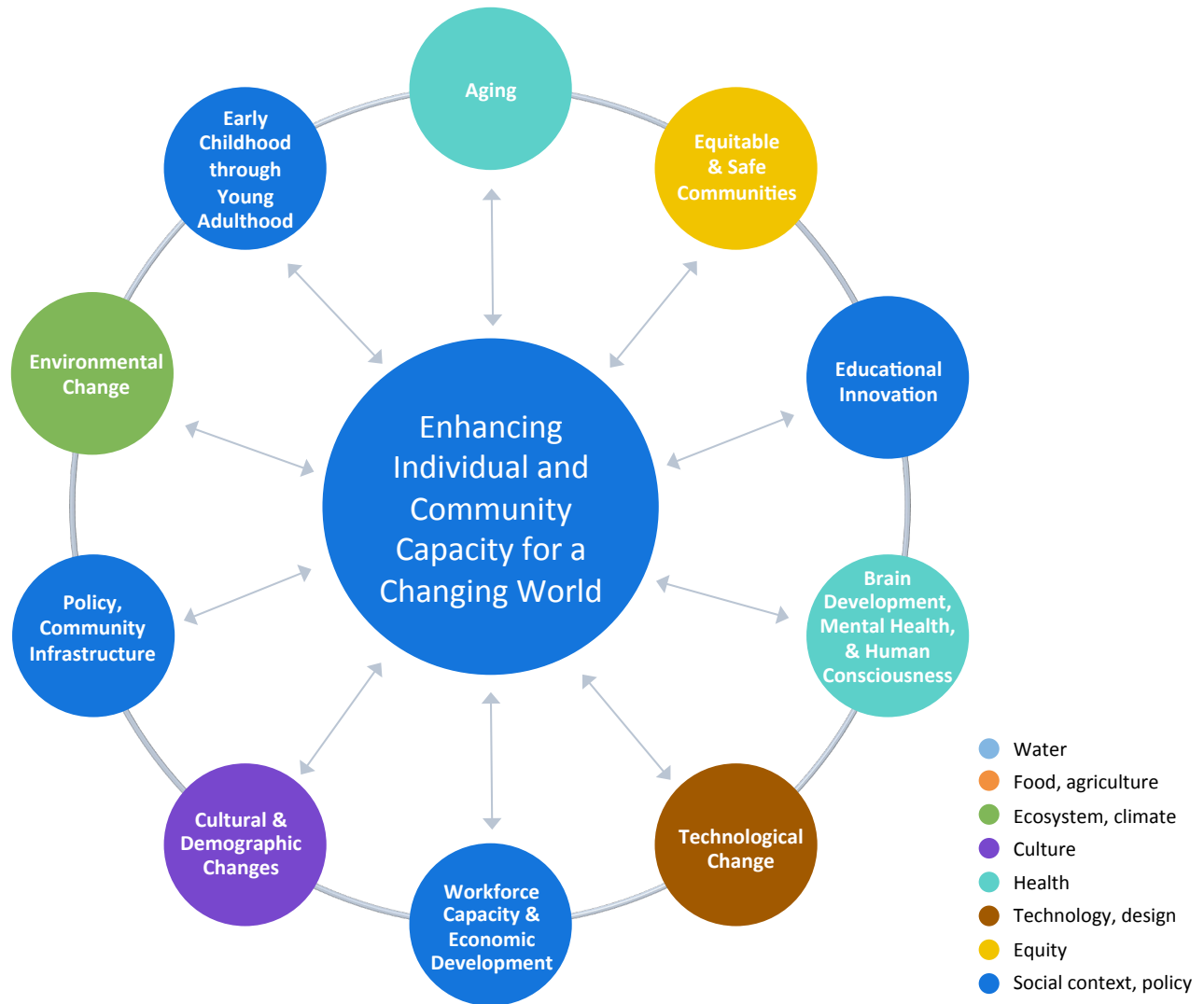
The University of Minnesota is well positioned to advance prevention and treatment tailored to both the individual and diverse communities in the ways most appropriate for each. Our comprehensive and globally engaged institution possesses unique strengths relevant to this challenge, with field-leading programs in the health sciences and salient research strengths in the humanities, social sciences, law, and policy. Our institution includes internationally recognized centers for the development of innovative health interventions; outstanding programs in the behavioral and social sciences focused on promoting better health and avoiding health risks; and vibrant research programs in the humanities and social sciences exploring health in relation to social equity, access to care, human dignity, and quality of life.

Among land grant institutions, the University houses a rare combination of leading scholars across core scientific areas: medicine; nursing, pharmacy, public health; veterinary medicine; food production and delivery; biological sciences, chemistry, and engineering. These capacities, and our other comparative advantages, will enable us to develop more effective ways of promoting targeted physical, mental, and psychosocial health; ensure that the benefits of health promotion enhance social equity and human dignity across diverse communities; and devise new training models for health care professionals prepared to deliver more effectively tailored health care.

The University has an illustrious history of contributing to improvements in human health and well-being through work in and with the diverse communities of the Twin Cities region and through high-impact partnerships with government, nonprofits, and the private sector—including a large medical devices industry, agribusiness and food industry, and health care organizations. In particular, the University maintains a long tradition of collaborating successfully with Minnesota-based organizations and businesses to develop medical devices. This provides a strong foundation for the expanded interdisciplinary collaborations needed for a complex, multifaceted Grand Challenge research program that in turn will lead to coordinated comprehensive approach to precision advancement of human health. This work has great potential to further distinguish the University of Minnesota as innovative leader in fostering health for the 21st century.

Enhancing Individual and Community Capacity for a Changing World

Foster physical, mental, and cognitive well-being from early childhood through late maturity, across the course of life transitions, ensuring that individuals and communities thrive amid great social, technological, and ecological change



Contemporary difficulties brought about by the mismatch between fast-paced economic, technological, demographic, and ecological transformations, together with institutions, policies, mindsets, and practices inherited from and designed for the last (20th) century, generate challenges at every scale. New technologies are promoting uncertainty and insecurity, for example, disrupting jobs and careers through processes of automation and outsourcing. In turn, losing or not being able to obtain a job can initiate a cascade of negative impacts for individuals, families, and social systems. Technological advances are also postponing mortality and significantly increasing the numbers of persons who live well into the late stages of aging.

At the individual level, this mismatch promotes uncertainty and stress, which are harmful to both health and psychological well-being, because it is difficult to have the confidence needed to meet the demands of the rapidly changing realities. For communities and society more broadly, the mismatch challenges the ability to anticipate necessary adjustments for quality workforce, educational systems, economic development, interactions with the biophysical environment, and policy. Individual and community capacity for resilience in response to the challenges is shaped across the course of life transitions. Early life course transitions (such as moving into, through, and out of formal education; entering the workforce; building relationships; and becoming a parent) are especially difficult. But so too are later transitions, such as the onset of chronic illness, retirement or employment termination, and being suddenly thrust into caring for grandchildren or aging parents.

Enhancing the capacity of individuals and communities to prepare for and navigate these transformations and their untoward effects across the course of life transitions poses one of the most complex Grand Challenges of our time. To meet this Grand Challenge, it will be necessary to create the means to support those experiencing the course of life transitions—especially for people with few resources—including resetting the rules, expectations, and institutional practices concerning education, work, family, and retirement to enhance capacity to meet future changes and promote quality of life for people at all ages and stages of life.

Research at the University of Minnesota will address this Grand Challenge by advancing technological and institutional innovations to promote well-being and human capacity throughout the life course. The most rapid rate of individual development—physical, cognitive, and emotional—occurs in early childhood. Our research will contribute to the development of programs and policies to improve a child’s capacity to develop, learn, and be prepared for school. University researchers will also identify solutions to disparities of educational access, opportunities, and outcomes for students—and adults—at all levels, especially disparities related to socioeconomic status, race/ethnicity, immigration status, gender and being differently abled.

The aging population in Minnesota, the United States, and across the globe presents challenges for the respective communities, but also opportunities to benefit from the talent and time of retirees as they exit their jobs. Research at the University will help determine how best to harness the skills and expertise of this demographic as well as to promote health and well-being for those in the second half of adulthood. The new longevity is unknown territory, a challenge unique to the 21st century, and requires cross-disciplinary research concerning new modes of working and retirement, workforce development and labor markets, civic engagement, community organizations, urban-rural connections, transportation, housing, public safety, and health care provision.

All stages of the life course will benefit from further research by the University on the brain and consciousness to address cognition, improve treatments for mental health and well-being, and enhance quality of life for those with brain disorders such as early childhood neurodevelopmental disorders, Parkinson’s disease, and Alzheimer’s, as well as post-traumatic stress disorder, intractable pain, epilepsy, and neuropsychiatric disorders such as addiction, eating disorders, degenerative diseases, and psychosis. University research that focuses on brain function at the nanoscale will lead to the discovery of new treatments for brain conditions. It will also advance our understanding of human consciousness and the enhancement of human capabilities through

computers and software resources. Research that elucidates the more specific needs of diverse populations within changing societies will help to ensure access to education and lifelong learning, new technologies, health care, housing, and safe and inviting community environments, for all.

The University of Minnesota is especially well positioned to apply its interdisciplinary research strengths to these and other related topics to enhance human capacity to meet the transformational changes that will continue to be a characteristic of the 21st century. Research advances will be anchored in the interrelated contributions of University faculty in the strength areas of child development, including early childhood education; aging; brain research; health care; education, including in science, technology, engineering, arts, and mathematics (STEAM) fields; business practices, employment markets, and workforce development; organizational design; diverse communities; and law and policy. Key relationships with the medical device, high-technology, and health care industries; with pre-K through post-secondary educational organizations; and with community organizations focused on underrepresented populations and social concerns will enhance the University of Minnesota's position as a leader in addressing the challenge of enhancing human capacity for a changing world.

Feeding the World Sustainably

Produce, distribute, and maintain safe and sufficient food supplies through environmentally sustainable practices to ensure the vitality of growing and demographically diverse populations



World population has passed seven billion and is expected to exceed nine billion by 2050. At the same time the world is becoming wealthier, with global per capita Gross Domestic Product increasing nearly four-fold since 1950. Greater global population and affluence interact to place extraordinary demands on food production and distribution systems. Adequately nourishing everyone on the planet and accommodating a global diet that is richer in protein will require crop production to increase as much as two-fold over present levels by 2050.

The challenge of dramatically increasing crop production to ensure sufficient supplies of safe and nutritious food for local and global communities is intensified by many interrelated factors,

including constraints imposed by lack of arable lands and clean water. Increased production to meet growing demand is stressing supplies of fresh water and contributing to climate change. In a vicious feedback cycle, climate change and its attendant floods, droughts, cold snaps, and heat waves are exacerbating the stresses placed on agriculture. Droughts made worse by climate change are causing crop failures and driving depletion of aquifers in some regions, while in others climate change has increased extreme rainfall events that are flooding croplands and aggravating the detrimental effects of agriculture on downstream water quality and the resilience of proximate ecosystems. Climate change affects global patterns of crop production and the distribution of crop pests and pathogens, often in unpredictable ways.

Difficulties of food storage, transport, and distribution compound the problem. Large regions of the developing world have significant populations that are not getting enough to eat. In some countries, food shortages have contributed to political unrest, further exacerbating the inequities of access to adequate supplies of food. In wealthy nations, underserved communities lack access to healthy food, contributing to obesity and other nutrition-related illness, at the same time that food waste is widespread and a growing global middle class is demanding a more protein-rich diet that is contributing to its own suite of health problems. Global trade in agricultural products, although essential, further threatens food security by spreading pests and diseases, and hindering control of food-borne illnesses and food adulteration.

To meet this multidimensional Grand Challenge, we will pursue research to develop new production techniques and systems, including, for example, cropping techniques, crop genetics, and safe and effective pesticides, fertilizers, and antibiotics in animals. We will focus research on sustainable agriculture, which encompasses a wide range of farming systems that strive to achieve long-term economic profitability, environmental stewardship, and quality of life for farmers and their communities. We will also marshal research expertise to help address agricultural intensification while managing limited soil and water resources, protecting ecosystems and biodiversity, and mitigating the effects of climate change. Research will address the complex politics of food in a rapidly changing environment, and lead to a better understanding of how these issues have been conceptualized and addressed in a variety of times and places, taking into account issues of diversity and socio-cultural disparities.

New technologies developed through research at the University will also target food storage and transportation, with a focus on energy efficiency, food safety, and specific needs in various communities. Our research will develop deeper understanding of the intersections of plant, animal, and human health, and address how they have developed historically and in a variety of cultural, social, and political contexts. Additionally, economic and policy research will contribute to advances in access to safe and nutritious food and food production resources, food security, and diet and nutrition programs. University research will further elucidate critical relationships between diet and health to help reduce the incidence of diet-related chronic disease and improve consumer information and understanding of nutritional bases of health.

The University of Minnesota is exceptionally well positioned to tackle this Grand Challenge. Agriculture has been key to the local economy since the University was established as a land-grant institution in 1851, preceding statehood by seven years. Minnesota is home to multinational food manufacturing and marketing companies as well as to noted organic producers and a robust local foods network—in addition to the diverse communities of the Twin Cities and Greater

Minnesota. The locational advantages create opportunities for meaningful cross-sector partnerships—not only with the food and agribusiness sectors, but with food and health nonprofits and both rural communities and urban agriculture. The University is able to contribute exceptional breadth and depth of research expertise to these collaborations, drawing on strengths in food production; human and animal nutrition, health, and welfare; agricultural economics and business; basic and applied plant, animal, and microbial sciences; sustainable agriculture; water resources; climate change and ecosystem sustainability; cultural diversity; social and cultural factors that shape patterns of food consumption, including demographic and lifestyle changes; and public policy.

This range of interdisciplinary strengths, claimed by few other institutions, has the potential to elevate the University as a national and international leader in addressing the Grand Challenge of producing, safely and equitably distributing, and maintaining sufficient healthy food for the world's growing population without compromising the health of the environment.

The Interrelated Challenges

The University of Minnesota’s configuration of the five Grand Challenges is distinctive in the explicit conception of their interconnections, with elements of each common to the others: Water as a natural resource is essential to food production, for example; similarly, both clean water and nutritious, readily available food are essential to health. Individual and population health are salient to the challenge of building individual and community capacity to meet 21st-century challenges and to that of fostering just and equitable communities; in turn, health and equity challenges are central to the provision of safe and sufficient food and water. The five challenges form an interrelated system.

Additionally, approaches to solving each of these challenges are touched by elements of scientific progress, technology, design, social relationships, culture, policy, the environment, climate change, and education, among others. These are not five independent, discrete challenges to be addressed through established, separate “silos” within an academic institution.

Intersecting boundaries of each of the Grand Challenges integrate disciplinary strengths that include humanities and the arts, science, engineering, and the professions—business, design, law, health and medicine, and policy. Active engagement and collaboration with partners in the public and private sectors and with communities will help to ensure the enhanced research and education that lead to sustainable solutions. Local, national, and global dynamics are highly salient to each Grand Challenge.

The elements implicit within each Grand Challenge and, importantly, across the five Grand Challenges, lay the foundation for interdisciplinary research cohesion, collaboration, and creativity at a comprehensive level. The result is a stronger institution and a surer contributor to solutions to the great societal issues of our time.

To lead in addressing these vexing issues, the University must also exemplify steps toward their solution internally. Indeed, it is critical that the focus of the Grand Challenges be not only external. The University itself should model a just and equitable community, committed to enhancing the capacity of its community members. The University should also model sustainable food practices and water use, as well as enhance the environmental and human



ecosystems of the Mississippi River, which flows through the campus. Tailored health innovations should also be implemented and demonstrated as increasingly routine practice for members of the University community, and then replicated elsewhere.

The five Grand Challenges, with seamlessly integrated boundaries, offer the pathway for the University of Minnesota to become the leading exemplar for interdisciplinary research and institutional practices among its peers as it draws on the strength of its disciplines, its character as a comprehensive land-grant university, and its extensive engagements with external constituents locally, nationally, and globally.

Grand Challenges Vision

The recommended set of Grand Challenges has been informed by a long-term vision and with an expectation of significant results for Minnesota, the nation, and the world. As emphasized in the Strategic Plan, the Grand Challenges must have strong relevance locally, both in the Twin Cities and across Greater Minnesota. This is in keeping with the University's mission as Minnesota's flagship land-grant research university, reflecting our responsibility and commitment to research, teaching, and engagement benefiting the state and its local communities, as well as more broadly and, indeed, globally.

The Grand Challenges are intentionally inclusive, reflecting the inherent complexity each embodies. Various facets of each challenge will draw the interest and expertise of a variety of faculty, coming together to discover new ways to confront it. Leveraging our unique strengths in interdisciplinary collaborations, extending to engaged partnerships with constituencies beyond the University, will create a more coherent, comprehensive, and coordinated approach that will attract new recognition and new funding for the University while providing enhanced opportunities for faculty, students, and staff.

Thus, the pursuit of these five Grand Challenges is highly congruent with the foundational vision of the Strategic Plan:

The University of Minnesota Twin Cities will be preeminent in solving the Grand Challenges of a diverse and changing world. We will:

- Use our depth and breadth to capitalize on our exceptional students, faculty, and staff—and on our location in a vibrant metropolitan setting—to generate and disseminate new knowledge, creative work, and insights.
- Create an educated populace able to identify, understand, and solve demanding problems.
- Leverage the power of divergent paths to knowledge and creativity in order to address the grand challenges of society.
- Partner with the communities and people of the state of Minnesota to benefit the common good.

Implementation of the vision will involve all sectors of the campus in initiatives and collaborations to strengthen transformative research, outstanding education, meaningful outreach, and productive collaboration, as captured in the four key goal areas of the plan:

- Leverage exceptional research and curricular strengths to address society’s “Grand Challenges”—develop and support more ambitious and innovative collaborations across disciplines as well as through new learning and career pathways that prepare students to be outstanding leaders, innovators, and global citizens.
- Reject complacency to foster an invigorated campus culture of ambition, challenge, exploration, and innovation—encourage experimentation and highest expectations in all aspects of our mission
- Recruit and retain field-shaping researchers and teachers from diverse disciplines and backgrounds—make Minnesota a magnet for diverse high achievers and innovators who will advance excellence in research, outreach, and engagement and provide world-class educational experiences for graduate, professional, and undergraduate students.
- Capitalize on the campus’s unique location and its global reach to build a culture of reciprocal engagement—expand partnerships and shared purposes to benefit the state, strengthen opportunities for students, and to deepen Minnesota’s connections around the globe.

The vision and goals of the Strategic Plan position the University for a transformation—one that will more powerfully demonstrate the 21st-century relevance of a comprehensive place-based research University. The recommendations presented by the Provost’s Grand Challenges Research Strategies Team are intended to contribute to that transformation—marshaling the University’s research and creative capacity more powerfully and to foster field-shaping interdisciplinary approaches to research.

Grand Challenges collaborations will provide a new landscape of opportunities to faculty and students, including stronger external partnerships that build on knowledge and strengths of local and global communities. Our institution will take full advantage of its mission, breadth, location, configuration, traditions, partnerships, and knowledge-creation prowess to produce research that makes crucial contributions to solving the Grand Challenges of our time.

Additional Interdisciplinary Research Priority Areas

The Provost's Grand Challenges Research Strategies Team recognizes that the proposed Grand Challenges do not fully encompass the breadth of research strengths across the University. Benefits to society and to the institution will also come from a focus on additional interdisciplinary efforts. Consistent with the vision and goals of the Twin Cities Strategic Plan and implementation steps, we recommend that the Provost's Office recognize interdisciplinary strengths in addition to the Grand Challenges as key research areas to highlight and support.

Those additional areas include at least the following as worthy examples:

- Tackling climate change: mitigation and restoration. Limit further climate change and adapt to the climate changes already under way, for the sake of human well-being.
- Promoting resilience and well-being in urban social-ecological systems. Reimagine and redesign cities to support opportunity and quality of life for citizens through interdisciplinary knowledge of urban systems.
- Understanding the brain: consciousness, perception, and neurodevelopment. Expand research related to the structure and function of the brain, including nanotechnology-enabled neuroscience, brain mapping, mental health, brain injury, and dementias.
- Transforming the understanding of immigration. Address the individual and community transformations and challenges that continue as immigrants and refugees seek new homes in Minnesota, other parts of the United States, and in other countries.
- Fostering human rights. Advance human rights and universal human dignity through reconciliation and restorative justice, civil rights, and peace-building.
- Nanotechnology and nanoscience research. Enhance research leading to technological advances that support solutions to multiple Grand Challenges and that include novel nano-enabled approaches to the screening, diagnosis, and treatment of disease.
- Renewable energy. Pursue research on solar, wind, and bio-based renewable alternatives; technologies to increase energy efficiency; urban infrastructure; and energy policy.

Institutional Recommendations

As emphasized in the Strategic Plan, “the transformative strategic goal for the University is not simply identifying one or more Grand Challenges as a focus for concerted attention,” but unleashing the full potential of University research and creative work. Building on the recommendations outlined in the plan, we recommend the University take several important steps that facilitate implementation of the Grand Challenges research agenda and more broadly enhance institutional support for interdisciplinary research and curriculum.

1. Take immediate actions that demonstrate institutional commitment to the Grand Challenges to capitalize on current momentum and enthusiasm for the GC Research opportunities. Through strong communication and engagement efforts, faculty should be invited to participate in interdisciplinary and cross-collegiate clusters that will be facilitated as soon as possible around each of the selected Grand Challenges. Interdisciplinary Grand Challenge dialogues will support faculty exchanges, brainstorming around research strategies, and new collaborations. The faculty who participate in each Grand Challenges interdisciplinary cluster can be encouraged to develop criteria and a process for identifying faculty leaders for the respective Grand Challenges. They should also establish research goals, set priorities for engaging external partners, develop research proposals in conjunction with the interests of funders, and identify mechanisms to hold the process accountable, including regular reporting to the broader faculty.

The processes needed to develop Grand Challenges clusters and to build and sustain excellent interdisciplinary work of high impact will require clear and significant logistical and financial support by the Office of the Senior Vice President for Academic Affairs and Provost and other vice presidential units, as well as concrete encouragement by collegiate deans.

2. Make a noteworthy investment of funds to support interdisciplinary endeavors, including but not limited to the Grand Challenges. A recurring theme from faculty who attended one or more of the October 2015 Grand Challenges Research Forums was the importance of institutional mechanisms to continue to bring faculty together to learn about one another’s research, foster new collaborations, and support interdisciplinary research around the Grand Challenges and other research priorities. The important institutional support for convening faculty and enabling interdisciplinary engagement is not a substitute, however, for financial investment. The combination of interdisciplinary engagement and designated funds will create powerful opportunities for the University to address some of the most vexing societal problems of the day and elevate its reputation nationally and internationally.

Reallocating resources to invest in Grand Challenges research of high potential impact will help faculty compete for external research funding, enhance fundraising by the University of Minnesota Foundation in support of the University’s mission, and strengthen the University’s partnerships with alumni, external partners, and the state.

3. Design institutional mechanisms to enhance interdisciplinary research, including breaking down barriers to and providing incentives for collaboration across colleges. The institution should further integrate diverse interdisciplinary strengths through new University of Minnesota initiatives that remove barriers to collaboration. In particular, deeper integration of STEM-related disciplines with the arts, humanities, and social sciences is imperative to the success of the University's strategic research goals. The deans and other University leaders should be engaged in discussion and recommendations for streamlining avenues to interdisciplinary research for faculty and to benefit student research and learning.
4. Assure that University incentives, cultures, values and resources are compatible with the interdisciplinary Grand Challenges goals, principles, and processes. Where resource allocation processes and institutional incentives are at odds with effective interdisciplinary and cross-college research, strategies and processes should be developed to realign those processes and practices. This is not to displace core disciplinary research, but to supplement it by using the Grand Challenges to connect and integrate rather than to separate. Doing so will foster institutional sustainability.
5. Emphasize the institution's commitment to interdisciplinary research through opportunities, recognitions, awards, and engagement. In addition to the importance of acknowledging faculty for their disciplinary contributions, the University should also recognize interdisciplinary efforts, which can pose additional challenges for faculty. The institution should sponsor regular interdisciplinary symposia that are theme-, issue-, or problem-centered; establish new interdisciplinary fields, as appropriate; and support interdisciplinary Ph.D.s and postdoctoral fellowships (like the Graduate School's Interdisciplinary Graduate Fellowships) and team-taught graduate and undergraduate courses.

Conclusion

Why Grand Challenges? Other academic institutions have declared a commitment to addressing Grand Challenges, as have federal agencies, philanthropic foundations, and others. The approach to solving big problems is not unique. But Minnesota is unique. The Grand Challenges for the University of Minnesota emerged as a central component of a larger vision—developed through an extensive strategic planning process completed in 2014—for our comprehensive and globally engaged university to most effectively harness its exceptional strengths and competitive advantages for greater excellence. The report completed by extended teams of faculty, staff, and students took note of the University’s dual role as Minnesota’s public land grant university and its flagship research institution—roles separated in many other states.

The Strategic Plan also highlights the University’s extraordinary breadth and depth in comparison to peer academic institutions, the advantages afforded by its location in a dynamic metropolitan area and state. We are a Tier 1 research university and vital anchor institution in a region bestowed with a great river and a great lake; four distinct biomes (from forest to grassland); and agricultural, forestry, and mining industries. The advantages of our location also include the region’s diverse rural and urban communities; thriving arts and non-profit sectors; and 17 Fortune 500 companies. We also have a notably large and strong alumni base and many existing private and public partnerships and collaborations.

Our faculty members generate high-quality disciplinary and interdisciplinary work, based on expertise, interest, and the desire to find solutions that will serve the greater good. Embracing Grand Challenges priorities offers a powerful new way to elevate our research and enhance opportunities for the faculty and the institution. Expanded Grand Challenges collaborations will take place within the broader context of goals for advancing Grand Challenges curriculum, recruiting and retaining field-shaping faculty, supporting reciprocal engagement, and creating a University culture that rejects complacency and breaks down barriers that impede ambition and innovation.

The Grand Challenges are about making a strong University even more excellent. They are about ensuring that our faculty can do their best work in a setting that is not only unencumbered but also that supports and encourages them to collaborate with colleagues in various departments within the University and with public and private sector organizations and communities.

Academic research alone will not solve critical societal challenges or make our great institution greater. But a more creative and integrated approach to addressing challenges does have the potential for great impact, not only because it harnesses a greater range of expertise and methodologies but because it will build new partnerships—local and global—with those who bring practical knowledge of a problem and those who are in positions to make change. The University of Minnesota’s expanded commitment to Grand Challenges research will better serve our faculty, students, staff, the state, and the broader public. It underscores the continued relevance and value of a vitally engaged research university in the 21st century. The Grand Challenges priorities and strategies we recommend clearly highlight exceptional opportunities

we have to achieve the overall vision of transformational institutional change that will continue to benefit our state and its citizens over the coming decades.

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Supporting documents are appended, as follows:

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Appendices

Appendix A: Criteria for Grand Challenges Research (Twin Cities Campus Strategic Plan)

University of Minnesota Twin Cities Strategic Plan | [Summary/Report of the Strategic Planning Workgroup](#)

Grand Challenges—Research: Identifying Grand Challenges

The Shape and Nature of Grand Challenges [Strategic Planning Report, p. 28]

Grand challenges are generally understood as the most important and complex problems facing local communities, states, nations, and the world. The grand challenges are not only deep and difficult problems, but also *multifaceted* challenges, requiring expertise and ideas drawn from many spheres and disciplines in order to be effectively addressed.

Selecting Grand Challenges That are to be Designated Institutional Priorities [pp. 28–30]

University of Minnesota Grand Challenges Should:

- **Meet key criteria** (*outlined below*)— factors that would make collaborations both transformative and strategic for the University.
- **Reflect the University’s relative advantage in pursuing some challenges rather than others.** All criteria should be considered; strength in some may compensate for weakness in others.
- **Should Involve a diverse cross-section of disciplines around a large problem** that has both a societal impact and the potential to make contributions to individual fields of study.
- **Have a local element**—a reason it makes sense for our university to pursue it and for the policymakers and citizens of Minnesota to care about the outcome. At the same time, selected challenges should also clearly scale from local to global impact.

Key Criteria for Grand Challenges

- **Global impact and local relevance.** Should be a challenge of significant scale and complexity selected with an eye to long-term vision and expectation of globally significant results. Also must have local relevance, underscoring the U’s responsibility and commitment to produce knowledge benefiting the state and local communities.
- **Build on current faculty strength and leadership.** Should both fit and leverage existing scholarly strengths and emerge from what faculty are already pursuing, especially if faculty have opportunities to strengthen connections with faculty/students from other areas. *Grand-challenges leaders* should be chosen based on existing national and international reputations and clear evidence that their trajectory of contributions is rising.
- **Disciplinary diversity.** Must have impact on and involve more than one academic discipline and expertise from multiple fields of knowledge. The U should take advantage of its exceptional breadth and look for opportunities to bring together diverse perspectives and methodologies.

continued

Appendix A, *continued*

- **Impact on the University and its reputation.** Should advance the University’s scholarly leadership in the challenge area, as well as its national and global status—looking broadly at the resources and strategic assets we would bring—faculty, staff, students, financial resources, collaborators and partners, and local assets or advantages.
- **Suitability for a land-grant research university.** Should involve challenges that fundamentally draw on our institution’s research power and creative activity; that foster open, shared advances in fundamental disciplines; and that bring together basic and applied research with education, outreach, and public engagement.
- **Interconnection with education.** Should engage students in innovative and groundbreaking ways. Should centrally involve graduate and professional students, integrate with curriculum, and provide experiential and intercultural learning opportunities for undergraduate students.
- **Engagement of external constituencies.** Should capitalize on U’s location in a vibrant and diverse state and metropolitan area and on our extensive network of national and international partners.
- **Sustainability.** Should be understood to involve support of that effort for at least 10 years—a timeline commensurate with the scale and complexity of these problems. Challenges should be evaluated based on our capacity to sustain effort over time (via grants, foundations, support from industry, state funding, University development efforts, or other sources).

Framework for Selecting Grand Challenges [*Next Steps, p. 78*]

Grand Challenges Research implementation team to seed potential grand challenge areas, shape an iterative process to define institutional priorities, and recommend short- and long-term research implementation steps.

The complete Strategic Plan is online at strategic-planning.umn.edu.

Appendix B: Provost's Charge to the Grand Challenges Research Strategies Team

UNIVERSITY OF MINNESOTA

*Office of the Senior Vice President
for Academic Affairs and Provost*

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February 27, 2015

To:

Raymond Duvall, Distinguished University Teaching Professor of Political Science and former interim dean of CLA; *chair*
Bruce Blazar, Regents Professor of Pediatrics and CCRF Land-Grant Chair in Pediatric Oncology, Director of Clinical and Translational Science Institute, Chief of Blood and Marrow Transplantation Program, Medical School
James Bradeen, Professor of Plant Pathology, CFANS
Tom Clayton, Regents Professor Emeritus of English Language and Literature, CLA
Marilyn DeLong, Professor of Design, Housing, and Apparel, CDes
Efi Foufoula-Georgiou, Distinguished McKnight University Professor of Civil Engineering, Joseph T. and Rose S. Ling Chair in Environmental Engineering, CSE
Gunda Georg, Professor and McKnight Presidential Chair in Medicinal Chemistry, Robert Vince Endowed Chair, Director of the Institute for Therapeutics Discovery and Development, College of Pharmacy
Apostolos Georgopoulos, Regents Professor of Neuroscience, McKnight Presidential Chair in Cognitive Neuroscience, American Legion Brain Sciences Chair, Medical School
Marc Hillmyer, Distinguished McKnight University Professor and McKnight Presidential Chair of Chemistry, Director of the Center for Sustainable Polymers, CSE
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Sonja Kuftinec, Professor of Theatre Arts and Dance, CLA
Richard Leppert, Regents Professor of Cultural Studies and Comparative Literature, CLA
Ann Masten, Regents Professor, Distinguished McKnight University Professor, and Irving Harris Professor of Child Psychology, Institute of Child Development, CEHD
Matt McGue, Regents Professor of Psychology, CLA
Phyllis Moen, Professor and McKnight Presidential Chair in

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Thomas Molitor, Distinguished University Teaching Professor of Veterinary Population Medicine, VetMed
Gary Muehlbauer, Distinguished McKnight University Professor and Endowed Chair in Molecular Genetics, Agronomy and Plant Genetics, CFANS, and Plant Biology, CBS
Fionnuala Ni Aoláin, Professor and Dorsey & Whitney Chair in Law, Law School
Harry Orr, Professor of Laboratory Medicine and Pathology, Edmund Wallace Tulloch and Anna Marie Tulloch Chair in Genetics, Director of the Institute for Translational Neuroscience, Medical School
Mike Osterholm, McKnight Presidential Chair in Public Health, Director of the Center for Infectious Disease Research and Policy, SPH
F. Abel Ponce de León, Professor of Molecular Genetics, Animal Science, CFANS
David Pui, Distinguished McKnight University Professor of Mechanical Engineering, CSE
Peter Reich, Regents Professor and Distinguished McKnight University Professor of Forest Resources, F.B. Hubachek Sr. Chair in Forest Ecology and Tree Physiology, CFANS
Steve Ruggles, Regents Professor of History, Director of the Minnesota Population Center; CLA
Karen Seashore, Regents Professor of Organizational Leadership, Policy and Development; Robert H. Beck Chair of Ideas in Education, CEHD
Donald Simone, Professor of Dentistry and Division Director/Basic Sciences, School of Dentistry
Joe Soss, Cowles Professor for the Study of Public Service, Humphrey School of Public Affairs
Ann Waltner, Professor of History, CLA
Jean Wyman, Professor and Cora Meidl Siehl Endowed Chair in Nursing Research, School of Nursing; Director, Minnesota Hartford Center of Gerontological Nursing Excellence; Co-Director, Powell Center of Women's Health, Medical School

From: Karen Hanson, Senior Vice President for Academic Affairs and Provost

Subject: Provost's Grand Challenges Research Strategies Team

Dear Colleagues,

Thank you for agreeing to serve as members of the Provost's Grand Challenges Research Strategies Team. I am grateful for your willingness to provide guidance on the research goals of the newly adopted campus strategic plan. The plan envisions, among other elements of institutional reinvigoration, that we will harness our research breadth and depth more powerfully to address some of society's most complex and consequential problems. As

Driven to DiscoverSM

continued

Appendix B, *continued*

Provost's Grand Challenges Research Strategies Team
February 27, 2015
Page 2

a team of leading researchers and thoughtful University citizens, you are being asked to share your expertise and judgment—and consult with others, both on campus and off—to identify the areas of inquiry where we have exceptional strength and where we are, or could soon be, a national and international leader.

Our first meeting has been scheduled for Friday, February 27, 1:30-3:00 p.m., Room 307 Coffman Union - Boardroom to allow us an opportunity to get acquainted as a team and to begin to discuss approaches for a collaborative campus process for identifying grand challenges. Please reply to this email to let us know whether you can attend; future meetings will be scheduled based on the availability of members. We will share notes from the meeting and obtain the thoughts of others who can't be at our first meeting next week.

As background information, I have attached the section of that strategic plan that is most salient to the task I have outlined (the full report is available online at <http://strategic-planning.umn.edu>). It frames the research goal as a part of the larger strategic vision and suggests criteria for the evaluation and selection of the grand challenges that are to be designated institutional priorities. It also identifies the three grand-challenge areas where we have already staked a public claim—areas where we have robust interdisciplinary work that we are well-positioned to broaden and elevate. A two-page summary is also attached.

I hope that this team will be able to meet several times this semester, and thereafter at least quarterly. I hope that members will also be available for individual consultation or to meet as subgroups when that seems appropriate. I know you all are balancing a huge and complex set of antecedent commitments, so we expect to revisit and refresh the composition of this team year by year.

Thank you again for agreeing to serve. I look forward to meeting with you next Friday afternoon and to working with you.

Best wishes,

Karen

Attachments: 2

cc: Deb Cran, chief of staff, Office of the Senior Vice President for Academic Affairs and Provost
Carla Carlson, Office of the Senior Vice President for Academic Affairs and Provost;
senior staff to committee
Kate Tyler, assistant to the provost, Office of the Senior Vice President for Academic Affairs;
senior staff to committee
Brian Herman, Vice President for Research
Mary Nichols, Professor, CSOM; Dean, CCE; *ex officio*, special assistant to the Provost

Appendix C: Chair's Charge to GC Research Team Subcommittee, March 2015

UNIVERSITY OF MINNESOTA

Office of the Senior Vice President
for Academic Affairs and Provost

234 Morrill Hall
100 Church Street S.E.
Minneapolis, MN 55455-0110
Office: 612-625-0051
Fax: 612-624-3814

March 9, 2015

To: Grand Challenges Research Subcommittee

From: Raymond Duvall, chair, Provost's Grand Challenges Research Strategies Team

To: **Gunda Georg**, College of Pharmacy
Apostolos Georgopoulos, Medical School
Marc Hillmyer, College of Science and Engineering
Sarah Hobbie, College of Biological Sciences
Richard Leppert, College of Liberal Arts
Phyllis Moen, College of Liberal Arts
Gary Muehlbauer, College of Food, Agricultural, and Natural Resource Sciences
F. Abel Ponce de León, College of Food, Agricultural and Natural Resource Sciences
Karen Seashore, College of Education and Human Development
Joe Soss, Humphrey School of Public Affairs

Subject: Engaging the Faculty

I look forward to working with all of you to advance the charge outlined by Provost Hanson for the Grand Challenges Research Strategies Team. At our initial meeting on Feb. 27, the provost reviewed the charge for our team: to advance broad consultation with all levels and elements of our campus to identify areas of exceptional cross-disciplinary research strength—research strengths we might harness more powerfully to address some of society's most complex and consequential problems.

One outcome of our meeting was agreement that a subcommittee should be tasked with drafting a proposal that: (1) outlines a good process for **focused consultations and information gathering** to advance our charge; and (2) outlines an **inclusive process for engaging faculty broadly**—beyond those directly consulted—in a discussion of potential grand challenges aligned with criteria in the Strategic Planning Report.

Thanks to each of you for agreeing to serve as members of this ad hoc subcommittee. We will be back in touch shortly to confirm the date, time and location of our initial meeting.

The charge to the subcommittee evolved from our discussion on the 27th:

- Consultation process. Structure a process for inviting academic leaders and faculty to inform a robust discussion of cross-disciplinary areas of research and scholarship where we have, or are poised to have, exceptional strength and a competitive advantage. This process might include some or all of the following, as well as other possibilities:
 - focused consultations with deans or others who can help identify signal research strengths across colleges (this might include review of reports by deans about their collegiate strategic research priorities).
 - members of the Provost's GC Research Strategic Team (our larger committee) consult with leading research faculty in their respective domains
- Faculty engagement process. Structure a process for inviting the faculty (and broader University community) to suggest areas of research strength that might set the basis for Grand Challenge

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continued

Appendix C, *continued*

foci, as well as to comment on procedures to support consultative goals and determine general communications strategy.

- Determine the need for supporting materials that might be useful to compile and to share with participants in this process (related to the Strategic Planning vision and goals, Grand Challenges criteria, etc).

Provost Hanson has assigned Carla Carlson and Kate Tyler as provost's office staff liaisons to our team, and both will be available to assist the committee as needed.

Thank you for your contributions of time and intellect. I look forward to our discussions.

c: Provost Karen Hanson
Members, Grand Challenges Research Committee
M. Nichols, Provost's Special Assistant
Carla Carlson, Kate Tyler, Provost's Senior Staff to the Committee

Grand Challenges Research: Identifying Campus Priorities

From Provost Karen Hanson



UNIVERSITY OF MINNESOTA
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Senior Vice President for Academic Affairs and Provost

Dear Colleagues,

As you know, our Twin Cities campus has declared that it will be a place where research, teaching, and engagement integrate to bring solutions to society's complex problems. Which of those many problems should we collectively affirm to be our first targets? I write to ask for your help in answering that question.

Your best thoughts are needed as we work toward the goals identified in the Twin Cities campus strategic plan. The Provost's Grand Challenges Research Strategies Team, 30 distinguished faculty members led by Professor Bud Duvall, developed steps that, with your participation, will lead us to define a set of Grand Challenges that our campus will very publicly embrace. A description of the process to identify Grand Challenges priorities is [posted on the strategic planning website](#), along with submission guidelines--the "Call for Ideas."

Please respond to the "Call for Ideas," offering ideas that can help foster interdisciplinary connections with colleagues across the campus. The guidelines include web links to full details and instructions for submission. This process will continue into the fall semester, but I encourage you to be an early contributor and submit your idea or ideas by the initial June 26 deadline.

You may be aware that the Strategic Plan includes three Grand Challenges areas, noted as examples of strong interdisciplinary efforts already under way on our campus. Your suggestions might, e.g., be directed to the enhancement of work in the three identified areas--food, industry/environment/climate change, and vibrant communities--or you might instead indicate ways that our institutional strengths can address *additional* pressing societal issues. By the end of the fall semester, we intend to have identified three to five additional Grand Challenges.

continued

Appendix D, *continued*

We need your intellect, your curiosity, and your passion for addressing the difficult, multi-faceted problems that weigh on populations locally and globally. As noted in the attached information, campus forums will be planned to support collaboration and enhance strengths in existing and emerging areas of scholarship. But first, we need your ideas.

I want to emphasize that the campus will be making a significant commitment to the Grand Challenges that are adopted as institutional priorities. Please help determine the direction and force of that commitment.

Thank you for joining with other faculty across the Twin Cities campus to contribute to these steps in the implementation of the Strategic Plan, helping both our institution and the communities we serve.

As always, I invite your comments and suggestions.

Sincerely,

Karen Hanson
Senior Vice President for Academic Affairs and Provost

This message was sent May 19, 2015 by Provost Hanson to Twin Cities faculty.

Appendix E: Call for Ideas—Grand Challenges Research, May 2015

Provost's Grand Challenges Research Strategies Team—Call for Ideas

The GC Research Strategies Team shaped the Call for Ideas as part of a multifaceted process to consult broadly with the campus community in fulfillment of the charge from the provost. The Call for Ideas sought faculty suggestions for complex, multifaceted Grand Challenges that capture areas of scholarship in which the University already has exceptional strength, in which it has the potential to have global impact and enhanced local relevance, and in which it also has potential to make a deeper connection with students and reciprocal partnerships with communities (among eight criteria in the [TC Campus Strategic Plan](#), which was appended to the Call for Ideas).

Cover Letter for the Call for Ideas

Grand Challenges Research: Identifying Campus Priorities

May 2015

Dear Colleagues,

Now is the time to identify the Grand Challenges that will further distinguish the Twin Cities campus. The Grand Challenges will guide our interdisciplinary strengths toward solutions to some of society's most complex problems.

As your peers, we seek what only the faculty can provide—the innovative ideas that underpin the scholarly future of our institution. We invite you to contribute ideas that can translate into Grand Challenges, a major element of the Strategic Plan implementation.

The Provost's Grand Challenges Research Strategies Team, a group of 30 faculty members, developed the attached "Call for Ideas" that will be the basis for focused campus discussions to identify Grand Challenges.

Please review the simple form and:

- Submit your idea by *August 17, 2015, the second of two summer deadlines*. To have greater impact on shaping the discussion, please respond early!
- The Call for Ideas form is attached (copies may be downloaded at <https://strategic-planning.umn.edu/gc-research-process>).

The Call outlines a simple template for submissions of no longer than two pages. Please email your submissions to GCrsrch@umn.edu.

- Campuswide forums will be held in September and October to engage faculty in more detailed discussions of the potential Grand Challenge ideas that have been submitted.
- Following final recommendations from the Grand Challenges Research Strategies Team, the Provost expects to announce the Grand Challenges by the end of the Fall 2015 semester.

continued

GC Research Call for Ideas, Cover Letter, continued

We need your best ideas for complex, multifaceted Grand Challenges, not discrete research project proposals. A Grand Challenge idea will capture areas of scholarship in which the University already has strength, in which it has the potential to have global impact and enhanced local relevance, and in which it also has potential to make a deeper connection with the land grant commitment to engaged teaching and learning and reciprocal partnerships in the public and private sectors.

Three to five Grand Challenges will be identified, in addition to the three areas of existing strength already described in the Strategic Plan (related to food, industry/environment/climate change, and vibrant communities—[pages 33–35 of the plan](#)). Your contribution of ideas may expand upon these already-identified areas in new ways, or importantly, identify other potential areas in which the University can bring interdisciplinary strengths powerfully to bear on the critical problems of society.

Questions about the process and idea submissions can be directed to Raymond Duvall, chair of the Grand Challenges Research Strategies Team, at rduvall@umn.edu.

Thank you for your contributions of time and intellect.

[The Provost's Grand Challenges Research Strategies Team](#)

List of members is at <https://strategic-planning.umn.edu/gc-research-team-members>

Call for Ideas Guidelines

Call for Ideas

A Process to Identify Potential Grand Challenges

Issued by Provost's Grand Challenges Research Strategies Team

May 2015

The Provost's Grand Challenges Research Strategies Team at the University of Minnesota seeks ideas from faculty that will help to identify Grand Challenges that enhance exceptional cross-disciplinary research strengths and expand collaborations for greater impact. This is a key component of the Strategic Plan for the Twin Cities campus, which envisions—as part of a larger project of institutional reinvigoration—that we will harness our research breadth and depth more powerfully to address some of society's most complex and consequential problems.

Grand Challenges are areas where the University will further excel as a research campus—areas where our breadth and depth is such that we are, or soon could be, a national and international leader. We are at an exciting juncture, at which the faculty can help to define the signature Grand Challenges foci of the institution for the near-term future.

continued

The first of a series of deadlines for submission of Grand Challenges ideas is Friday, June 26, 2015. To have greater impact on shaping the discussion, you are encouraged to submit as early as possible. If you are unable to meet the June 26 deadline with a full submission, please submit by that date a brief statement of intention to submit at a later date, indicating the rough contours of your idea. **[Note: A second summer deadline has been set for Mon., Aug. 17.]**

In responding to this Call for Ideas, we ask that you, in no more than two pages (12-point font, singlespaced, 1-inch margins):

1. Provide your contact information: name, title, departmental affiliation(s), email, and phone.

NOTE: If this submission represents a team of faculty, provide contact information for the lead individual and the names of team members. Team submissions are not required, but we encourage you to have conversations with colleagues as you consider possible Grand Challenges that draw on a range of research strengths across the campus.

2. Describe your idea for a Grand Challenge and its significance.

In the narrative, be sure to describe the relationship of your idea to the Grand Challenges research criteria outlined in the [Twin Cities Strategic Plan](#) (pages 29–32; summary is attached).

- Global impact and local relevance
- Build on current faculty strength and leadership
- Disciplinary diversity
- Impact on the University and its reputation
- Suitability for a land-grant research university
- Interconnection with education
- Engagement of external constituencies
- Sustainability over 10 years

3. Provide examples of one or more faculty (or groups of faculty) whose work has the potential to contribute to interdisciplinary advancement of the proposed Grand Challenge.

Please email your submission to GCrsrch@umn.edu. Thank you!



UNIVERSITY OF MINNESOTA
Driven to Discover™

Senior Vice President for Academic Affairs and Provost

Dear Colleagues:

As the fall semester approaches, I want to give you an update on our progress in implementing the Twin Cities campus strategic plan and to extend thanks to all of you for the exceptional work you do every day to advance our University's tri-fold mission of research, education, and service.

There has been a tremendous faculty response to the Grand Challenges Research Strategies Team's Call for Ideas. Approximately 130 ideas on a wide range of topics have been submitted. The contributions have come from every college, cover a broad range of topics, and highlight the vigor, innovation, and reach of our researchers and teachers across many disciplines. Over 350 faculty are named as leads or co-leads on these proposals—with many more identified as potential contributors.

Consideration of the submitted ideas is under way by the Grand Challenges Research Strategies Team, which includes thirty distinguished faculty members and is chaired by Raymond Duvall, professor of political science and former interim dean of CLA. The committee is considering each submitted idea in relationship to the eight **Grand Challenge criteria** outlined in the strategic plan, and is looking especially for potential connections among the submissions.

Campus-wide forums are being planned in October and November to explore and develop the topics and overarching themes proposed in this summer's submissions. In addition to helping to shape the Grand Challenges priorities we will embrace as an institution, the forums are intended to help seed and foster interdisciplinary connections that could advance integrative research goals across the campus. Our aim is to use this process to create opportunities for faculty, students, and staff to discover and discuss shared research interests and to consider together how we might further benefit the variety of communities that we serve as a land-grant research university.

continued

Appendix F, *continued*

In addition, this fall we roll out the first offerings in our developing **Grand Challenge Curriculum** with an initial set of courses-on issues ranging from fracking to global hunger to reconciliation and justice-that will pave the way for consideration of how to integrate grand challenges into the University curriculum.

I ask all of you to engage with our ongoing work to leverage our academic strengths toward greater excellence and impact-and to make sure our campus in every way reflects the highest ideals of our institution.

Sincerely,

Karen Hanson

Senior Vice President for Academic Affairs and Provost

This email was sent to Twin Cities faculty and staff by the Office of the Senior Vice President for Academic Affairs and Provost, 234 Morrill Hall, 100 Church St. S.E., Minneapolis, MN, 55455, USA. [Read our privacy statement.](#)

Appendix G: Grand Challenges Research Ideas Submitted by Faculty, Oct. 2015

Provost's Grand Challenges Research Strategies Team Call for Ideas

Summaries of GC Research Ideas Submitted by Faculty

The Provost's Grand Challenges Research Strategies Team invited ideas from faculty for "grand challenge" research priorities the University could fruitfully embrace. Many faculty responded, submitting ideas spanning a wide range of topics and disciplines. The ideas were the basis for five campus forums that were intended to focus and broaden Grand Challenges research ideas and strengthen campus research connections.

Following is a list of the ideas contributed by faculty, grouped under broad themes that overarch multiple submissions. (These were also posted [online](#), along with notes following each forum). Submitters identified one of the discussion themes as a fit for their idea.

Each submitter was asked to distill their submission into a short summary that explicitly described: (1) how or why the idea is a Grand Challenge, and (2) how the University of Minnesota is especially well positioned to marshal exceptional strengths and to lead in finding solutions to this Grand Challenge.

Lead submitters are listed, along with any identified co-submitters. Many of the original submissions also identified expanded lists of potential contributors across the campus.

Ideas are clustered in this appendix as follows:

Just and equitable societies—p. 47

Human potential and well-being across the life course in a diverse and changing world—p. 56

Human health—p. 65

Sustainable cities and resilient communities in a world of climate change—p. 76

Secure food, water, and energy—p. 82

How will we ensure just and equitable societies?

Beyond Atrocity and War: Reconciliation and Justice

Lead Submitter: Alejandro Baer, Sociology

Co-Submitter: Catherine Guisan, Political Science

What choices face societies, which emerge from war, genocide and grave human rights violations? The USA confronts this question on every continent and within, as ancient racial and economic divides continue to threaten the fabric of its society. Heightened knowledge in promoting reconciliation and justice is crucial to the well-being of future generations.

This proposal will stimulate collaboration between U of MN scholars with a theoretical, methodological, and policy interest in post-violence justice and reconciliation processes who have already established an impressive research record. It will promote new research on and with external constituencies, such as the local migrant communities from countries plagued with ongoing conflict; on the economic, cultural and psychological factors causing and solving conflict between and within countries; and the development of violence prevention and conflict management programs. It will also involve our excellent and diverse undergraduate and graduate students in community-engaged research and outreach activities.

Promote and Protect Human Rights

Lead Submitter: Elizabeth Heger Boyle, Professor, Sociology

Co-Submitters: Barbara Frey, Global Studies; Lisa Hilbink, Political Science; Joachim Savelsberg, Sociology

Enshrining human rights in international law is one of the greatest achievements of the 20th Century. Human rights are a broad yet influential framework, shaping criminal justice systems, influencing transitions to peace after war, combatting discrimination and violence, and supporting health care, education, housing, and other basic needs. Still, promoting the implementation of human rights and protecting individuals from rights violations remains a grand challenge both locally and globally.

University of Minnesota faculty and professional staff from at least 24 units and 8 colleges or schools are a ready resource for achieving breakthroughs in understanding and responding to this challenge. Furthermore, the state of Minnesota is a hub of human rights activity, unparalleled by any other state, uniquely attracting top talent from around the country. Identifying this Grand Challenge will secure for the U of M an institutional reputation as a global leader in human rights.

Land Grant Universities, American Indian Land, and American Indian Communities

Lead Submitter: David A. Chang, Associate Professor, History

Co-Submitters: Katherine Hayes, Anthropology; Brenda Child, American Indian Studies

What is the responsibility of Minnesota's land grant university system to the state's American Indian nations, the original owners of all of the state's lands? In 1862, the federal government endowed the university with tens of thousands of acres—every one of which it had taken from the Dakota, Ojibwe, and Ho Chunk nations in the preceding 25 years. The question of the University's responsibility is therefore inescapable. How can the University best fulfill its educational, research, and social missions when we remember that its land grant was a grant of Indian land? What are the University's special responsibilities to Indian communities?

Bringing this challenge to the center of University life would manifest a commitment to deal honorably with Minnesota's Native communities. Moreover, it would position the University to lead the way for the nation's other 75 land grant universities in placing Indian land and people at the core of their land grant mission.

Inequality

Lead Submitter: Tracey Deutsch, History

The University is well suited to interrogate the question of inequality at the broadest level, and it is essential for the University to do so. The contemporary world is marked by measures of inequality of property, health, income, employment, and opportunity that are unprecedented in the modern period, creating complex, interlocking, and pervasive dangers to individual and societal survival. The methodologies and mobilizations necessary to address such massive inequality and to build a more equitable world will require focusing on the interconnections and intersections between multiple catalysts and producers of inequality.

We are interested in how multiple kinds and contexts of inequalities work in tandem and get mobilized, such as the links between white supremacy, property accumulation, and notions of worth and investment; and between bodily integrity, foodways, land use and the environment, and racism. We ask why have particular inequalities become even more pronounced in the modern period. It is crucial to simultaneously investigate inequality in the present and how it has historically been formed, maintained, and changed.

New Approaches to Violence Against Women and Girls

Lead Submitter: Ana Forcinito, Spanish and Portuguese Studies

With strong emphasis on the intersection of gender and feminist studies and human rights, this grand challenge focuses on violence against women and children, and its alarming increase during the last decades, in three major areas of concern: 1) femicide/femicide, 2) rape in the context of genocide, armed conflict or state terrorism, and 3) trafficking in women and girls. This grand challenge involves education and advocacy as well as intercultural and transdisciplinary research projects, dialogues among different disciplines (arts, humanities, law, social sciences), and collaboration with local and global organizations and institutions.

The University of Minnesota is well positioned to address this grand challenge because of its leading role in the understanding and promotion of human rights, and its commitment to produce knowledge that is meaningful to our society globally and locally.

Creation of Critical/Applied Disability Studies at the University of Minnesota

Lead Submitter: Nancy K. Herther, University Libraries

Co-Submitters: Alex Lubet, School of Music; Christopher Johnstone, Organizational Leadership, Policy, and Development; Debra DeBruin, Center for Bioethics; Gordon Legge, Psychology; Michael Silverman, Music; Kirk Allison, Public Health; Donna Johnson, Disability Resource Center; Linda Wolford, Disability Resource Center; Erica Seidel, VA Hospital; Kandi Heard, Music Therapy; David Ketroser, Bioethics; Joia Tellez, Music Therapy; Lara Hermanson, Music Therapy

The World Health Organization estimates that 1 billion people in the world have some form of disability. As a complement to medical interventions, the field of Disability Studies (DS) seeks to engage scholars in sociological, cultural and political interpretations of disability. Such perspectives are imperative as disability is constructed and understood in myriad ways around the world.

Our collaborative seeks to engage the grand challenge of disability and its social applications. We build on a strong network of DS scholars representing at least two colleges, the AHC, and the library system, as well as the 88 scholars who have completed DS dissertations at our University. Through this work we will quickly establish a formal academic presence (including coursework and collaborative research), create new synergies, and relationships with funders in order to develop an area of study that addresses one of the world's most far-reaching grand challenges.

Sustainability of Human-Environmental Systems

Lead Submitter: Roman Kanivetsky, Bioproducts and Biosystems Engineering

Co-Submitters: John Nieber, Bruce Wilson, Gary Sands, Lawrence Baker, Jason Hill, Shri Ramaswamy, Bioproducts and Biosystems Engineering; Mae Davenport, Forest Resources; Mark Kanazawa, Economics

Sustainability challenges can be solved only by convergence of knowledge from many disciplines in natural, social, economic and governance sciences. The key message of convergence is that merging ideas, theories, approaches, and technologies from widely diverse fields of knowledge at a high level of integration is one crucial strategy for solving complex problems and addressing complex intellectual questions underlying sustainability. Convergence represents an expanded form of transdisciplinarity in which bodies of specialized knowledge comprise "macro" domains of research activity that together

create a unified whole. Convergence, integrated effectively, offers the possibility of a new paradigm capable of generating ideas, theories, discoveries, methodological and conceptual approaches, and forms and strategies of education and training.

The University, as an institution of universal knowledge, should develop a mechanism for collaboration, network governance and other form of multi-authority initiatives supported by some form of legal status that come from legislation, executive order, etc.

UMN International Humanitarian Crisis Simulation

Lead Submitter: Sarah Kesler, Assistant Professor, Pulmonary, Allergy, Critical Care and Sleep Medicine

The UMN International Humanitarian Crisis Simulation addresses the Grand Challenge of improving provision and quality of aid during international humanitarian emergencies. Almost 1 percent of the world's population is currently displaced due to conflict. People in these circumstances are vulnerable to problems such as human rights abuses, malnutrition, poor access to health care, and lack of education. All of these problems can be addressed by high-quality humanitarian relief. Through the provision of effective humanitarian relief, the quality of life of our fellow world citizens can be preserved, and a tremendous amount of human capital can ultimately be used to rebuild healthy societies.

Our interdisciplinary, experiential educational event gives prospective humanitarian workers knowledge and a realistic experience that will allow them to manage the initial stages of complex international humanitarian emergencies. Our program also has tremendous potential for the study of simulation as an educational tool.

Addressing Religious Diversity, Interaction, and Conflict: Developing Strategies for Ensuring Vibrant Communities

Lead Submitter: Jeanne Halgren Kilde, Religious Studies Program

Co-Submitters: Andrew Scheil, English; Stephen Ahearne-Kroll, Classical and Near Eastern Studies; JB Shank, History; Ruth Mazo Karras, History; Penny Edgell, Sociology; Nita Krevans, Classical and Near Eastern Studies; Riv-Ellen Prell, American Studies; Nabil Matar, English; James Parente, German, Scandinavian, and Dutch

We propose that UMN address the challenges of religious diversity, interactions, and conflicts facing Minnesota and global communities. The societal role of religions (past and present) has run the gamut from advancing positive social change to serving as a tool of domination and oppression. Concerns about contemporary religion abound, yet public forums addressing religion-related issues often rely on misunderstandings or stereotypes.

UMN houses dozens of educators involved in the study of religions from 3 colleges and over 20 departments, centers, and programs. We also have long-established links to a diverse array of religious and non-religious groups on and off campus. We are thus exceptionally well positioned to educate students about the contemporary and historical complexities of diverse religious publics, foster deeper public understandings of the relationships between religious thought/practice and global societies, and aid communities facing religiously informed civic, social, political, and ethical challenges.

Undoing Domination

Lead Submitter: Nancy Luxon, Political Science

Co-Submitter: Robert Nichols, Political Science

Despite progress in global political and economic development, hierarchies of domination persist across the world. This century has just begun to confront the experiences of domination lived through racism, sexual violence, police brutality, exploited labor, and the legacies of colonialism. Already, faculty have taken up the challenge of “undoing domination”—through research on incarceration, poverty

governance, global market inequalities, indigenous peoples, and politics—and have sought to identify and transform old patterns and institutions, moving towards new forms of political, social, medical, and cultural community. Minnesota’s historic relation to indigenous peoples, and its contemporary location as a center for political refugees from Somalia, Vietnam and beyond, give it a special obligation to research these topics.

This challenge brings together scholarship that stretches across Political Science, AIS, ALL, Sociology, Geography, the Humphrey School of Public Affairs, and the Law School. Importantly, it pivots between global and local, between structures and agents.

Investing in Early Child Development for Prosperity in a Changing World

Lead Submitters: Ann Masten, Institute of Child Development; Megan R. Gunnar, Institute of Child Development

Co-Submitters: Cawo Abdi, Sociology; Simone French, Epidemiology and Community Health; Michael Georgieff, Pediatrics; Abigail Gewirtz, Family Social Science; Priscilla Gibson, Social Work; Maria Hanratty, Social Policy; Wendy Hellerstedt, Maternal and Child Health; Linda Lindeke, Nursing; Geoffrey Maruyama, Educational Psychology; Perry Moriearty, Law School Academic Programs; Jeylan Mortimer, Sociology; Arthur Reynolds, Institute of Child Development; Arthur Rolnick, Human Capital Research Collaborative; Aaron Sojourner, Work and Organizations; Frank Symons, Educational Psychology; Judy Temple, Social Policy

Inequality of opportunity for healthy child development is threatening the future of Minnesota and many societies worldwide. Burgeoning science underscores the profound effects of poverty, discrimination, and stress on brain development and human potential for academic, social, and economic success. The intransigent achievement gap in our state and elsewhere is an alarming symptom of our collective failure to address pervasive opportunity gaps related to inequality. To date, our solutions have been too fragmented, narrowly focused, and poorly timed to work.

Effective strategies will require coordinated, evidence-driven efforts that span multiple disciplines and levels of science, from neurons to economic and social policy. The University of Minnesota is uniquely situated to tackle this challenge in innovative ways due to outstanding multidisciplinary programs focused on child development at multiple-system levels and extensive engagements in regional, national, and international efforts to invest strategically in children, our future human capital.

Confronting Inequalities

Lead Submitter: Joanne Miller, Political Science

Co-Submitters: Center for the Study of Political Psychology Faculty—Eugene Borgida, Psychology; Christopher Federico, Psychology and Political Science; Paul Goren, Political Science; Howard Lavine, Political Science; Dan Myers, Political Science; Al Tims, Journalism & Mass Communication

Identifying ways to confront inequalities that plague local communities, states, and nations, is undoubtedly one of society’s most complex and consequential problems. Inequalities come in many forms: income, wealth, geography, race, ethnicity, and gender—and they are growing at alarming rates. There are many societal ills that have their roots in inequality, including: poor physical/mental health, educational achievement gaps, domestic violence, alienation, crime, intergroup conflict, racial/ethnic/economic segregation, depressed economic development, environmental degradation, radicalism, terrorism, and war.

With our existing faculty strengths across numerous units (e.g., CLA, Law School, Medical School, Public Health, Humphrey School, School of Design, CEHD), as well as our centers and workgroups dedicated to solving the problem of inequalities (e.g., the MPC, the School of Public Health’s Health Disparities Workgroup, and the Human Rights Center), means that the UMN is poised to become a global leader in the interdisciplinary study of *solutions* to inequality.

Creating the Equitable City

Lead Submitter: Kristine Miller, Department Head, Landscape Architecture, College of Design

How can we imagine, plan, design, build, and manage cities of equity—where everyone has fair and just access to opportunities resources? The Twin Cities has some of the worst racial disparities in the United States. These disparities cross disciplines and are seen in areas including economics, health, education, and housing. As one of the few urban land grant universities in the country, the challenge of equitable cities is highly suitable to our mission. Furthermore, as one of the largest anchor institutions in the Twin Cities, we have a responsibility to help transform these disparities.

Mass Incarceration: The Grand Civil Rights Challenge of our Day

Lead Submitter: JaneAnne Murray, Law School Academic Programs

Co-Submitters: Antony Duff, Richard Frase, June Carbone, Myron Orfield, Jessica Clarke, Francis Shen, Perry Moriearty, Law School; Joachim Salvesberg, Christopher Uggen, Joshua Page, Michelle Phelps, Sociology; Samuel Myers Jr., Joe Soss, Humphrey School of Public Affairs; Howard Lavine, Paul Goren, Christopher Federico, Political Science; Eugene Borgida, Psychology; Rebecca Shlafer, Medical School; Wendy Hellerstedt, School of Public Health; Priscilla Gibson, Traci Laliberte, School of Social Work; Julia Robinson, School of Architecture; Katharine Gerbner, History; Edward Goetz, Kathie Doty, Center for Urban & Regional Affairs; Sara Langworthy, Mary Marczak, Cari Michaels, Judy Myers, Children, Youth, & Family Consortium

Mass incarceration in the United States is a civil rights issue, both because of its unprecedented scope and its selective concentration among the poor and communities of color. With multi-level and bipartisan reform initiatives afoot, the tide may be turning. The challenge is to transform this impulse into effective prosecution, sentencing and reintegration policies that respect civil liberties and avoid reinforcing age-old inequalities.

The University of Minnesota is a national leader in generating a wealth of interdisciplinary research and expertise on the causes and consequences of mass incarceration, as well as ways to ameliorate it. Moreover, extensive historical partnerships between University academics and local criminal justice institutions are being, and can be, harnessed, to incubate and study innovative reforms. Finally, faculties can add to their already extensive roster of original courses and clinical opportunities to engage students on the issue, thus influencing the decision-makers and policy leaders of tomorrow.

Global Justice, Local Diversity, Ethical Translations

Lead Submitter: Richa Nagar, Gender, Women, and Sexuality Studies

Co-Submitters: Suvadip Sinha, Asian Languages and Literatures; Roozbeh Shirazi, Organizational Leadership, Policy and Development; Zenzele Isoke, Gender, Women, and Sexuality Studies; Ajay Skaria, History and Institute for Global Studies; in consultation with Himadeep Muppidi, Political Science, Vassar College

In a world of intensifying disparities and conflicts, what role can the University play as a global translator and mediator of multiple, potentially conflictual, local diversities? Rather than seeing translation as "faithful" transference of one system of linguistic and cultural signification to another, we regard it as a dynamic, multidirectional process of ethical mediation among otherwise impermeable local diversities. Striving for ethical translations across difficult borders and uneven terrains can invigorate the manner in which academic knowledges are conceptualized, and allow local conceptions of justice to get a fairer hearing in global dialogues.

The University, with its faculty strengths in translation studies; race, indigeneity and gender studies; bioethics; and environmental studies, and with its interdisciplinary programs and initiatives (e.g., ICGC, IGS, IAS, RIGS) structured around multiple national and global diversities, can play a crucial role in sparking wide conversations to build multi-sited and innovative research and teaching partnerships.

Race, Africa, and the University

Lead Submitter: Helena Pohlandt-McCormick, History

Co-Submitters: JB Shank, History; Qadri Ismail, English; Tom Wolfe, History; Gary Minkley, History

The events of the past year—and most recently in Charleston, S.C.—have made abundantly clear that the specter of race haunts the present. This Grand Challenge looks to the University to (re-)consider how race functions in disciplinary configurations and institutional formations, how the disciplines have determined ways of understanding race, the racial and racism, and how they have prescribed and often uncritically repeated articulations and hierarchies of difference. It challenges the University and its community to think Africa not only as the (historical) grounds (and the people) upon which race was built, or as a beneficiary of our human rights, environmental, health and other interventions, but to think also of the critical humanities and social sciences in the South as a starting point of new thought, of a critical intervention—a radical way of revolutionizing the order of thinking that might suggest a way out of our current predicament.

Existing initiatives and collaborations and current faculty strength: ICGC and partner institutions: Centre for Humanities Research (University of the Western Cape); South African Research Chair Initiative Chair in Social Change (University of Fort Hare); Mellon Consortium for the Study of the Premodern World African Studies Initiative.

Reconceiving the Penal System: Grand Challenge Proposal

Lead Submitter: Julia W. Robinson, Professor, Architecture

Co-Submitters: Samuel Myers, Roy Wilkins Center for Human Relations & Social Justice; JaneAnne Murray, Law School; Howard G. Lavine, Political Science; Joe Soss, HHH Social Policy and Policy Analysis

The penal system is ripe for rethinking, with the prison population over-representing people of color, with mental illness, with developmental disabilities and in poverty. While formerly incarceration was based upon rehabilitation, today its focus is retribution and incapacitation rather than social re-entry. This proposal will identify and analyze present-day models of treating people (patient, customer, worker, student, etc.) to create an alternative approach for a penal and justice system, and for treating people accused of or who have committed crimes. This model would meet criteria for presumed innocence, for equity, for security and for dignity of the individual and of society.

The University is an ideal place to address this interdisciplinary question because we have access to people from the Law School, social sciences, Medical School, design, and ethnic/racial/gender studies, as well as deep partnerships with criminal justice institutions in the community to implement these new models.

Becoming the Healthiest Urban Center in the Nation by Bridging the Food Insecurity Gap in Underserved Communities via Urban Agriculture Initiatives

Lead Submitter: Mary Rogers, Assistant Professor, Sustainable & Organic Horticultural Food Production Systems, Horticultural Science

Co-Submitters: Emily Hoover and Julie Grossman, Horticultural Science; Nick Jordan, Agronomy & Plant Genetics; Mindy Kurzer and Kris Igo, Healthy Foods, Healthy Lives; Tim Kenny and LaDonna Redmond, MN Landscape Arboretum; Helene Murray, MN Institute for Sustainable Agriculture; Amy Shanafelt, Jerica Berge, and Caitlin Caspi, Family Medicine and Community Health; Chrisa Arcan, Epidemiology; Kate Venable, Internal Medicine & Pediatrics; Sara Axtell, Family Social Science; David Wilsey, Global Policy; Virajita Singh, Design for Community Resilience; Jamie Bain, Urban Research and Outreach-Engagement Center

Our urban centers are made up of a diversity of cultural, ethnic, religious, racial, and socioeconomic populations, and also claim the greatest discrepancy in access to high-quality fruit and vegetables. Lack of access to healthy food perpetuates social inequities and to rising obesity rates and nutrition-related

illness that create large preventable social and economic costs. Sixty percent of deaths in our state are from diet-related illnesses, and two in three Minnesotans are overweight or obese, including one in three children.

This burden is unequally distributed to underserved groups who shoulder great inequities in access to both healthy food and resources that influence healthy choices. Additionally, connecting both urban agriculture and the emergency food system with our community clinics can help bridge the food access and nutrition education gap. We propose to integrate diverse UMN disciplines in food, agriculture, and health to reduce food insecurity and make us the healthiest urban center in the nation via urban agriculture.

Meta-Grand Challenge

Lead Submitter: Naomi Scheman, Philosophy

We should provide a structure for critical reflection about what we are doing and becoming, posing questions such as: What makes academic research trustworthy in a diverse democracy? How do humanities and liberal arts more generally fit into the U's missions? How does the knowledge we create and discover relate to other ways of knowing, including diverse indigenous, traditional, and local knowledges? How do concerns about the protection of human research participants fit within broader concerns about trustworthiness and the role of the whole university community in grounding that trustworthiness?

We are ideally situated to contribute to this global challenge, given the scope and depth of our international connections, the large indigenous population of the state, growing Twin Cities immigrant communities, and ongoing efforts at critical and constructive engagement across all those lines, as well as our land grant mission and unusual breadth of colleges and departments.

Countering Neomania, Preserving Our Vital Compact with the Past

Lead Submitter: JB Shank, Associate Professor, History, and Director, Center for Early Modern History and Andrew W. Mellon Foundation Consortium for the Study of the Premodern World

"Neomania" describes a pervasive modern affliction: the one-dimensional belief that the new is always better, and that intellectual and societal advancement must involve the replacement of the status quo with something new and different. Not every progressive innovation is neomaniacal, yet this pathology is rampant within modern society and especially plagues major research universities. We propose a counter offensive against neomania through a University-wide mobilization of faculty and students in projects that scrutinize the relationship between old and new and work to integrate our essential connection with the past into all of our progressive research.

The Andrew W. Mellon Foundation recognized the institutions, programs, and faculty at the University already oriented toward this project through a \$600,000 grant to create a new Consortium for the Study of the Premodern World here (likely to be renewed and expanded in 2017). It therefore marked our institution as a distinctively innovative university in this area. This Grand Challenge is a way to make complex historical thinking a signature of our distinction as a major research university.

Inequalities, Social Identities and Social Justice

Lead Submitter: Catherine R. Squires, Communication Studies and Race, Indigeneity, and Sexuality Studies

Co-Submitters: Jigna Desai, Gender, Women, and Sexuality Studies; Yuichiro Onishi, African American and African Studies; Kevin Murphy, American Studies; Katherine Hayes, American Indian Studies; Karen Ho, Asian American Studies; Edén Torres, Chicano and Latino Studies

To confront the persistent patterns of inequality and injustice present in our society requires complex, subtle thinking that goes beyond traditional modes of scholarly activity; it requires critical engagement

with the local, experiential knowledge of social identity groups that have negotiated systemic inequality for generations. Efforts to resolve the fundamental problems of inequality require understanding of the dynamics of social identities and attention to multiple dimensions of the experiences of the oppressed. Such is the type of an inquiry we propose: an effort that spans disciplines and methods to foster multi-tiered, long-term initiatives to address social identities, inequalities, and justice.

This effort would leverage the knowledge, experience, and infrastructure that already exist on campus. A publicly engaged, interdisciplinary program focused on inequality and social justice can engage students, policymakers, and wider publics on multiple levels to develop more effective models for creating a more just and equitable society.

Institutions Matter: Effecting Change

Lead Submitter: Joan Tronto, Political Science

Co-Submitter: Laura Bloomberg, Humphrey School

Institutions—public and private, large and small, from the World Bank to the U.S. Senate to the university to the family—matter. Despite the recent emphasis that entrepreneurs will save and change the world, human activities are organized in institutions.

Nevertheless, institutions are now in crisis; levels of trust for political institutions are at historic lows. When institutions only attract the trust of some, they cannot be enlisted to produce and sustain change. This problem of disaffection from institutions is not yet “on the radar” as a major world problem. This is therefore a great opportunity for the University of Minnesota, where scholars from business, social science, public policy, education, and public health can work together to address this problem.

Building Peace in a Conflicted World: Moving from Ethnic Conflicts, Terrorism, and Violence to Restorative Justice Dialogue, Reconciliation and Community Well-being

Lead Submitter: Mark Umbreit, Professor, School of Social Work, and Director, Center for Restorative Justice & Peacekeeping, School of Social Work

Co-Submitters: Cawo Abdi, Sociology; Mary Jo Kreitzer, Center for Spirituality & Healing; and JaneAnne Murray, Law School Academic Programs

Peacebuilding is a grand challenge as conflicts escalate locally and globally from a complex interweaving of societal inequities. Paralleling the growing threat of mass violence and the fear that ensues is a significant bolstering of military spending. Yet, military force to achieve peace has not proven to be effective. Civilians continue to suffer the greatest death toll from acts of extreme violence worldwide. More than 59 million people were displaced from their homes in 2014 fleeing violence.

New strategic responses are necessary that include authentic intracultural and cross-cultural engagement to repair harm, restore justice, and reconcile relationships. The concept of restorative justice bypasses polarizing rhetoric and moves towards solutions for achieving peace in our one global community. It offers change by building bridges of understanding through applied research and experience, interconnected with education. The University is at the forefront of elevating this research approach, informing systems change efforts among nations.

Financial Wellness Initiative

Lead Submitter: Andy Whitman, Finance

Personal and societal goals are achieved by effectively allocating financial resources to strategically build both personal and societal financial capital, analogous to the health wellness program. Choices of education and careers are both guided and constrained by our personal financial knowledge and resources. Societal stakeholders are guided and affected by financial choices and opportunities from daily

consumption to preparation for life changing events: family changes; educational changes; career changes and freedom to contribute during pursuit of career goals and in retirement.

Just as annually there is an open enrollment in health benefits to again make choices to fit changing family circumstances, this idea of an annual financial wellness program would guide and facilitate financial decisions to fit personal strategic plans and changing circumstances. Enhanced financial literacy can facilitate and support just and equitable societies.

How will we foster human potential and well-being across the life course in a diverse and changing world?

Relocating and Redefining Expertise in Educational Equity

Lead Submitter: Heidi Barajas, Organizational Leadership, Policy & Development; Executive Director, UROC
Co-Submitters: Generation NEXT-UROC Fellows: Michele Allen, Family Medicine and Community Health; Peter Demerath, Organizational Leadership, Policy & Development; Jigna Desai, Gender, Women, and Sexuality Studies; Michael Goh, Organizational Leadership, Policy & Development; Ross VeLure Roholt, School of Social Work, Youth Studies; Catherine R. Squires, Communication Studies

Our idea seeks to realize Horace Mann’s 1848 vision of education as “The Great Equalizer.” Our approach pivots on a reconceptualization of the causes of educational equity. We understand predictable achievement gaps as originating largely in what we refer to as relationship gaps in classrooms, schools, communities, and between universities and the communities they serve.

It is imperative for a land grant institution like the University of Minnesota to be deeply engaged with communities to solve the complex issues that undermine educational equity. Every scholar on this interdisciplinary team has deep ties to school partners and their communities. Accordingly, our approach is guided by an innovative ground-up framework: First, reciprocal engagement in our research partnerships; and second, a commitment to “scale down” research to capture innovation at the local level. This approach emphasizes local collaborations that yield practice-based evidence which can produce new models and interventions for achieving educational equity.

Understanding Language Communities in Minnesota

William O. Beeman, Anthropology

Co-Submitters: Kendall King, Second Language and Cultures, Curriculum & Instruction; Carol Klee, Spanish and Portuguese Studies; Amy Sheldon, Communication Studies; Polly Szatrowski, Institute of Linguistics; Elaine Tarone, Center for Advanced Research on Language Acquisition; David Valentine, Anthropology

We propose concentrated interdisciplinary research studying the social and cultural dynamics of the diverse language communities of the Twin Cities metropolitan area and the state of Minnesota.

Minnesota is one of the most linguistically complex states in the United States—a natural laboratory for the study of language communities, which are poorly understood “vibrant communities” in our midst. As seasoned researchers in linguistic anthropology, sociolinguistics, communication studies, second language instruction, cultural studies, and geography, we know language to be a basic component of personal identity and community social organization. No language community exists in isolation. Interactions of members of linguistic communities with each other are fundamental in structuring the nature and quality of the larger comprehensive society. A high-quality research program in this area will capitalize on Minnesota’s rich human environment, add to human knowledge, bring distinction to the University and serve as a model for similar research elsewhere.

Let's Get Along! Community, Workplace, Law and Policy Interventions to Enhance Positive Effects and Reduce Negative Effects of Increased Cultural Diversity

Lead Submitter: Avner Ben-Ner, Center for Human Resources and Labor; Claire A. Hill, Professor, Law School

Everyone has multiple identities; societies can influence which identities an individual experiences as salient, and how these identities are constructed. We think an interdisciplinary perspective that incorporates evolutionary factors, economics, law, sociology, political science and cognitive and social psychology can elucidate critical features of identity, explaining the pathologies we observe but also providing hope for improvement. What evolutionary functions has identity served? When might an in-group become less cohesive? When is the need to define an in-group stronger or weaker than the need to define an out-group? What causes particular identities to be more or less oppositional—that is, to be defined in part by opposition to other identities? What (community, workplace, legal and other societal) interventions could affect the salience or construction of particular identities?

Our University has outstanding faculty with interests in related topics and can make exceptional contributions to this vexing global challenge.

Institutional Transformation through Grand Challenges: Understanding How We Are and Need to Change

Lead Submitters: Lynne Borden, Professor and Chair, Family Social Science; Geoffrey Maruyama, Professor and Chair, Educational Psychology

U.S. universities need to transform themselves to address Grand Challenges (GCs) of today and tomorrow. This idea is a meta-grand challenge to rigorously study our transformation process. UM possesses great researcher capacity to study its transformation. Faculty from six colleges will evaluate processes of choosing areas, factors influencing success and longevity of GC groups, impacts on participating faculty scholarship, and impacts on the University community.

We propose (a) integrating existing knowledge from multiple disciplines about the processes and institutional transformations that need to occur in order to effectively mobilize/transform to address challenges, (b) determining the implications of the information with respect to engagement and problem-focused initiatives for research, teaching (particularly graduate education), and service and outreach, and (c) building and implementing a mixed method evaluation model and approach to track the impacts of the GC process and initiatives on an array of proximal and more general institutional outcomes

Optimizing Research around Planning for Aging

Lead Submitter: Marilyn J. Bruin, Professor, Housing Studies and Community Development

Co-Submitters: Sauman Chu, Graphic Design; Lin Nelson-Mayson, Goldstein Museum of Design; Juanjuan Wu, Retail Merchandising

We propose a program of engaged interdisciplinary aging research around the multiple and interrelated perspectives of design, health, human services, and public policy. Team members have expertise in public engagement partnering with marginalized communities and global networks. We can leverage these connections to lead a global effort of engaged interdisciplinary research focused on the design and planning of apparel, communication, and residential, retail, and public spaces. We propose a rigorous collaborative rigorous program of research to influence public policy, infrastructure, and services to promote physical and spiritual well-being across the life course.

The University of Minnesota, a large comprehensive urban public-engaged land grant university, is well positioned to compete for external funding for aging research with applications for diverse and global populations. Furthermore, we have unique opportunities to translate discovery and disseminate through undergraduate, graduate, and continuing education courses, museum exhibitions and symposia, and outreach activities.

Improve the Health and Well-Being of Children, Particularly Those Growing Up in Conditions of Risk

Lead Submitters: Dante Cicchetti, McKnight Presidential Professor and William Harris Professor of Child Development, Psychology, & Psychiatry, Institute of Child Development; Abigail Gewirtz, Professor, Family Social Science & Institute of Child Development & Director, Institute for Translational Research in Children's Mental Health; Gerald August, Professor, Family Social Science

Co-Submitters: Gerald August, Family Social Science; Sonya Brady, Epidemiology; Dante Cicchetti, Child Development, Psychology, & Psychiatry; Meredith Gunlicks-Stoessel, Psychiatry; Megan Gunnar, Institute of Child Development; Traci LaLiberte, Center for Advanced Studies in Child Welfare; Rich Lee, Psychology; Ann Masten, Institute of Child Development; Faith Miller, Educational Psychology; Carolyn Porta, Nursing Academic Programs; Timothy Piehler, Family Social Science; Aaron Sojourner, Work and Organizations; Alisha Wackerle-Holman, Educational Psychology; Lindsay Weiler, Family Social Science

Violence, poverty, and related family stressors increase the likelihood of mental health problems, interfering with children's well-being and their capacity to form healthy relationships, learn, and participate in society. Fortunately, advances in basic and applied research have resulted in effective prevention programs and laid the groundwork to potentiate their optimization, and large-scale dissemination. Currently, however, the gap between research and practice—i.e., the use of a research finding in the practice community—is vast, estimated at almost 20 years.

This Grand Challenge idea will harness the unique talents of faculty across the University of Minnesota to accelerate research into practice in order to improve the lives of our most vulnerable children. Bridging research and practice requires interdisciplinary teams of basic (biological, genetic, psychological) and intervention/prevention researchers, and partnerships for a continuous feedback loop to practice and policy; the University of Minnesota is well positioned to lead these efforts.

Language, Cognition and Society

Lead Submitter: Jeanette Gundel, Professor, Linguistics,

Co-Submitters: Claire Halpert, Linguistics; Apostolos Georgopoulos, Neuroscience; Serguei Pakhomov, Pharmaceutical Care and Health Systems

It is widely agreed that the formal properties shared by all human languages are rooted in the human cognitive capacity for thought and language. At the same time there exist almost 5,000 mutually unintelligible linguistic systems used by humans around the world. Both the universality and diversity of human language are linked to a number of societal problems and scientific questions. We will investigate some of these, focusing on the unique linguistic landscape in the Twin Cities with its large number of speakers and learners of endangered indigenous languages, (e.g., Dakota and Ojibwe) as well as significant populations from East Africa, Southeast Asia, and Central and South America, who have brought with them a large number of different languages more recently.

Our investigations will draw on expertise from faculty and student researchers in colleges across the University of Minnesota who approach questions related to language, cognition, and society from distinct disciplinary perspectives.

The Digital Turn: A Grand Challenge for the University of Minnesota

Lead Submitter: Michael Hancher, English

Co-Submitters: Douglas Armato, University of Minnesota Press; Lucy Fortson, Physics and Astronomy; Laura Gurak, Writing Studies; Daniel Keefe, Computer Science and Engineering, Interactive Visualization Lab; Wendy Pradt Lougee, University Libraries; William McGeeveran, Law School Academic Programs; Thomas J. Misa, Charles Babbage Institute; and Claudia Neuhauser, Informatics Institute

A Grand Challenge for the University is to define and especially to design “the digital turn”; that is, the computer- and network-based transformation that has renewed all scholarly, administrative, and creative

enterprises in the last quarter century and that will continue to remake them in the decades to come. We propose that the University bring its attention and expertise from all corners to understand and embrace this technological shift, so as to maximize benefits for society. Nothing is more interdisciplinary than this fundamental change, which shapes the advancement of learning and discovery in our time. All the other Grand Challenges depend on it in one way or another.

The University brings to this challenge particular strengths in computer science (e.g., data mining, recommender systems), behavioral sciences (group behavior and collaboration), geography (GIS), and law (intellectual property), as well as special expertise with information management and data curation (Informatics and Libraries).

Innovation for All: In an Increasingly Automated World, Ensuring that the University of Minnesota's Research Benefits the Common Good

Lead Submitter: Brent Hecht, Computer Science & Engineering

Co-Submitters: Loren Terveen, Computer Science & Engineering

Recently, technical innovation has begun to eliminate significantly more jobs than it creates. Consider the driverless car. Its use likely will eliminate over 8 million truck driving-related jobs in the United States. This includes the jobs of tens of thousands of Minnesotans; truck driving is the No. 1 job in our state. This situation poses an existential challenge to our University's mission of serving the common while continuing our strong tradition of innovation. However, we believe we are well positioned to address this challenge.

Scholars from the Humphrey School, the School of Law, and Economics can develop new policies suitable for a world where the amount of work and type of available work has changed; social and political scientists can trace the implications for individuals, families, social organizations, and politics; and computer scientists and engineers can develop technologies that empower individuals to engage in new types of work and non-work activities.

Theorizing Diversities

Lead Submitter: Maki Isaka, Asian Languages and Literatures

By maximizing a potential of the University as a research university, I propose that we further theorize diversities—pertinent concepts, mechanism, logic, etc.—in a most interdisciplinary way possible, in which theory and praxes, together in tandem, help us contemplate the subject matter. One theoretical challenge—especially in possible theory-praxes collaboration—lies in a formidable relation between two principles: fairness, which relies on consistency, and diversity, which presupposes multiplicity. There must be numerous approaches to this problem across disciplines; two examples from my own background are the possibility of co-existence of plural epistemes in a society and that of manifold somatic grammar in one body.

On many levels, issues related to diversity must be relevant to many of us at the University, which houses, for example, a pioneering department on American Indian Studies; an ambitious RIGS initiative; and the Disability Resource Center, whose collaboration with faculty is deemed pioneering nationwide.

Living Better, Living Longer: Addressing the Global Challenge of Health & Wellness Across the Lifespan

Lead Submitter: Li Li Ji, Kinesiology

How can we effectively marshal our world-class resources to transform the issues facing an aging population across the lifespan, addressing the challenges of aging while a person ages (proactive) instead of taking an end-of-life approach (reactive)?

The School of Kinesiology is uniquely positioned to answer and illuminate solutions aimed at meeting this Grand Challenge. With myriad and diverse expertise, the School of Kinesiology can cohesively create—and proposes to establish—a Center for Research on Active Aging (CRAA), aligning University faculty, our local health care industry, and international collaborators to address this global challenge of aging well. The center’s distribution of research can be transferred across systems and will seek applications in health care industry, education, and government and will provide service locally through outreach, education, and testing. Our financial model is based upon research funding and discovery-to-market opportunities, including partnership with corporate enterprises and subscription services.

Educational Equity, Transnational Youth, and Local Solutions to International Challenges

Lead Submitter: Kendall King, Professor of Second Language Education, Curriculum & Instruction

Co-Submitters: Martha Bigelow, Curriculum & Instruction; Elaine Tarone, CARLA

Minnesota is home to the largest population of East African immigrant and refugee youth in the country. A central challenge is to ensure educational equity and opportunity for these transnational youth through research, curriculum and policy that lead to effective integration and productive future lives for this group. This proposal will research, harness, coordinate, and further develop existing resources at the University to meet the challenge of providing educational equity and post-secondary opportunities for transnational youth, thereby providing local solutions to international problems.

This challenge builds on current faculty strength and leadership assets. In addition to extensive faculty research, the presence of East African communities here has inspired many students to engage in research. Presently, much of this work happens independently. This GC allows for expanded synergy across research, curriculum development, and teaching efforts. This initiative is sustainable because it is built upon faculty strengths, developed over years of engagement.

Digital Wayfinding: Understanding, Exploring, and Engaging for Everyone

Lead Submitter: Joseph A. Konstan, Distinguished McKnight Professor and Distinguished University Teaching Professor, Computer Science and Engineering

Co-Submitter: Lana Yarosh, Computer Science and Engineering

In the physical world, wayfinding is figuring out where you are in your environment, where you want to be, and how to get there from here. We define “digital wayfinding” as the process of understanding your context, identifying your goals, and achieving those goals in a digital terrain. Most people today are inadequately prepared for challenges such as evaluating digital content and context, personal science and engineering, and moving from digital consumers to digital actors demand that we develop and broadly disseminate digital wayfinding skills.

The U of M is particularly well positioned to address this Grand Challenge. We have faculty strength in the diverse disciplines of communication, computing technology, innovative digital humanities, personal health, and other application areas. The U has made significant recent investments in design, social computing, and informatics. Minnesota’s medical device industry embraces the “quantified self” and Minnesota has a tradition of community engagement and action.

Fostering Successful Transitions to Adulthood Locally and Globally

Lead Submitter: Deborah Levison, Social Policy

Co-Submitters: Ragui Assaad, Global Policy; Laura Bloomberg, Humphrey School of Public Affairs; Liz Boyle, Sociology; Karen Brown, ICGC; Emily Bruce, UM-Morris; MJ Maynes, History; Joan DeJaeghere, OLPD; Barb McMorris, Nursing; Ann Meier, Soc; Jeylan Mortimer, Sociology; Roozbeh Shirazi, OLPD; Fran Vavrus, OLPD; Rob Warren, Sociology

Successful transitions to adulthood are the linchpin to the future security of local and global communities. Negotiating successful transitions requires positive future orientations (optimism, efficacy, goal setting),

acquiring relevant education, defined pathways to work, and the resources needed for family formation; however, large numbers of youth lack requisite personal and social resources.

The University of Minnesota is particularly well positioned to examine inequalities in this multifaceted issue through its cutting-edge ongoing research about youth transitions—including many aspects of learning, working, and family formation—across its colleges and disciplines. The Youth Development Study (Life Course Center, CLA), the Learn-Earn-Save initiative (CEHD), Partnering for Healthy Student Outcomes (Nursing-Pediatrics), and work by Assaad and Levison on youth employment (HHH) exemplify this research. Connections among these efforts were fostered by two recent interdisciplinary collaborations sponsored by IAS and ICGC, creating synergies primed for further development in a Grand Challenges research strategy.

Images of “Humanity” for the 21st Century

Lead Submitter: Alan C. Love, Associate Professor, Philosophy

Co-Submitters: Mark Borrello, Program in the History of Science, Technology and Medicine; Michael Travisano, Ecology, Evolution, and Behavior

A characteristic feature of the 20th century was the growing gap between scientific images of humanity and those traditionally found in different cultures and societies. Many complex societal problems derive from blurred images of humanity that encourage an overreliance on technological solutions or increasing tribalism. We need stereoscopic images that combine perspectives from across cultures, societies, and the sciences. This requires organizing expertise from multiple disciplines to generate a balance of perspectives that have local relevance and global impact.

The University of Minnesota is poised to lead from its signature research strengths in identifying images of humanity for the 21st century that address societal problems, such as by marshaling psychology, nutrition science, and metabolic genetics to combat obesity. These efforts must be sustained over time through diverse avenues of funding because they touch a nerve close to each and every one of us—*what does it mean to be human?*

Sound Studies

Lead Submitter: Matthew Rahaim, Music

Co-Submitters: William Beeman, Anthropology; Michael Gallope, Cultural Studies and Comparative Literature; Sumanth Gopinath, Music; Elliott Powell, American Studies; Diane Willow, Art

Over the past century, new technologies have profoundly changed both what we hear and the way we listen. Recording, radio, amplification, portable music players, smart phones, and streaming audio have dramatically broadened the scope of sonic life worldwide. Drawing from the arts, humanities, and the sciences alike, the expanding interdisciplinary field of Sound Studies is centrally concerned with understanding the complex nature of these changes. It is especially poised to address the new ways that powerful phenomena like political chatter, religious oratory, and collective musical expression can be understood to connect Minnesota’s communities to larger global social, political, and cultural movements.

The University of Minnesota is unique in its existing faculty strengths in Sound Studies. In recent years, it has gathered nearly 40 tenure-line faculty in 22 different units across the University whose research engages sound. Several members of the faculty are emerging intellectual and creative leaders in this interdisciplinary field.

Going Up North, A Northern I-35 Research Corridor

Lead Submitter: Paul L. Ranelli, Professor, Social Pharmacy, Pharmacy Practice & Pharmaceutical Sciences

Start a vibrant research corridor, moving north from the Twin Cities campus, with the Duluth campus and city as the northern anchor. Focus on all areas of research, especially where there is strong rural and community needs, including health care services, the business of health care, engineering and related fields, the environment, basic sciences, and tourism. The northern corridor is ripe for research and development initiatives. It's a Grand Challenge.

Going Up North is a win-win on several fronts. The Twin Cities campus is metro-centric, as maybe it should be; however, the University System needs to develop strong corridors of research and development for the entire state, including the Northland. Expansion of a statewide vision will enhance the University's reputation publically and privately. Nothing will help state legislative initiatives and national grant initiatives more than evidence of statewide coverage by including other campuses and communities up front.

Educational Equity and Achievement Gaps

Lead Submitter: Michael C. Rodriguez, Campbell Leadership Chair in Education & Human Development; Professor, Educational Psychology

Educational equity (addressing achievement gaps) is a Grand Challenge. At the UofM, we take a cradle-to-career view of educational equity in access, opportunities, and outcomes. We work on larger issues of equity through the lens of evidence, focused on the production of knowledge, linking theory and research to practice to inform practice and policy. Evidence is the unique contribution of the University in this arena, including expertise from supporting policy scholarship on health, housing, transportation, and economic development. As a Grand Challenge, educational equity is a local, state, and national issue. Minnesota faces some of the largest achievement gaps in the country.

As we move away from "What works" to "What works for whom, under what conditions and contexts," the notion of tailoring evidence-based practices and policies to meet local needs is powerful, including areas of significant expertise—Experts@Minnesota identifies over 140 faculty and researchers with relevant expertise.

Social Conflict

Lead Submitter: Terry Roe, Applied Economics

The Arab Spring, the massive movement of migrants to Western countries, and social conflict in our own society reflect the failure of institutions to help arbitrate social differences in beliefs and to deal with growing imbalances in wealth within and between countries. These changing economic conditions are broad based. Globalization of the world economy affects the returns to resources and income streams in all countries. It confronts entrenched social beliefs with those of other societies on a scale never seen before and skews the income stream to selected elements of society.

The University is well placed to address social conflict and its sources if it were better able to coordinate its strengths in the social sciences, including but not limited to the School of Public Affairs and the departments of Political Science, Economics, and Applied Economics. This multidisciplinary effort might best be coordinated by the Graduate School. These units also have various international connections and activities which suggests the possibility of making such a thrust to have an international dimension.

Transforming STEM Education through Research Partnerships Spanning Kindergarten to the PhD

Lead Submitters: Karl Smith and Kathleen Cramer, Co-Executive Directors, STEM Education Research Center
Co-Submitters: Robin Wright, College of Biological Sciences; Mike White, Greg Cuomo, College of Food, Agricultural and Natural Resource Sciences; Frank Symons, College of Education & Human Development; Mos Kaveh, Paul Strykowski, College of Science and Engineering; Kris Gorman, Center for Educational Innovation

Numerous reports call for transformational change in science, technology, engineering and mathematics (STEM) education in the U.S. in order to increase the number and quality of STEM graduates. Our proposal advocates for a University-wide research and innovation center to (1) develop the body of knowledge of evidence-based teaching practices that prepare a broad range of STEM graduates, and (2) to foster a culture of innovation to help transform the practices of STEM faculty.

This approach will allow the University to enhance our own educational practices while impacting practices preK-PhD nationally. We have faculty across the institution who are passionate about delivering high quality evidence-based education and we are an emerging international leader in STEM education research and innovation. These strengths span multiple colleges; however, currently there is little coordination or collaboration. Working together we can advance the state of the art of STEM education.

Multilingualism and Knowledge Discovery in a Globalized Century

Lead Submitter: Elaine Tarone, Distinguished Teaching Professor, CARLA (GPS Alliance)
Co-Submitters: Carol Klee, Spanish & Portuguese; Charlotte Melin, German, Scandinavian and Dutch; Dan Soneson, CLA Language Center

Global knowledge-creation depends on the ability to engage effectively in multilingual, multicultural contexts; the goal of this GC is to foster knowledge creation in deeper and more inclusive ways across disciplines, languages, and cultures. The University community needs to better understand and find ways to improve the multilingual and multicultural skills of faculty, students, and decision-makers. Interdisciplinary research is needed to better understand the cognitive and social dimensions of developing multilingual minds, and applied research befitting the University of Minnesota's land grant mission is needed to use that growing knowledge base to improve the quality of multilingual education in Minnesota's K-12 and postsecondary contexts.

This proposal capitalizes on current faculty strength and leadership assets in world languages and cultures, and would create synergy across faculty and graduate student research initiatives, building on headway already established by CARLA, the Language Flagship Proficiency PACE project, and C&I faculty in second language education.

Creating a Community of Ethical Agents

Lead Submitter: Valerie Tiberius, Philosophy

Solving any major problem, whether it's climate change, poverty, or cancer, requires people who are motivated to solve it. What motivates people to make ethical, socially desirable choices and how can these motives be cultivated? This is a challenge that lies behind efforts to tackle other grand challenges. It is also a challenge for any diverse community of individuals with competing interests, and one that raises particular questions for the University: What ethical obligations and constraints does the university face with respect to encouraging students to make ethical and socially desirable choices? What form should ethics training in professional schools take?

The University of Minnesota is an ideal place to investigate these questions because of faculty expertise in ethics, character, and volunteer motives; numerous professional schools with a genuine interest in the ethics of their graduates; and widespread concern about the ethical role of the University in light of some recent events.

Revolutionizing Mathematical Understanding

Lead Submitters: Sashank Varma, Associate Professor, Educational Psychology; Michèle Mazzocco, Professor, Institute for Child Development; Kathleen Cramer, Associate Professor, Curriculum and Instruction,

The proposed challenge has the goal of making rapid progress towards understanding both what mathematics is and how best to teach it. Faculty in mathematics, philosophy, educational psychology, developmental psychology, and mathematics education are already engaging in innovative research. The proposed challenge will organize their efforts across four strands: *Conceptual foundations*. What are the philosophical and historical foundations of mathematics? *Mental and neural mechanisms*. What mental representations and processes underlie mathematical thinking, and what are their neural correlates? *Mathematics education*. How can we apply this understanding to increase mathematical achievement in Minnesota schoolchildren? *STEM training*. How can we extend this application to improve STEM training of University students?

The proposed implementation will marshal faculty from across the U; spur new collaborations that attract external funding; initiate a new *Mathematical Studies* interdisciplinary graduate minor; and produce robust, sustainable institutional structures for supporting research and community outreach.

Chronodiversity

Lead Submitter: Christophe Wall-Romana, French and Italian

Global culture, and academic culture too, now favors a one speed fits all: *rapid* changes, *urgent* challenges, *quick* results, *accelerated* profits, *expedient* postures, *immediately* applicable outcomes. Slower practices are becoming invisible: threatened species. How historical wrongs can be mitigated or repaired is a burning geopolitical question (Syrian refugees) without quick fix. Chronodiversity cultivates and studies the variety of time scales of human processes, natural processes, and their interactions.

Humanities, art, faith, personal development, cosmology, ecosystem analysis, epidemics, social justice, and, *yes, research and education*, take their own time, cannot be summoned. The result-driven ethos minoritizes practices at multiple time frames. This sustainable and distinctive grand challenge recruits sciences, social sciences, arts and humanities to foster and publicize exchanges between dancers, lexicographers, astronomers, theologians, genome researchers, and social planners as a platform for thoughtfully reappraising time as our multifaceted resource, whether as individuals, communities, knowledge seekers, or the global commons.

In an Era of Abundant Data, Are Communities' Essential Information Needs Being Met?

Lead Submitter: Brendan R. Watson, Assistant Professor, School of Journalism & Mass Communication
Co-Submitter: Seth C. Lewis, Journalism & Mass Communication

Information needs are defined as a gap between existing knowledge and knowledge needed to address more fundamental community needs like housing and safety. While data and information are abundant, according to the Federal Communication Commission, the decline of local news reporting and the rise of dubious online sources have exacerbated gaps in access to local information that people need to address fundamental community needs. In this "Grand Challenge," we propose evaluating whether communities' information needs are being met, the University's role in fulfilling those needs, and the impact that closing information gaps has on improving public life.

These questions engage diverse disciplines in addition to mass communication: psychology (information search/processing); sociology (community and institutions); political science (civic/political engagement); computer science (information systems/retrieval); and law and public affairs (communication policy). They also capitalize on outreach centers, such as the Center for Urban and Regional Affairs and the Minnesota Journalism Center.

Digital Data Health Collaborative

Lead Submitter: Rebecca Wurtz, School of Public Health

Only a small proportion of health takes place within the confines of the health care system. A much larger proportion of our health is determined by who we are and what we do. Huge amounts of data about an individual's exposures and activities are generated in the course of daily life in the digital age: data from commercial interactions (e.g., the purchase of groceries or outdoor equipment); activity data recorded by smart phones; Facebook and blog posts, etc. This "life course" data is more structured and more accessible than electronic medical data.

We propose a University-community collaborative to capture digital life course data generated by a cohort of Minnesotans over the next 30 years. Opportunities for scholarship—and impact beyond the University—abound. A few examples: Computer Science: advanced techniques for complex data storage; Mathematics: de-duplication and de-identification; Economics: the relationship between income and health; Public Health: epidemiology of individuals *and* populations; Design: visual display of data; CFANS: nutrients and cancer prevention on an individual-by-individual basis; and the Medical School's Program in Translational Genomics.

How will we advance human health?

The Right to be Human

Lead Submitter: Joseph R. Allen, Asian Languages and Literatures.

Co-Submitters: Evelyn Davidheiser, Institute for Global Studies; Carl Flink, Theatre Arts and Dance, Vinay Gidwani, Geography; David Odde, Biomedical Engineering; Shaden M. Tageldin, Cultural Studies and Comparative Literature; Klaas van der Sanden, Institute for Global Studies.

Our Challenge turns towards interior worlds as defined by science, art, social science, and the humanities to explore anew the conditions of being human. Rapid global changes and dramatic advances in disciplinary technologies both threaten and benefit us. We ask questions about consciousness, creativity, ethics, and communication, as seen through research and practice. What are the relationships between the brain and the rest of the body; individual and species; privacy and public good; marginalized communities and dominant powers? We also must address the counter challenge: the right to be nonhuman.

The University areas of strength for this project are creative arts, both plastic and performance; biological sciences and engineering, especially neuroscience and neuroengineering; social sciences, psychology being at the center, but including history and geography; and widely in humanities, especially at the intersections of language, media, and ethnicity studies. Each of these is represented by research teams and collaborative projects.

Neurobiology and Novel Therapeutic Targets of Psychotic-Spectrum Illnesses

Lead Submitters: David J. Bond, Associate Professor, Psychiatry; Kelvin O. Lim, Professor, Psychiatry

Illnesses that can cause psychosis—major depression, bipolar disorder, and schizophrenia—affect 1.5 billion people worldwide, and are highly disabling. The vast complexity of the brain has created challenges in understanding them, and far less is known about their biological basis or optimal treatment than other medical conditions. However, several "big science" projects currently underway will generate a profound increase in our knowledge of the brain over the next decade.

UMN's long experience in treating and researching psychotic illnesses mean that we are uniquely positioned to use this knowledge to understand how aberrations in brain functioning cause psychotic

illnesses, and to identify novel therapeutic targets. We have assembled a multidisciplinary team including clinicians and experts in brain imaging, genetics, pharmacology, novel treatments, and community engagement with the goals of 1) understanding the biological basis of psychotic illnesses, 2) developing more effective treatments, and 3) using this knowledge to benefit Minnesotans.

Building a Culture of Health and Well-being

Lead Submitter: Barbara F. Brandt, Associate Vice President for Education, Academic Health Center; Director, National Center for Interprofessional Practice and Education; Professor, Pharmaceutical Care and Health Systems

Co-Submitters: Kenneth Bartlett, Organizational Leadership, Policy and Development; Milton Eder, Populations and Community Engagement; Brian Isetts, Pharmaceutical Care and Health Systems; MaryJo Kreitzer, Center for Spirituality and Healing; Vanessa Laird, Center for Integrative Leadership; Daniel Pesut, Katherine J. Densford Center for Nursing Leadership; Sheila Riggs, Dentistry Primary Care; Brian Sick, Academic Health Center; Brandon Sullivan, Leadership and Talent Development; Daniel Zismer, MHA and Executive Studies Programs

Many systems, alignment, and payment issues stand between where we are today and a vision for a Culture of Health and Well-being where individuals are able to live the healthiest lives possible. To support progress toward such a culture, we propose an approach designed to prepare academic, research and clinician leaders with practical tools and resources needed to address grand challenges in society that stand between today's status quo and our vision. This requires collaboration across sectors, organizations and communities to assess problems and implement solutions.

With Minnesota's marks of distinction in health and policy, extensive cross-sector faculty expertise and the National Center for Interprofessional Practice and Education, UMN would lead the nation in supporting development of boundary-spanning clinicians, researchers and leaders who will address challenges by tackling significant and solvable issues affecting health in their communities and leverage new and existing relationships for greater collective impact.

Nano-Enabled Neuroscience

Lead Submitter: Stephen Campbell, Penrose Chair, Professor of Electrical and Computer Engineering; Director, Minnesota Nano Center

Understanding how the brain works requires measurements at the nanoscale, where brain activity actually occurs. Furthermore, methods are needed to sense and ultimately manipulate the activity of massive numbers of neurons ($\gg 10^6$) at this scale. Fortunately, the University of Minnesota has rich reservoirs of both talent and facilities in both neuroscience and nanotechnology. Likely avenues of approach include brilliant massively parallel electrode arrays, optogenetics, nanoparticles and other nanoscale structures, and new multimode approaches.

Researchers would be drawn primarily from CMRR and the departments of Neuroscience, Neurology, Psychiatry, Psychology, Biomedical Engineering, Electrical and Computer Engineering, Computer Science and Engineering, Chemistry, and Mechanical Engineering. A Grand Challenge initiative such as the one proposed here, one that *explicitly* demands cross collegiate collaboration, is the only way for Minnesota to make radical, game-changing advances in this vital area.

Development of Niger

Lead Submitter: James Carey, Professor, Program in Physical Therapy

Niger, located in sub-Saharan West Africa, is ranked by the UN as the least developed country in the world. The purpose of this proposal is not to follow the traditional humanistic path of sending food, clothing, money, etc to those in need. Instead, we will send ourselves to develop Niger into a healthier and modernized state through collaborative teaching/research/service at the Université Abdou

Moumouni (UAM) in the capital city of Niamey. A seven-year relationship already exists between one of the departments on this proposal and UAM; thus, feasibility is high.

Through dialogue, participation in this proposal now extends to faculty/students from animal science, engineering, horticulture, international development, linguistics, medicine, physical therapy, public affairs, and water management. Ultimately, efforts for improving Niger's health, water, food, etc will be sustained by working with Niger's current and future leaders, i.e., UAM faculty/students, in combination with their government.

Emerging, Pandemic, and Treatment-Resistant Pathogenic Disease

Lead Submitter: Erin E. Carlson, Associate Professor, Chemistry and Graduate Faculty Member of Medicinal Chemistry, Biomedical Informatics and Computational Biology Program

The economic and environmental foundation that supports our planet and its increasingly interwoven societies will be severely challenged by the changing dynamics of pathogenic disease. Globalization, climate change and the scale of human population have provided the foundation for a perfect storm of emerging pathogens and global pandemics.

The University of Minnesota is uniquely poised to tackle this emergent threat because of the vast network of researchers and resources available to identify the master regulators of microbial pathogenesis, to apply these insights to the development and deployment of the next generation of diagnostics, antibiotics and vaccines and to devise powerful strategies to prevent the rapid spread of infection by the integrated application of the engineering design, medical technology, applied economic models, and public health strategies required for implementation of a global strategy for effective disease management.

Closing the Gaps (CTG) Initiative for Minority Youth: A Research-to-Practice Consortium

Lead Submitters: Clayton R. Cook, Educational Psychology; Amanda Sullivan, Educational Psychology

We propose the Closing the Gaps (CTG) Initiative that will put the UMN at the epicenter of global work involving the *translation of research to practice* to close the widespread opportunity and achievement gaps that exist for minority youth. This topic cuts across themes of fostering justice and equity, population health, and human potential and well-being in an increasingly diverse world. The CTG will involve three inter-related but distinct cross-disciplinary strands high-impact work that focus on addressing educational disparities: research partnerships, translational research, and dissemination, outreach, and community engagement.

The University of Minnesota is well positioned to be a leader on this topic because of its faculty expertise, existing efforts to engage communities and educational systems (e.g., UROC, Generation Next, Educational Equity Resource Center), and existing resource infrastructure to supports collaboration across multiple levels to successfully execute high-impact research and ultimately scale-up dissemination efforts (e.g., UROC, CAREI).

Vaccine Development, Clinical Trials and Policy

Lead Submitter: Sunil A. David, Medicinal Chemistry

A pivotal component of our armamentarium against emerging infectious diseases is the development of safe and efficacious vaccines. Fundamental deficiencies exist in current vaccine development programs. With its numerous strengths and resources, the University of Minnesota is uniquely positioned to take on the challenge of developing new, alternate, paradigms for accelerating the discovery and development of vaccines in a cost-effective manner.

The Center for Infectious Disease Research and Policy (CIDRAP) headed by Dr. Osterholm; the Clinical and Translational Science Institute (CTSI) directed by Dr. Blazar; the Center for Infectious Diseases and Microbiology Translational Research (CIDMTR), directed by Dr. Bohjanen; the Center for Immunology

directed by Dr. Jenkins; the Institute for Therapeutics Discovery & Development (ITDD) directed by Dr. Georg; the Coordinating Center for Biometric Research at the School of Public Health, headed by Dr. Neaton; and faculty at the College of Veterinary Medicine, are but some of the many resources.

Unraveling the Riddle of Mind, Body, and Consciousness

Lead Submitter: Apostolos Georgopoulos, Neuroscience

Co-Submitter: JB Shank, History

A crossdisciplinary effort can uncover the intricacies and depths of consciousness. The interdisciplinary nature of this problem—which has enchanted scientists and laymen alike since the beginning of time—is one to which we believe the University’s faculty and students are well positioned to make advances in current understanding. This is a Grand Challenge that draws the “mindfulness” and “embodied consciousness” from the practice of medicine and health care as well as the “cognitive turn” of the arts and humanities, and the “neurohistory” of historians. Recent developments in brain imaging, neuro-pharmacology, and cognitive science generate new knowledge. Further, the recent explosion of cognitive science research has also reoriented inquiry in new directions—from creating better artificial intelligence to redefining human states of consciousness to creating better policies for protecting brain-injured patients.

The explorations and applications of consciousness are complex and require the sustained exchange between disciplinary boundaries. This continued exchange underpins the scholarly future of the University and opens the opportunity for scholars to collaborate in ways never before possible.

Understanding Neurodevelopmental Disorders

Lead Submitter: Tasoulla Hadjiyanni, Design, Housing, and Apparel

Neurodevelopmental disorders, such as Autism Spectrum Disorder and Obsessive Compulsive Disorder are a grand challenge for two reasons: they are difficult to diagnose and treat, and they both have a pediatric onset, which means that early intervention can change lives for the individual sufferers, their families, and their communities. These disorders have global and local implications. OCD for example, is one of the world’s top 10 causes of disability based upon total lost pay and diminished quality of life.

Expanding understanding of neurodevelopmental disorders and forming diagnosis and treatment takes a multitude of disciplines—from the Medical School to the College of Design (to explore environmental factors that have impact, such as space layout, lighting, and acoustics) to the College of Science and Engineering (to develop automated processes via computer vision). Increasing understanding of neurodevelopmental disorders will take persistence and commitment and can only happen in a large research university with the faculty expertise and interdisciplinary breadth needed to pull this together.

Creating Health through Cross-Cultural Engagement

Lead Submitter: Craig Hassel, Food Science and Nutrition

Co-Submitters: Cindy Wilcox, AHCSH Spirituality and Healing; Derek Jennings, Pharmaceutical Science; John Finnegan, School of Public Health; Andy Furco, Office for Public Engagement; Alan Love, Philosophy; Len Marquart, Food Science and Nutrition

Community voices remind us that valuable human knowledge exists well beyond conventional parameters of academic/professional societies. How should academic professionals engage and interface with culturally diverse (non-biomedical) knowledge systems addressing the grand challenge of preserving and protecting human health?

The University of Minnesota is uniquely positioned for this Grand Challenge. We must: take responsibility for our histories of oppression; invest in human relationships teaching us reciprocity, mutual respect and self-knowledge; be more fully open to what other cultures offer while honoring our commitments to

“scientific integrity;” and transform habitual tendencies to distort, misinterpret, extract and misappropriate knowledge. We are uniquely situated among comprehensive, public land-grant research universities. Within a 15-mile radius of our Twin Cities campus, over 50 different languages are spoken. We serve the largest urban Hmong population, the largest Somali population, the second largest urban indigenous population in the U.S., and have 11 reservations within Minnesota whose members assert sovereignty and reclaim indigenosity.

Personalized Medicine

Lead Submitter: Bin He, Institute for Engineering in Medicine Biomedical Engineering

Co-Submitters: John Bischof, Mechanical Engineering; Wei Chen, Radiology; Arthur Erdman, Mechanical Engineering; Kalpna Gupta, Medicine; Allison Hubel, Mechanical Engineering; Paul Iaizzo, Surgery; Kelvin Lim, Psychiatry; David Odde, Biomedical Engineering; Bob Tranquillo, Biomedical Engineering; Jianping Wang, Electrical and Computer Engineering

With the aging demographics of our population, the cost of routine health care is soaring; moreover, many diseases remain difficult to diagnose, prevent or effectively treat in people of all ages. Our vision for “Personalized Medicine” is to vastly increase our fundamental biological understanding using affordable engineering solutions with under-utilized technological advancements for diagnosis, treatment, and prevention on an individualized basis. The realization of early disease detection and diagnosis, along with individualized treatment and prevention, can significantly improve the quality of life for all ages and tremendously lower the economic burden on our health care system.

The UMN is uniquely positioned to tackle this grand challenge, with many world-class research programs in medical imaging, cancer biology, cardiovascular and neural engineering, and medical devices. UMN is one of only a few institutions with a broad spectrum of comprehensive programs in both medicine and engineering needed to tackle the grand challenge of personalized medicine.

Aging and Chronic Care

Lead Submitter: Robert L. Kane, School of Public Health

Co-Submitters: Jim Pacala, Family Medicine and Community Health; Jean Wyman, Nursing Academic Programs

By 2035, 1.3 million Minnesotans will be aged 65+; of whom 67 percent will have 3 or more chronic conditions and 25 percent will be functionally dependent with complex medical and social needs. Our land grant institution has a responsibility to support innovative cross-disciplinary thinking about the pressing social and moral issue of caring for our aging society.

Our society’s approach to care of the aged has resulted in a system that is expensive, inefficient, technology-laden, overinvested in medical services, underinvested in social services, and overly focused on quantity rather than quality of life. These themes transpire in an environment of special interest groups and industries. We are ripe for change but need interdisciplinary solutions. The University is well positioned to lead; faculty and students across 15 schools could engage in research that improves the lives of older adults in our state and globally. We can begin by bringing together people from across the campus; we also need to connect practitioners with researchers, implementers with policy people, social scientists with operations people.

Capitalizing on Strengths in Microbiota Therapeutics at the University of Minnesota

Lead Submitter: Alexander Khoruts, Medicine; Associate Professor, Division of Gastroenterology

Co-Submitters: Michael Sadowsky, BioTechnology Institute and Soil, Water, and Climate; Dan Knights, BioTechnology Institute and Computer Science and Engineering

Microbial communities (microbiota) inhabiting the human body are critical to our physiology, disease, and health. Different diets and widespread use of antibiotics have brought changes to microbiota within our

population in ways that constitute a potential catastrophe. Altered microbiota is an important contributor to the epidemics of many modern diseases including: many associated with obesity (e.g., diabetes, cancer), gut diseases, allergic and autoimmune disorders. Academic institutions around the country have recognized the importance of the microbiome, pouring tens of millions of dollars into new research.

The University of Minnesota stands in a unique position to build on its established leadership role in developing microbiota therapeutics, which heals diseases by restoring healthy microbial communities in the body. This is ultimately what patients and the entire field need most. Our strength going forward is in our diverse faculty in biomedical sciences, engineering, ecology, and ethics, which can be united into a world-class research powerhouse.

Materials for Advancing Nanomedicine

Lead Submitter: Efi Kokkoli, Chemical Engineering and Materials Science

Nanomedicine, the use of nanotechnology in the screening, diagnosis, and treatment of disease, is an emerging field with potential to revolutionize individual and population-based health care. However, nanomedicine follows a “one-size-fits-all” approach, in which the same nanomaterial can be used, for example, in different cancer types in the clinic. Considering though our recent ability to match therapies to the tumor’s genetic signature and tailor them to each patient, the design of materials that can advance personalized nanomedicine is exciting and defines the future of treating different diseases.

The University of Minnesota is well positioned to make a difference in this area as it has the faculty and facilities to seed this effort and make this opportunity a timely investment that will propel our University’s reputation as the world leader in nanomedicine. The impact in life quality of millions of patients will be the most important outcome of this effort.

Obesity Prevention: A Grand Challenge the University is Positioned to Address

Lead Submitters: Co-Directors of the Obesity Prevention Center, Division of Epidemiology & Community Health, School of Public Health: Lisa Harnack, Professor; Melissa Laska, Associate Professor

More than one-third of Americans are obese, and as a result are at increased risk of diabetes, heart disease, cancer and numerous other diseases. Obesity prevention is key, since treatments are costly and have limited long-term effectiveness. Our research teams, representing a wide range of disciplines (e.g., nutrition, epidemiology, policy, computer science, economics, biostatistics, psychology, medicine, and more) are internationally known for rigorous research in developing and evaluating innovative obesity prevention strategies.

Examples include: Increasing school breakfast participation in rural adolescents. (M. Nanney, Medicine); evaluating local policies to improve healthy food access. (M. Laska, Public Health); improving the frequency and quality of family meals. (J. Fulkerson, Nursing); reducing sugary beverage portion sizes through pricing interventions. (S. Gollust, Public Health); using standing workstations to improve health in worksites. (M. Periera, Public Health). Targeting obesity prevention as a Grand Challenge will bolster our existing research efforts and spur new and innovative ideas.

Toward the Conquest of Disease

Lead Submitter: Clarence Lehman, Ecology, Evolution, and Behavior

Co-Submitter: Tucker LeBien, Academic Health Center

Eradicating infectious disease, or subduing it where that is not possible, is one of the feasible grand challenges of our time. We propose integrating novel ecological ideas with those from medicine and public health to address the conquest of disease—incorporating understanding of disease in humans, wild and domestic animals, crops and other plants. Some might reasonably object that it is impossible to conquer disease because disease is part of the ecology of life. But we do change our ecology. Dr. William

Foegen, who orchestrated the elimination of smallpox from the natural world, explains that we can conquer diseases because we evolve more rapidly than pathogens—we socially and they biologically. We turn the tables and attack the disease. Thus far that has eliminated two major diseases of the world.

Given the University's research and educational strengths in biology, ecology, medicine, and public health, this grand challenge offers great opportunities.

Slow the Aging Process and Extend Human Healthspan

Lead Submitter: Ling Li, Experimental and Clinical Pharmacology

Co-Submitter: Walter Low, Neurosurgery

Our society is aging at an unprecedented pace. Life expectancy has been increasing over the years. However, many of those who exceed the average life expectancy suffer a very poor quality of life due to significant health problems, posing great challenges to health care systems and national economies along with emotional and financial burden on the patients and their families. Strategies to increase the quality of life at advanced age are therefore greatly needed, both at the level of individuals and society.

The University hosts a large number of leading investigators who are engaged in a wide spectrum of cutting-edge research on aging and age-related diseases, from organ rejuvenation, mitochondrial dysfunction, frailty, and dementia to social infrastructure and policy. The goal of this proposal is to harness the collective power of basic, clinical, and social science research at the University and develop a program to promote healthy aging.

Microbiome Grain Foods and Health

Lead Submitter: Len Marquart, Professor, Food Science and Nutrition,

Co-Submitters: Dan Knights, BioTechnology Institute; Michael Sadowsky, BioTechnology Institute

Scientific evidence indicates microbial communities residing in the gastrointestinal tract play a crucial role in health and disease. Increasingly evident is that diet is important in the establishment and maintenance of a microbial ecosystem that supports good health. Epidemiological studies provided insights into components of whole grains and influence on gut health. More research is needed to understand the impact of whole grain consumption on host metabolism and gut microbial communities. Additionally, the modulation of gut microbiota with probiotics and prebiotics is suggested as a treatment of, or prevention for irritable bowel syndrome, diarrhea, and allergies. Establishing a public-private partnership to examine the impact of whole grains and other food/ food components on the microbiome may fill a scientific gap in linking food to health outcomes.

This cross-sector partnership would span the University's discovery, education, and outreach missions and would engage external partners such as General Mills, Cargill, etc., to leverage academic research to develop innovative products for consumers that promote gut health.

The 10,000 Families Study

Lead Submitter: Heather Nelson, Division of Epidemiology and Community Health, School of Public Health

Co-Submitters: Logan Spector, Pediatrics; Ellen Demerath, Epidemiology; Bharat Thyagarajan, Lab Medicine and Pathology; Anna Prizment, Epidemiology; DeAnn Lazovich, Epidemiology; Nicole Basta, Epidemiology; Shalini Kulasingam, Epidemiology; Alvaro Alonso, Epidemiology; Silvia Balbo, Environmental Health; Jen Poytner, Pediatrics; Susan Mason, Epidemiology

The Grand Challenge: Addressing critical gaps in knowledge of disease causation by establishing a population resource to identify the biological, social and environmental factors that shape human health. We will enroll 10,000 families into a long-term, prospective cohort study covering three generations of Minnesotans (~100,000 individuals). Our novel approach of following families provides unmatched flexibility to study the determinants of health across the life course. We will bank bio-specimens, collect

exposure histories, and link to participants' electronic medical records. Health outcomes will be collected at appropriate intervals. Our study will be a platform for translational research initiatives.

UMN strengths: Our proposal builds on the expanding capacity for informatics, genomics and microbiome research at the University. We have substantial experience in cohort research and a strong collaborative research environment. With an engaged, educated, and stable populace, Minnesota is the ideal state in which to assemble such a cohort.

Harnessing University and Community Assets to Achieve Health Equity: A Grand Challenge

Lead Submitter: Kolawole Okuyemi, Professor, Family Medicine and Community Health.

Co-Submitters: Faculty in Program in Health Disparities Research; Clinical and Translational Science Institute; Masonic Cancer Center; and Minnesota Center for Cancer Collaboration

Despite Minnesota's high ranking nationally in overall health status, its underserved populations experience disproportionately poor health. Globally, the poorest of the poor have high levels of illness and premature mortality which makes addressing health inequities both a matter of social justice and an ethical imperative. Because the causes of health disparities are complex, solutions require a synergistic interplay of multiple disciplines.

This proposal builds on the expertise of a growing critical mass of faculty across multiple disciplines at the UMN. Using an asset-based model, we have established Community Advisory Boards, held community dialogues, conducted health checkups in barbershops/beauty salons, and awarded community-academic collaborative research and dissemination grants. In the U.S., Minnesota has the largest population of Somalis, the largest population of Native Americans in an urban area, and the second largest Hmong population. This creates a tremendous opportunity for developing innovative cross-cultural models and strategies to achieve health equity.

Vibrant Communities—Treating Sensory Deficits

Lead Submitter: Andrew J. Oxenham, Psychology

Co-Submitters: Gordon Legge, Psychology; Peggy Nelson, SLHS; Hubert Lim, BME; Meredith Adams, Otolaryngology; Sandra Motezuma, Ophthalmology

Sensory deficits, such as hearing loss and low vision, affect hundreds of millions worldwide. Such deficits can have a devastating social impact on individuals, with serious economic consequences for society. Treatments, such as hearing aids, cochlear implants, and retinal implants, remain at best incomplete and are in need of radical improvement.

The University of Minnesota has a unique concentration of internationally leading researchers in auditory and visual sciences, with a particular focus on hearing loss and low vision. This expertise is augmented by strong links between scientists (Psychology, SLHS), engineers (BME, EECS), and clinicians (Otolaryngology, Ophthalmology), providing an outstanding environment for novel, transdisciplinary approaches to solving this critical problem. In addition, the Twin Cities area has a large number of hearing aid and other medical device companies, many of whom already have productive partnerships with University labs. The time is right to harness this unique environment to tackle this grand challenge.

Reconfiguring Minnesota's Poultry Industry to Reduce Risk of Future Influenza Outbreaks

Lead Submitter: Patrick T. Redig, Professor, College of Veterinary Medicine

The inability to foresee and control the 2015 avian influenza epidemic, the demonstrated vulnerability of the current industry operations, and the likelihood of HPAI re-occurrence in Minnesota argues for a new approach. The new approach, the Grand Challenge, would be *to create a sustainable system with inherent resistance and resilience in a world with continuously changing biochallenges*. A production system that is ecologically compatible with the region's biogeography (prairies and wetlands with abundant waterfowl

populations), the intercontinental movements of wild birds and the dynamics of influenza virus biology is critical to ensuring the economic strength of an industry inherently important to Minnesota's economy.

A multidisciplinary systems-based model is needed where resistance to influenza is innate and multi-layered by virtue of built-in factors such as the genetic diversity of the birds, the design of facilities, flock management, and the sustainability of feed and energy inputs to operations.

Scaling Evidence-Based Prevention Programs through Pay-for-Success Financing

Lead Submitters: Arthur Reynolds, Co-Director of HCRC and Professor of Child Development; Judy Temple, Professor, Applied Economics, and Director, Early Childhood Policy Certificate; Art Rolnick, Senior Fellow, Humphrey School of Public Affairs; Gerald August, Director of CPPR and Professor of Family Social Sciences; Abigail Gewirtz, Professor of Family Social Sciences and Director, Prevention Science Minor

In the realm of social programs for children and families, fewer than 5% of efficacy and effectiveness trials are scaled to their intended populations at local, state, or larger levels. This is primarily a problem of insufficient resources and inadequate collaborations. Innovations in social impact investing provide a unique opportunity to address the barriers to scaling. Social impact bonds or human capital bonds implementing "Pay for Success" financing provide a feasible and growing approach to scaling that has been successfully applied at the University by the Human Capital Research Collaborative (HCRC). Such novel approaches were recommended in the TC Campus Strategic Plan as a strategy for advancing a cross-disciplinary Grand Challenges research agenda, with private and public funders investing in long-term work likely to achieve real impact.

We expand on this approach in a concerted children's prevention initiative between faculty of the HCRC and the Center for Personalized Prevention Research in Children's Mental Health. Two early childhood development programs will be emphasized for scaling: Midwest Child-Parent Centers and Early Risers.

Salivary Biomarkers for the Diagnosis of Cancer

Lead Submitter: Nelson L. Rhodus, Professor, Diagnostic and Biological Sciences; Adjunct Professor, Otolaryngology

Co-Submitters: Timothy Griffin, Biochemistry; Frank Ondrey, Otolaryngology; John Carlis, Computer Science

When diagnosed late, cancer kills. But when discovered early, survival rates soar. Oral cancer has a miserable 50% survivor rate but upwards of 90% when discovered early. Our widely interdisciplinary team has been conducting research on biomarkers for early detection of oral cancer and breast cancer for over 10 years. Our team has been investigating methods for sampling and discovering biomarkers of cancer in a non-invasive fashion. These samples are ideally suited for our system-wide analysis using genomic and proteomic technologies for protein biomarker discovery. Global impact: the largest to-date quantitative catalogue of the oral cancer saliva proteome, which informs the selection of candidate saliva protein biomarkers from patient samples and a panel of promising saliva protein biomarkers—providing an important step towards non-invasive, early detection of cancer.

Our investigative team here is uniquely poised to further develop these emerging genomic and proteomic strategies to identify non-invasively collected biomarkers that could improve the early diagnosis of cancer and improve survival rates.

The Grand Challenge of Brain Health

Lead Submitter: Francis X. Shen, Associate Professor of Law

Have you or a loved one been touched by stress, anxiety, depression, dementia addiction, autism, ADHD, depression, PTSD, or some other brain disorder? Has your child or someone you love struggled to perform cognitively at school or emotionally at home? For most the answer to these questions is a resounding yes. Internationally and at home we face the grand challenge of brain health.

The University of Minnesota can become internationally recognized as *the* leader in brain health. What's more, we can do it without hiring a single new faculty member. There are a vast number of *existing* research centers and individual researchers already focusing on brain issues, but they are not yet collaborating. Brain-related research is already underway in virtually every part of the University. This existing potential can be harnessed into a Minnesota Model of Brain Health, spanning the lifespan from the prenatal brain through the aging brain.

Transforming the Biomedical Research Training Paradigm for the 21st Century

Lead Submitter: Yoji Shimizu, Laboratory Medicine and Pathology

This grand challenge seeks to transform the biomedical research training paradigm throughout the educational continuum (middle school, high school, undergraduate, and graduate) in order to accelerate discoveries that improve human health. The challenge seeks to utilize an integrated approach that will allow the University of Minnesota to innovate and successfully address fundamental issues in biomedical research and education that are not being effectively addressed today, including developing resilience and grit in students, training emerging scientists in entrepreneurship, teamwork and communication in order to prepare students to work in transdisciplinary teams, developing training models that integrate research experiences across the educational continuum and reduce the overall training timeline, and effectively increasing the diversity of the biomedical research workforce.

The University of Minnesota has community partnerships and strengths in biomedical research and science education that can be leveraged to develop a new approach to biomedical research training that will have national impact.

Establishing a Sports Nutrition Center at the University of Minnesota

Lead Submitter: Joanne Slavin, Professor, Food Science and Nutrition

Co-Submitters: Renee Korczak, Food Science and Nutrition; Carrie Peterson, Food Science and Nutrition; Daheia Barr-Anderson, Kinesiology; Brittany Francis, Athletics; Quincy Lewis, Athletics

This Grand Challenge idea focuses on the development of a Sports Nutrition Center at the University of Minnesota. In comparison to other Big Ten schools, the University is behind in sports nutrition. The area of sports nutrition is continuing to expand due to the large number of students and student athletes who want to learn about optimal nutrition during performance and gain careers in this field.

The University is well positioned to grow this area by hiring more full-time dietitians to work with our sports teams and leverage the knowledge of experienced faculty across various departments. For example, Food Science and Nutrition has skilled faculty in all nutrition topics, including carbohydrates, vitamins and minerals, fluids and electrolytes, and nutrition across the life cycle. Our expertise in food science is also important to help design foods and beverages with appropriate nutrient composition for the wide range of athletes. Finally, by bridging the gap between the Food Science and Nutrition and Athletics, we can work towards the implementation of a Sports Nutrition Center.

Precision Medicine and Health

Lead Submitter: Robert Straka, Professor and Head, Experimental and Clinical Pharmacology,

Co-Submitters: Pamala Jacobson, Experimental and Clinical Pharmacology; Peter Igarashi, Medicine; Susan M. Wolf, Medicine & Public Policy; Faegre Baker Daniels, Law, Consortium on Law and Values in Health, Environment & the Life Sciences; Saonli Basu, Division of Biostatistics

The University of Minnesota should become a national leader in precision medicine and health. Precision medicine is an emerging approach that uses individual variability in genes, environment, and lifestyle to "individualize" prevention and treatments. It requires a transdisciplinary framework integrating health care, public health, behavioral and social sciences, environment, health disparities, law, ethics, economics, and public policy. Earlier this year, the U.S. government launched a major Precision Medicine Initiative.

The U is ideally positioned to lead nationally in developing this next-generation approach to diagnosis and treatment. Investigators in pharmacology, genomics, biostatistics, informatics, public health, law, and ethics are already collaborating on funded research and building essential connections. Involving more faculty, trainees, and students in a cross-University effort—and leveraging partnerships with Minnesota’s leading health care systems, medical industry, and patients—will allow us to lead in this revolutionary new approach to medicine and to translate cutting-edge discoveries into health solutions.

Restoring Health: Organ Regeneration and Repair for People and Animals

Lead Submitter: Jakub Tolar, Pediatrics

Co-Submitter: Walter Low, Neurosurgery

Medical care’s most significant burden is management of chronic disease. Changing the paradigm of health care from chronic disease management to restoration of normal health through organ/cell replacement and repair would transform the lives of people, animals and societies. We are proposing a Grand Challenge that will provide the solution for shortages in replacement organs, repair of aged or damaged organs, and correction of genetic damage to organs/cells. The technologies to address these issues are based on stem cells and gene engineering. These advances can produce healthy replicas of a person’s or animal’s organs/cells, repair damaged portions of existing organs, or replace damaged or missing genes.

The new technologies of TALEN gene editing and stem cells that will propel this Grand Challenge were developed by faculty at the University of Minnesota who are internationally known for their leadership in these research areas and who provide exceptional strength for this proposal.

Circuit-based Neuromodulation for Brain Disorders

Lead Submitter: Jerrold Vitek, Neurology

Co-Submitters: Bin He, Biomedical Engineering/IEM; Matt Johnson, Biomedical Engineering / IEM; Tay Nestoff, Biomedical Engineering /IEM; Arthur Erdman, Medical Device Center; Michael Park, Neurosurgery; Ken Baker, Neurology; Scott Cooper, Neurology; Colum MacKinnon, Neurology; Paul Tuite, Neurology; Timothy Ebner, Neuroscience; Erin Holker, PM&R; Jonathan Gewirtz, Psychology; Monica Luciana, Psychology; Moan Harel, Radiology/CMRR

Nervous system disorders affect 1 in 5 Americans at an annual cost of ~\$500 billion. With the aging population these disorders will continue to grow in number and cost. Effectively treating these disorders is a Grand Challenge that the University is well positioned to address. Most drugs provide only temporary, if any, relief, for many of these conditions, leaving patients and families desperately seeking new therapeutic interventions to improve quality of life and lessen the economic burden. Deep brain stimulation (DBS) delivers electrical stimulation within abnormal brain circuits to restore function.

Leveraging our strengths in imaging and DBS together with other forms of neuromodulation, the University is at the forefront for development of circuit based treatments for these complex and debilitating brain conditions. We are uniquely positioned to undertake this Grand Challenge because of wide faculty clinical expertise, interdisciplinary research strengths, existing infrastructure, and senior leadership across schools and colleges.

Center for Accessible Cancer Immunotherapy

Lead Submitter: Carston Wagner, Medicinal Chemistry

Cancer is the second leading cause of death worldwide. In 2015, it is estimated that in the U.S. over 1.6 million new cancer cases and nearly 600,000 deaths will be attributed to cancer. Recently there has been tremendous excitement over the potential to harness a patient’s immune system to fight cancer. Despite the remarkable preliminary clinical success of these methods, there are significant technical hurdles that prevent them from being widely used and cost-effective. Current therapies can cost over \$250,000,

putting an enormous financial burden on health care systems. In addition, cell-based therapies require highly trained staff and sophisticated production facilities that only a few major health care centers are capable of providing.

To overcome these limitations, we propose to establish a multidisciplinary Center for Accessible Cancer Immunotherapy (CACI) whose goal is to develop new cost-effective and portable approaches for activating, targeting and tracking immune cells for the treatment of cancer.

How will we develop sustainable cities and resilient communities in a world of climate change?

Minnesota as a Model for a Prosperous Low-Carbon Economy

Lead Submitter: Ellen Anderson, Executive Director, Energy Transition Lab

Co-Submitters: Jessica Hellman, Institute on the Environment; Richard Graves, Center for Sustainable Building Research; Ned Mohan, Electrical and Computer Engineering; Sabine Engel, University Economic Development; Nicholas Jordan, Agronomy and Plant Genetics; John Carmody, Center for Sustainable Building Research; Beth Mercer Taylor, Sustainability Education Coordinator

As the world confronts the Grand Challenge of climate change, we must overcome energy inequity. Historically, prosperity for wealthy nations was built upon fossil energy. As world leaders move to decarbonize, developing countries may be left further behind in the global economy. To solve this inequity, we need pathways to prosperous low carbon economies that can be scaled up and replicated. Minnesota's natural resources, policy framework, and lack of fossil fuels create an ideal laboratory to model pathways. Rising to the challenge of creating a low carbon, prosperous Minnesota economy would put us on the world stage for innovation without emissions growth.

This proposal leverages the University's existing strengths in energy, technology, planning, design, transportation, agriculture, forestry, ecology, public health, human rights, and other fields, and the research already under way on industry reducing environmental impact while improving economic return. Researchers will partner with Minnesota leaders to discover low carbon solutions.

Sustainable Urban Systems (SUS-GC)

Lead Submitter: Lawrence A. Baker, Bioproducts and Biosystems Engineering

Achieving urban sustainability for global cities is a complex ("wicked") problem that defies disciplinary solutions. The SUS-GC could (a) create intellectual space for transdisciplinary theoretical advances in urban sustainability, (b) become an integral part of the U of M's *commitment to engagement* (perhaps restoring the University's perceived value within Minnesota), (c) become a UM-wide core educational theme, and (d) be a compelling focus for major private funding—a SUS-GC would be a hugely compelling theme, politically neutral (who does not want sustainable cities?), and well suited for a range of major investor goals.

The U of M is unique in having the combination of a land grant college (CFANS) alongside major schools of public health, architecture, law, and public policy; complemented by strong science and liberal arts departments. Arguably the U of M is the *best-positioned school in the country to initiate a SUS GC*.

Designing Solutions to the Grand Challenges

Lead Submitter: Thomas Fisher, Director, Metropolitan Design Center

Co-Submitters: Abimbola Asojo, Design, Housing and Apparel; Marilyn DeLong, College of Design; Richard Graves, Sustainable Building Research; Pat Hemmis, Design, Housing and Apparel; Lin Nelson-Mayson, Goldstein Museum; Richard Strong, Sustainable Building Research; Theresa Tichich, External Relations; Matt Tucker, Landscape Architecture; Becky Yust, College of Design

We need to devise creative responses to the Grand Challenges that are affordable, implementable, and sustainable. To do this, the University of Minnesota should include, on every grand-challenge team, the disciplines that have a long history of creating out-of-the-box solutions to problems that require a paradigm shift in thinking: the design disciplines. Designers are trained to develop inventive solutions and to integrate multiple perspectives in a collaborative way.

The private and public sectors have successfully used design methods to address systemic problems not normally thought of as design-related, enabling companies and communities to come up with creative new solutions to their greatest challenges. The University of Minnesota would set itself apart from the many other institutions focused on grand challenges by using design methods to develop innovative, actionable ways of resolving them. Designers could also help in coordinating the diverse disciplines on each team and in moving projects to completion.

A Hotter, Drier World Drives Diversity in Minnesota Agriculture

Lead Submitter: John Erwin, Horticultural Science

Co-Submitters: N. Anderson, M. Clark, J. Luby, S. Hokanson, V. Fritz, M. Rogers, J. Cohen, A. Hegeman, Horticultural Science; J. Slavin, Food Science and Nutrition; R. Blanchette, Plant Pathology; C. Rosen, Soil, Water and Climate; C. Yue, Applied Economics; N. Mohan, Electrical and Computer Engineering; D. Handeen, Center for Sustainable Building Research; N. Phelps, Veterinary Population Medicine/Food Policy Research Center; Greg Schweser, Kathy Draeger, Minnesota Extension Service; Carissa Schively Slotterback, Urban and Regional Planning

Existing fruit and vegetable production regions are increasingly hot and dry. As temperatures increase, photosynthesis and crop yield decrease. Water availability and quality are also decreasing resulting in greater competition between farmers and the public. Therefore, fruit and vegetable production will increasingly move to places with greater water availability and moderate temperatures; Minnesota is one such place during the growing season. *We propose to:* 1) understand the basis for temperature effects on crop yield and quality, 2) identify and breed temperature tolerant crops, 3) utilize new energy technologies to produce food in different systems in Minnesota.

Minnesota faculty are uniquely positioned to identify or breed temperature tolerant fruits and vegetables, produced with fewer pollinators, with high nutritional value, explore alternative ways to capture, store, and utilize energy for food production in controlled environments, and identify novel ways to design homes, yards, parks, and cities to produce healthier foods for Minnesotans.

Remaking the Mississippi River Corridor

Lead Submitter: Samuel Geer, Adjunct Assistant Instructor, Landscape Architecture

The University of Minnesota will remake the Mississippi River as a resilient ecological corridor capable of sustainably supporting people and wildlife within a symbiotic and regenerative landscape. This is a complex interdisciplinary problem that requires systems thinking to understand the social, economic, and environmental processes at work.

Given its location on the Mississippi River and its role as a land grant university, the University is uniquely positioned to develop new approaches to land use planning, conservation, ecological restoration, and cultural interpretation. This project could involve students and faculty from disciplines such as entomology, forestry, public policy, urban design, horticulture, and the humanities. The University is

already on the cutting edge of research regarding the protection of endangered species, invasive species control, and developing new land use typologies which enhance the ecological performance of human landscapes. This new approach can establish the UMN as a global precedent for others to follow.

A Grand Challenge to Support All Other Grand Challenges: Teaching Computational Thinking to All Students

Lead Submitter: Maria Gini, Computer Science & Engineering

This grand challenge is to teach computational thinking to every U undergraduate. Everyone encounters computational artifacts throughout their employment, home, travel, academics, business, in fact everywhere: it pervades all of society. It is a grand challenge because it impacts everyone regardless of major. Computational thinking is not computer programming nor technology literacy, it is a way of organizing the thought processes needed to generate a logical sequence of decisions to accomplish an intended task. It uses abstractions to deal with complexity and scale. What sets it apart from general problem solving is the precision needed in the solution so that the task can be accomplished by a human or a digital device despite the complexity of the goal. Students will be better informed citizens when it comes to making decisions that impact society.

The University is uniquely qualified because of its strength in computational disciplines, educational research, and interdisciplinary work.

A 21st-Century Grand Challenge: Investing in Urban Futures

Lead Submitter: Michael Goldman, Sociology and Global Studies

The 21st century is the era of *rapid* global urbanization: Global cities of 15-30 million people are being built, converting “under-valued” rural land into “higher valued” real estate. As they compete for scarce resources, and as they displace millions of people, global cities create tremendous social and ecological uncertainty. Our concern is that this grand social experiment lacks interdisciplinary, transnational, and collaborative study and evidence-based policy input.

Our University is uniquely situated as preeminent in researching this “global urban turn”: Our Global Urbanism Group has successfully organized conferences in Minneapolis (2008), Shenzhen (2010), and Jakarta (2012), and sparked collaborative research on questions of urban water, land, energy, and social equity. Minnesota is well positioned to intervene in these urban futures: Minnesota produces minerals for Asia’s urban expansion, its insurance and finance corporations invest in infrastructure risks and investments, and its firms export water, medical, and food technologies for new middle classes.

Building Community Resilience in a Dynamic World

Lead Submitter: Richard Graves, Director, Center for Sustainable Building Research, College of Design

Co-Submitters: Ann S. Masten, Institute of Child Development; Ozayr Saloojee, Architecture; Imagine Fund Chair in the Arts, Design and Humanities, Founder of the Duluth Studio

What is *resilience*? The Rockefeller Foundation defines resilience as the capacity of individuals, communities and systems to survive, adapt, and grow in the face of stress and shocks, and even transform when conditions require it. Our communities must become regenerative and resilient not only to be sustainable, but also to respond and adapt to stress and change in a dynamic global environment.

What does resilience mean for Minnesota? Resilience focuses on the challenges communities face in responding to their increasing carbon footprint, dependence on fossil fuels, and impact on our irreplaceable natural resources. Economic resilience in urban and rural communities focuses on the statewide impact of a changing population as well as a changing physical environment. Some communities exude hope as they grow and confront the future, others decline in fear as the process and pain of change causes despair.

The Problem of Water: Civic Engagement, Community, Identity, and Place

Lead Submitter: Jennifer Gunn, History of Medicine Endowed Professor; Director, Institute for Advanced Study

Co-Submitters: Katherine Hayes, Anthropology, American Indian Studies; Patrick Nunnally, River Life Program, Institute for Advanced Study

Minnesota and the region face a grand challenge: adjusting our values and treatment of water to meet changing climate and demographic trends. Historically, water management has been delegated to scientists and engineers; we need an interdisciplinary approach that embraces diverse human understandings and experiences of rivers and lakes.

The University of Minnesota can leverage its location in the Mississippi River ecosystem to develop new, inclusive, and sustainable solutions to water issues at a local scale, with potential for global applications. We have world-renowned water scientists and engineers (WRS, GLI, SAFL, IonE) who provide path-breaking applied research. Programs such as IAS collaboratives and River Life; and scholars in art, anthropology, history, and the professions, explore and communicate changing narratives of water and engage in community-based research and teaching. They complete the triad of perspectives necessary to manage water and encourage broad community buy-in, from the region's Indigenous to most recent residents, for the future.

Grand Challenge in Discipline-Based Educational Research

Lead Submitter: Ken Heller, Physics

Co-Submitters: Michelle Driessen, Chemistry; Leon Hsu, Education; Duane Nykamp, Mathematics; Emily Pelton, Chemistry; Christina Petersen, Center for Educational Innovation

We propose building a structure to support the continuous improvement of post-secondary education based on the research ethos of the University. Such an education would enable the University to marshal its disciplinary strengths, empowering its students to address rapidly emerging societal issues. Discipline-based educational research (DBER) would strengthen education in the disciplines while providing the interdisciplinary connection to coherently reinforce student learning across disciplines.

DBER builds on the expanding knowledge of the cognitive sciences while building on each discipline's knowledge base, ethos, and culture. DBER has been developing primarily in the STEM fields and our University has some of the leaders of biology education research, engineering educational research and physics education research on which to build this emerging area. We have a template in the successful structure of our History of Science, Technology, and Medicine program that locates its faculty in their departments while interacting across department lines.

Toward a Sustainable Infrastructure System

Lead Submitter: Jia-Liang Le, Civil, Environmental, and Geo-Engineering (CEGE)

Co-Submitters: Catherine French, CEGE; Lauren Linderman, CEGE; Dominik Schillinger, CEGE; Arturo Schultz, CEGE; Carol Shield, CEGE; Henryk Stolarski, CEGE; Yingling Fan, Humphrey School of Public Affairs; Tian He, Computer Science and Engineering; Frances Homans, Applied Economics; Nikos Sidropoulos, Electrical and Computer Engineering

A multidisciplinary approach is proposed for research and curriculum required to improve resilience and sustainability of infrastructure systems essential for economic and physical well-being of each individual, family, community, and nation. The proposed research features a multiscale approach from the material-level to the infrastructure component-level, all the way up to the infrastructure network-level, which can be applied to numerous types of infrastructure systems, including roadway networks, power grids, and gas networks. Multiple disciplines including engineering, science, economics, regional planning and public affairs are required to investigate funding models, planning, decision making, design, construction, and maintenance of these systems.

The UMN is uniquely positioned to tackle this grand challenge due to its human and physical resources including 1) outstanding faculty with expertise well suited for this research; 2) unique world-class large-scale structural testing facilities; 3) available in-state testbeds; and 4) strong relationship with the state legislature for research implementation.

Restoring Earth's Climate

Lead Submitter: Clarence Lehman, Ecology, Evolution, and Behavior

Co-Submitter: David Tilman, Ecology, Evolution, and Behavior

The National Academy of Sciences has articulated a major societal need, "climate intervention," which includes the active removal of atmospheric greenhouse gases. Our Climate Restoration Grand Challenge is to discover ways of restoring global climate while simultaneously meeting global energy needs.

Climate restoration might be imagined as best occurring when energy-generating technologies themselves remove excess greenhouse gases. This would seem plausible with energy systems combining the abilities of ecosystems to store carbon in soil, advances in mechanical and chemical engineering to produce energy and pure streams of carbon dioxide, and geological heat extraction and carbon storage. This grand challenge thus involves several disciplines where the University already has great strengths. It is the kind of grand challenge that a research university should tackle—apparently feasible but at the limits of current knowledge. It is a necessary part of maintaining a sustainable, habitable, and equitable planetary ecosystem into the distant future.

(Re-)Designing Cities to Maximize Opportunity, Health, and Happiness

Lead Submitter: David Levinson, Professor, Civil, Environmental, and Geo-Engineering (CEGE)

Co-Submitters: Adam Boies, CEGE; Alireza Khani, CEGE; Julian Marshall, CEGE; Saif Benjafaar, ISYE; Yingling Fan, Humphrey School; Greg Lindsey, Humphrey School; Xinyu (Jason) Cao, Humphrey School; Ying Song, Geography; Matteo Convertino, Public Health

Cities have never been more important—more than 50% of global population lives in cities, rising to 70% by 2050 (UN 2008). These growing populations need places to live, work, and play, they need energy and water, they need means of getting around. Today's cities were designed around yesterday's populations and technologies, and are far from optimal for current and future needs.

Designing and re-designing cities to maximize opportunity, health, and happiness is a Grand Challenge the University of Minnesota should pursue. The Twin Cities possess unique features to enable design focused on maximizing health, happiness, and opportunity. The metropolitan area has a growing public transportation network, has the largest network of bike lanes and is among the top third of cities in terms of parkland per person (68.8 m²/person). Additionally, the city has relatively large tracts of underutilized land poised for redevelopment around the urban core.

Towards a Sustainable Global Environment: PM2.5 Health Effects and Control Technologies

Lead Submitter: David Y.H. Pui, Distinguished McKnight University Professor and Director of the Center for Filtration Research, Mechanical Engineering

Co-Submitters: Gurumurthy Ramachandran, Environmental Health Sciences

Fine particulate air pollution (PM_{2.5}) is one of the defining problems of our age, affecting many aspects of our lives—electricity production and use, cooking fuel, automobile use, human health, and climate change. These challenges involve technical engineering and medical and public health issues, but also social, economic, and cultural aspects.

We have assembled a world-class team of scholars from four different schools within the University (the Medical School, School of Public Health, College of Science and Engineering, and College of Food, Agricultural and Natural Resource Sciences) to collaboratively address this multi-dimensional problem as

well as to propose sustainable solutions. The team has strong partnerships with industrial stakeholders for whom this issue presents economic opportunities. Collaborative scientific projects with international partners have already begun to address air pollution problems in China. This initiative will position the UMN as a world leader on an important global health and sustainability issue.

Sustainable Infrastructure and Cities: Reimagining Urban Infrastructure

Lead Submitters: Anu Ramaswami, Professor, Humphrey School of Public Affairs; Jason Cao, Associate Professor, Humphrey School of Public Affairs; Matteo Convertino, Assistant Professor, School of Public Health; Sairaj Dhople, Assistant Professor, Electrical and Computer Engineering; Yingling Fan, Associate Professor, Humphrey School of Public Affairs; Greg Lindsey, Professor, Humphrey School of Public Affairs; Julian Marshall, Associate Professor, Civil, Environmental, and Geo Engineering; Paige Novak, Professor, Civil, Environmental, and GeoEngineering; Elizabeth Wilson, Professor, Humphrey School of Public Affairs; Jerry Zhao, Associate Professor, Humphrey School of Public Affairs; Tom Fisher, Professor, College of Design

Through a \$12M grant from the U.S. National Science Foundation, our group is leading a network of researchers across several colleges at UMN to address the challenge of developing environmentally sustainable, healthy, and livable cities through a focus on infrastructure. We explore and integrate engineering, urban design, economics, behavioral and policy solutions to transform urban infrastructure in the areas of energy, water supply and sanitation, transportation, green infrastructure, and food systems. Expected outcomes include enhancing the health and well-being of more than 70% of the world's people who will live in cities by 2050, while also preserving environmental and ecosystem resources during an era of climate change.

In addition to UMN faculty, our network includes city partners in Minneapolis and St. Paul, The Met Council, businesses such as Xcel Energy and Ecolab, and international organizations such as ICLEI and UNEP to translate research into action, befitting a Grand Challenge initiative.

Initiative of Building Eco-Community

Lead Submitter: Roger Ruan, Professor, Director, Center for Biorefining, Bioproducts and Biosystems Engineering, and Food Science and Nutrition.

Co-Submitters: Paul Chen, Center for Biorefining, Bioproducts and Biosys Eng.; Gerald Shurson, Animal Science; Dean Current, Center for Integrated Natural Resource and Agricultural Management, Forest Resources; Bradley Heins, West Central ROC Morris; Rob Gardner, West Central ROC Morris; Chi Chen, Food Sci. and Nutrition; Ce Yang, Bioproducts and Biosys Eng

The conflict between humans and natural environment is intensifying. Technology advancement in the developed world has contributed in part to this by excessively exploiting natural resources and creating pollutants at unprecedented rates. Urbanization, especially in the developing countries, is asserting tremendous pressure on already fragile natural environments. This initiative will focus on developing and demonstrating systematic solutions to help restore disturbed ecosystems and developing sustainable ecosystems that integrate human society with natural environment. An eco-community demonstration project would require tremendous technical and financial resources and long-term commitment and a holistic approach. UMN as a land grant university is in a unique position to involve researchers and community leaders with diverse expertise.

Tackling the grand challenges identified above not only provides solutions to countries experiencing rapid urbanization but also benefits the local communities. An initiative like this will certainly help build and maintain UMN's leadership and reputation in this important field.

Developing Infrastructure Resilience to Natural Hazards

Lead Submitter: Arturo Schultz, CSE/CEGE

Co-Submitters: Catherine French, CEGE; Patrick Huelman, BBE; Joseph Labuz, CEGE; Jia-Liang Le, CEGE; Lauren Linderman, CEGE; Rajesh Rajamani, ME; Dominik Schillinger, CEGE; Carol Shield, CEGE; Carissa Slotterback, HHH; Henryk Stolarski, CEGE

Resilience of the built infrastructure to natural hazards, that is, the capacity to recover quickly when major disasters occur, affects life-safety and the nation's economy. Natural hazards vary regionally and include coastal storms, tornados, straight-line winds, and earthquakes.

The University of Minnesota is ideally positioned to address this challenge through its faculty expertise, world-class research facilities, strategic location, and its relationships to the government and private sectors. Multidisciplinary research and education is proposed to improve the understanding of extreme events, develop resilient and sustainable infrastructure systems, and formulate effective mitigation strategies in three categories: Understanding the Effects of Extreme Loading from Natural Hazards on the Built Infrastructure; Improving the Resilience of the Built Infrastructure; and Developing Computational Tools for Natural Hazards. Disciplines required include atmospheric and earth sciences; computational fluid dynamics; sensor development, monitoring and structural control; structural and geotechnical engineering; sustainable design; building science; and planning and policy development.

How will we provide secure food, water, and energy today and for the future?

Cutting the Root of Anthropogenic Global Climate Change: Toward a Low-Carbon Society

Lead Submitter: Jeffrey Broadbent, Sociology

Facing the Grand Challenge of Global Climate Change requires a decades and centuries-long view. Continuing climate change will intensify heat waves, fires, floods, droughts, famines, migrations and wars, overwhelming adaptation efforts. Massive methane release could make warming unstoppable. The most strategic response is rapid reduction of the cause--human emissions of carbon dioxide and other greenhouse gasses. To do so, we must find the way to global well-being without carbon growth. This will require not only alternative technology, but social, economic, political and cultural change through global cooperation.

Our Institute on the Environment can focus university strengths in interdisciplinary groups to work on projects including sustainable agriculture, community design, alternative energy, green development, policy mechanisms, governance, risk interpretation, and education. For instance, one project studies media framing (Soc, Comm) of global weather anomalies (IT). The U can contribute greatly to understanding constraints and opportunities and to informing effective solutions.

Engineered Fracturing of Rock

Lead Submitter: Emmanuel Detournay, Civil, Environmental, and Geo-Engineering (CEGE)

Co-Submitters: Bojan Guzina, CEGE; Joseph Labuz, CEGE; Sonia Mogilevskaya, CEGE; Vaughan Voller CEGE; Fadil Santosa, Mathematics; Max Bezada, Earth Sciences; Christian Teyssier, Earth Sciences; Mihailo Jovanovic, Electrical Engineering; Carlos Carranza-Torres, Civil Engineering

The continued health and well-being of our society will be significantly enhanced by our ability to develop the Earth's subsurface. The extraction of resources, containment of waste, and expansion of infrastructure, however, are critically held back by the lack of reliable, efficient, and safe technologies for the fragmentation of rock.

Building on over 50 years of seminal innovations in rock mechanics at the University of Minnesota, our goal is to transform the practice of subsurface fragmentation to the point where the safe and efficient operation of such processes is on par with engineering operations on the surface. The goal will be realized through four main themes centered on developing the engineering, understanding, and technologies for: (1) mitigation of the hazards associated with subsurface excavation; (2) responsible resource extraction and waste isolation; (3) efficient excavation and drilling operations; (4) sensing and steering subsurface fracture processes in real time.

Systems-based Food Safety and Defense

Lead Submitter: Francisco Diez-Gonzalez, Food Science and Nutrition

A concerted effort in advancing knowledge and education for consumer protection from natural and intentional threats is proposed. Foodborne diseases are a major public health threat and pose a significant burden to the U. S. and world's economy. The challenges faced by the global food system present multiple opportunities. These prospects relate to globalization of food trade, anticipating to emerging pathogens, accelerating progress in food production and processing, addressing trends in consumer preference and reducing the potential for intentional adulteration driven by economic motivation or terrorism.

Minnesota and the University have been at the forefront of protecting consumers from farm to table. The University has multiple food-related programs and centers that promote food safety and defense. They include academic units within at least three colleges, as well as multidisciplinary centers with significant external funding. This GC will place the University as the academic leader in food protection.

Informatics for Environment and Natural Resources

Lead Submitter: Alan R. Ek, Professor & Head, Forest Resources (FR)

Co-Submitter: Joseph F. Knight, Remote Sensing and Geospatial Analysis Laboratory, Forest Resources

Extensive natural resource inventories, environmental monitoring, large area remote sensing tools plus new analysis capabilities for big data have great potential for increasing our understanding of natural and managed ecosystems—i.e., their dynamics and management approaches that foster productivity, biodiversity and sustainability.

The University and CFANS have a long history of research and development and public and private collaborations with applications in these areas, especially with respect to forests, wildlife habitat, soil productivity and clean water for urban and rural ecosystems. The focus is on environment and natural resources systems and will grow to include aspects of agriculture, water resources, including risk, biodiversity and ecosystem health over large areas. Risks include wildfire, climate change, floods, and crop failures. Eight component endeavors, five departments and numerous agencies are included in the planned initiative. Without this fundamental understanding of natural and managed systems, the four other themes have little chance of success.

Climate Change Adaptation: Building Resilience, Reducing Risks

Lead Submitter: Susan Galatowitsch, Professor & Head, Fisheries, Wildlife & Conservation Biology

Worldwide, planning to cope with the consequences of climate change is underway, but typically in a limited, ad-hoc manner—primarily engineering or technological “fixes” to existing disaster or water management programs. As noted by IPCC (2014), the current extent of climate adaptation is critically constrained must broaden to integrate social, institutional and ecosystem-based measures. Further, the complex challenges inherent to climate adaptation require “iterative risk management frameworks” that are currently lacking.

Minnesota is uniquely positioned to accelerate the comprehensive, multidisciplinary research agenda required to create actionable, integrated systems-based solutions. Faculty from several colleges spanning the social and natural sciences have done ground-breaking research on climate change adaptation, highlighting our comparative strength in key disciplines. In embracing this Grand Challenge, Minnesota would be positioned to pursue large multidisciplinary research and training initiatives. This designation would also create momentum for integrated, cross-disciplinary educational opportunities in “key domains,” to build climate adaptation problem-solving/decision-making skills.

MN Global Food Ventures

Lead Submitter: Craig Hedberg, Environmental Health Sciences

Co-Submitters: Trevor Ames, College of Veterinary Medicine; Scott Wells, Veterinary Population Medicine; Linda Valeri, Center for Animal Health and Food Safety; Brian Buhr, College of Food, Agriculture and Natural Resources Sciences; Philip Pardey, Applied Economics; John Finnegan, School of Public Health

Increasing food supplies to meet the needs of global population growth will increase pressure on natural resources that will be compounded by climate change. Resolving global food security challenges is intrinsically a transdisciplinary and multifaceted undertaking. Over its first two years, the MN Global Food Ventures of MnDRIVE funding has leveraged the extensive food and agriculture expertise of University faculty in partnership with global food and commodity companies, public policy, and regulatory agencies to seek economic and environmentally sustainable solutions to these challenges.

MN Global Food Venture is addressing the challenge of global food security through the development of projects targeted towards: a. Improving crop, livestock, and poultry productivity and health while sustaining the natural resource base for agriculture. b. Improving human nutrition, health, and food safety outcomes from agricultural products. c. Enhancing agricultural workforce capacity through training the next generation of food-system professionals.

Sustainability & Equity in a World with Limited Resources

Lead Submitter: Jessica Hellman, Institute on the Environment

How do we provide secure food, water and energy today and for the future? Equitable environmental sustainability. To meet the needs of tomorrow, we must responsibly steward resources today. We propose to bring science and technology in conversation with the public, stakeholders, policymakers, corporations, and landowners. Building economies that meet human needs in an equitable way is an extraordinary grand challenge, one that will require contributions from all disciplines.

This effort will discover solutions that generate benefits for all people given the constraints and opportunities of socio-economic systems that currently govern natural resource use. It emphasizes that natural capital, in farm fields, in cities, and in wild and semi-managed places, is the foundation on which our regional and global economies are built. This capital must be protected and revitalized to generate sustainable returns. Numerous sub-challenges will be pursued, including climate regulation and adaptation through natural and policy means, co-production of food and other environmental services, and delivery of clean water and energy through efficient recycling and renewable technologies.

Sustainability—Systems Approach to Ensuring a Sustainable Global Economy and Society

Lead Submitters: Jason Hill, Bioproducts and Biosystems Engineering; Tim Smith, Bioproducts and Biosystems Engineering; Anu Ramaswami, Bioproducts and Biosystems Engineering, Humphrey School of Public Affairs; Shri Ramaswamy, Bioproducts and Biosystems Engineering

Meeting the needs of the world's growing and increasingly affluent population will make the goal of achieving a more sustainable society all the more challenging in coming decades. Greater global demand for energy, land, water, and other raw materials are forcing us to rethink how we use our resources for the greater good. While these challenges are daunting, they provide us with tremendous opportunities to

improve upon the status quo. To ensure positive environmental, economic, and social outcomes, we must prepare and carry out comprehensive, long-term plans. This requires expertise and broad understanding of sustainability and an in-depth familiarity within a given sector.

The University of Minnesota has the most robust array of faculty expertise around sustainable systems of any institution in the state. We need to be at the forefront of scientific and technological advances meeting social needs. This is in line with our land grant mission.

Biodiversity, Symbioses, and Global Sustainability

Lead Submitter: Karen Hokanson, Managing Director, Stakman-Borlaug Center for Sustainable Plant Health, and Adjunct Assistant Professor, Horticultural Science

Co-Submitters: Jim Bradeen, Plant Pathology; Kathryn Bushley, Plant Biology; Gregg Johnson, Agronomy and Plant Genetics; Peter Kennedy, Biology Teaching & Learning/Ecology, Evolution & Behavior; Jim Kurle, Plant Pathology; Peter Morrell, Agronomy and Plant Genetics; Gary Muehlbauer, Plant Biology/Agronomy and Plant Genetics; Ruth Shaw, Ecology, Evolution, and Behavior; Nathan Springer, Plant Biology; Brian Steffenson, Plant Pathology; Peter Tiffin, Plant Biology

Understanding the diversity of species and leveraging species interactions (symbioses) are the keys to harnessing the complexity of the biological world for enhanced sustainability in agriculture, industry, environmental practices, and human health. Despite its importance and economic value, researchers still lack a comprehensive understanding of the world's biodiversity or the positive, negative, and neutral interactions between species. Such symbiotic interactions have profound, even deterministic effects on how ecosystems function, with direct small- and large-scale impacts on the way we live.

This Grand Challenge theme aligns with interests of diverse University of Minnesota researchers including biologists, agriculture and natural resource scientists, social scientists, economists, legal experts and policy analysts. Utilizing the significant intellectual and infrastructure capacity within the University, there are experts analyzing, documenting, preserving, and leveraging biodiversity and symbiosis. This Grand Challenge theme has the potential to position the University of Minnesota as a global leader in this arena.

Meeting Societal Needs for Food and Renewable Energy in a Water-challenged World, by Sustainable Development of the New Agricultural Bioeconomy

Lead Submitters: Nicholas Jordan, Agronomy and Plant Genetics; David Mulla, Soil, Water, and Climate; David Pitt, Landscape Architecture; Carissa Schively Slotterback, Urban and Regional Planning; Bryan Runck, Geography, Environment and Society; Timothy Smith, Bioproducts and Biosystems Engineering; Donald Wyse, Agronomy and Plant Genetics; Volkan Isler, Computer Science and Engineering

Humans face grave problems related to water supply, due to interactions between climate change and human activities that threaten severe water shortages and catastrophic impacts from flooding and oversupply. Agriculture strongly affects water supply; therefore, humanity must improve agricultural use of water, while also meeting growing needs for food and other products. There is now a major opportunity to do so, because a new agricultural "bioeconomy" is emerging, based on new crops and bioproducts for food, nutrition, health, industrial products and fuels. Felicitously, these new crops (and associated farming methods) can also protect and store water on large scales. Therefore, growth of this bioeconomy could enable an enormous "win-win," in which continental-scale water problems are addressed in concert with sustainable economic development.

Broad concerted action is needed, and the University of Minnesota can catalyze that action through systemic and transdisciplinary approaches that integrate crop development, "big data" technologies, democratic governance, and business development.

Harnessing the Power of Microbes for Creating More Efficient and Sustainable Systems

Lead Submitters: Linda L. Kinkel, Professor, Plant Pathology; Michael Sadowsky, Professor, Biochemistry Institute; Michael Murtaugh, Professor, Veterinary and Biomedical Sciences

Our grand challenge is to capitalize on the vast potential of microbial populations and communities to build better agricultural, environmental, industrial, fermentation, bioremediation, and food production systems. Major advances in molecular, genomic, and ecological science over the past decade have positioned scientists to make major strides in the integration of microbial population management, genomic manipulation, and process optimization into agricultural, environmental, food, industrial, and bioremediation sciences.

Nationally, few institutions possess the aggregate depth and breadth of microbiology research that exists among our faculty. Yet the distribution of microbiology-focused faculty among diverse departments and colleges at the University has posed significant challenges to the creation of an integrated and highly visible program targeting microbial applications. We propose a strong and clearly focused microbiology initiative that will integrate microbiology researchers from across the campus to meet the challenge of effective application of microbial sciences to improve humankind.

Food Data Science and Environment Platform

Lead Submitter: Amy Kircher, Food Protection and Defense Institute

We propose to create a Food Data Science and Environment Platform that allows researchers to harness the power of large and complex data through informatics and analytics to advance production and distribution of food as well as tackle food system challenges to include impact on the environment.

This platform would establish the UMN as a leader in data science as it relates to food and create a unique capability to build a cadre of the world's data scientists, a critical need in industry and governments. The platform will require investment in both faculty and infrastructure (technology and personnel). Students working, within the platform, will benefit from working on real world challenges and have the benefit of interaction with multiple disciplines. The effort will be most successful by leveraging the food industry who are uniquely positioned to engage in this platform through traditional partnerships as well as novel engagements that could include bi-directional sabbaticals, co-PI (private/public) research projects, technology "hacks," and innovation forums.

Spatiotemporal Data, Analysis, Visualization and Thinking: A Cross-Cutting Grand Challenge

Lead Submitter: Steven Manson, Professor; Geography, Environment, and Society

Co-Submitters: Shashi Shekhar, Computer Science and Engineering; Thomas Fisher, Metropolitan Design Center

Most grand challenges are spatial in nature because they involve human communities and natural ecosystems in particular places. Billions of people contribute to the trillion-dollar spatial technology economy by using tools such as Uber, Google Maps, and GPS. This spatial technology is also remaking scholarship, education, and outreach. Thousands of University students and staff combine spatial approaches with data gleaned from maps, satellites, smart phones, sensor networks, and social media. They tackle hundreds of challenges, including helping commuters minimize travel time; farmers plant and protect crops; epidemiologists identify disease hot-spots; planners develop smarter evacuation routes; and policy makers visualize climate change.

The University is a global leader in spatial scholarship. It is poised to broaden and deepen the use of spatial approaches to see connections within and among grand challenges that include advancing human health and well-being; building resilient and equitable communities; and sustainably provisioning food, energy, and water.

How Do We Power the World with Renewable Energy Systems?

Lead Submitter: Ned Mohan, Electrical and Computer Engineering

Co-Submitters: Sairaj Dhople, Electrical and Computer Engineering; Elizabeth Wilson, Humphrey School of Public Affairs

The energy system underpins modern society and links critical food, transportation, health, and water infrastructures across multiple spatiotemporal scales. Driven by the goals of sustainability and resilience, our energy system is rapidly undergoing fundamental transitions in form and function. How we harness and use energy connects new technologies, societal values, policies, institutions, and laws.

This Grand Challenge requires an integrated research agenda to focus on energy-generation innovations embedded within energy markets, policy contexts, and social acceptability. This challenge spans the management of the variability of renewable resources, explores the role of storage and demand, while ensuring economic and social sustainability. It also allows us to develop new educational paradigms to educate the next generation of leaders for the energy sector. We at the University of Minnesota are uniquely positioned to excel in this domain by engaging faculty across campus in engineering, physical sciences, biosciences, policy, law, and economics.

To Sustainably Provide Global Access to Safe Water

Lead Submitter: Paige J. Novak, Professor; Civil, Environmental, and Geo-Engineering

Co-Submitter: William A. Arnold; Civil, Environmental, and Geo-Engineering

By 2025 two-thirds of the world's population will live under conditions of water-stress. As global population and standards of living increase, pressure on energy and elemental resources will also increase. To provide safe drinking water, energy, food, and other resources to humankind while avoiding global conflict, innovation in water technology, water management, and water policy is needed.

The University of Minnesota has the opportunity to lead in this area, with internationally recognized expertise in the critical areas necessary to solve this Grand Challenge. Existing educational resources are present in this area and could easily be augmented and enhanced. Finally, the University is situated in a state that houses *the* global leaders in water technology (Dow, Pentair, GE, Ecolab, 3M). If we mobilize the University's expertise and partner with the extensive capability that exists in the private and public sectors, we *will* play a central role in solving this challenge.

Develop and Operationalize an International AgroInformatics Alliance

Lead Submitter: Philip Pardey, Applied Economics

Co-Submitter: Jim Wilgenbusch, Minnesota Supercomputing Institute

The grand challenge proposed here is to deepen and accelerate the development of a CFANS/MSI-catalyzed International AgroInformatics Alliance that will reimagine the role of informatics to improve agricultural, food and nutritional outcomes worldwide. The emphasis will be on integrating information a) across the "omics" (including genomics, phenomics, flavoromics, and economics), b) across public and private institutions (given an increasing share of the relevant food and agricultural information is now proprietary), and c) across geographical boundaries and different scales of analysis, with particular emphasis on the world's important agricultural producing countries.

The overriding goal is to integrate and deploy the scientific depth and breadth across CFANS, the bioinformatics expertise of the MSI, and strategic international public and private partners to stimulate the development, uptake and stewardship of new technologies and management practices that spur sustainable growth in the supply and accessibility of nutritious food worldwide.

STEM and Economics in One Health: Quality, Quantity, Policy, and Development

Lead Submitter: Andres Perez, Endowed Chair of Global Animal Health and Food Safety

Co-Submitters: Laura Bloomberg, Humphrey School of Public Affairs John Finnegan, School of Public Health; Meredith McQuaid, International Programs; Claudia Neuhauser, University of Minnesota Informatics Institute; Brian Buhr, College of Agricultural, Food and Natural Resource Sciences; Trevor Ames, College of Veterinary Medicine

It is projected that by 2050 the world population will reach the 9 billion mark, with a consequent increase in food demand and peri-urban populations that will impact the health and wealth of individuals and societies. In parallel, the volume and complexity of data available on health-, primary production-, and policy-related issues has grown to levels never seen in history. This rapid increase in the *quantity* of data availability has not necessarily resulted on a consequent ability to improve the *quality* of our information to create *policy*.

We argue that an emerging grand challenge is the ability to apply STEM tools and economics to big data through an interdisciplinary team of agricultural, medical, and social scientists in order to improve the quality of our policy, with the ultimate objective of improving access to food and economic development as a mean to improve health and wealth of local and global communities.

Water Security

Lead Submitter: Jeffrey Peterson, Water Resources Center

Co-Submitter: Faye Sleeper, Water Resources Center

The water security grand challenge is to understand the processes by which water resource conditions are impacted by human and other drivers, as well as to understand how changes in water resource conditions affect human behavior. Water security encompasses the protection of the quality and quantity of water resources through an informed understanding of the interacting factors in human and natural systems.

The University has over 100 faculty members actively teaching and researching water issues in multiple fields of study. Crosscutting units such as the Water Resources Center help bring expertise together and connect university faculty with outside partners. The interdisciplinary Water Resources Sciences graduate program includes faculty and students from the Duluth campus, creating further connections to partners in northern Minnesota. Minnesota's location is a further advantage, as a living laboratory at the headwaters not just of two major river systems but also the Laurentian Great Lakes.

MN Materials: Solving our Global Water, Food, Energy, Environment, and Health Care Demands Through Innovative Research, Education, and Economic Development

Lead Submitter: Theresa M. Reineke, Chemistry

The design and development of high-performance materials is revolutionizing technologies to solve our global grand challenges ranging from energy and the environment to water, food, and human health care. For example, new membranes hold tremendous promise for alternative water purification technology, novel polymers are selectively delivering therapeutics and personalizing medical devices, and biobased plastics are preserving our food longer yet are compostable and sustainable. Moreover, new light-harvesting materials are transforming solar energy conversion, materials with catalytic function are modernizing the way we refine oil for cleaner production and allowing higher power storage in innovative batteries. Indeed, materials innovation is central to solving the critical challenges that we face as a society.

UMN material science researchers have a decades-long history and world-renowned reputation of transformative research, education, and public engagement—funding multidisciplinary collaborative centers, fostering industrial partnerships, and technology translation that will continue to advance grand challenge solutions locally and globally.

Food and the Environment

Submitter: Terry Roe, Applied Economics

Food security, exhaustible resources (including water), and climate change pose major and interrelated challenges. At least one-third of the world's population live in countries either in process or on the verge of rapid economic growth, and another one-third are challenged to feed 20 percent of their populations. Many of the rare earth resources are becoming more scarce, the atmosphere is absorbing more contaminants, and declines in food production in many parts of the world are attributed to climate change.

The University of Minnesota has outstanding strengths in the food, agricultural, and biological sciences. Yet, a forum by which these units might focus on this type of multidisciplinary problem and the bringing of it to the classroom in a coordinated way is lacking.

21st-Century Biotechnologies for Minnesota—Drivers of innovation, Competitiveness, and Sustainability

Lead Submitter: Claudia Schmidt-Dannert Distinguished McKnight Professor, Biochemistry, Molecular Biology and Biophysics

The NRC of the National Academies and Institute of Medicine just released a roadmap to accelerate advanced bio-manufacturing of chemicals, which will drive federal funding of science and engineering in the near and long-term future. Taking advantage of the tremendous advances in biology and synthetic biology, this challenge proposes to position the U as major driver of 21st-century biotechnologies. Interconnected research areas along with interdisciplinary and entrepreneurial training will serve as pathways from discovery to commercialization, and training of our STEM workforce.

The University's breadth of research power spanning disciplines ranging from medicine, life sciences, and engineering to management and agriculture allows the U to distinguish itself from other institutions with strength in synthetic biology (e.g., MIT, UC Berkeley). If combined, these assets have the potential of making the University and state of Minnesota leaders in next generation biotechnologies, paralleling the state's leadership in medical technologies and device manufacturing.

Create Sustainable Solutions to Achieve Healthy Food

Lead Submitter: Tonya C. Schoenfuss, Associate Professor, Food Science and Nutrition

Co-Submitter: Devin G. Peterson, Food Science and Nutrition

A key challenge of the food system today is that advancements in agrosience have focused on yield and disease resistance, not on developing nutritious materials for the production of foodstuffs that people want to eat and are produced by sustainable agro practices. A contextual framework for this challenge is lacking despite intense interest from the global community. Enhancing our current efforts through targeted investments in food chemistry, processing and safety research will strengthen the University of Minnesota's leadership role at a time when food is being globalized at an astonishing pace. Food security is critical to national security and global sustainability.

The University of Minnesota is uniquely positioned as a nexus of food innovation with well-established ties to Fortune 500 food companies. Making food a focus area of the Grand Challenges through a concerted effort in food science will enhance our capacity to create sustainable solutions to achieve healthy food.

Optimizing Food Animal Production Systems for a Better World

Lead Submitter: Gerald Shurson, Professor, Animal Science

Co-Submitters: Chi Chen, Metabolomics, Food Science and Nutrition; Chris Faulk, Functional Genomics, Animal Science; Lee Johnston, Animal Nutrition and Management, WCROC; Yuzhi Li, Animal Behavior and Alternative Production Systems, WCROC; Kota Minegishi, Animal Systems Optimization, Animal Science; Milena Saqui-Salces, Gastrointestinal Physiology, Animal Science; Jennifer Schmitt, NorthStar Initiative for Sustainable Enterprise, UMN IonE; Pedro Urriola, Animal Nutrition, Animal Science

As a vital component of our growing global society, and representing 40% of global agricultural output, food animal production is constantly challenged by evolving needs in food security, food safety, as well as economic, social, and environmental sustainability. Using an integrated systems approach, we identified five major challenges to work on: 1) increasing caloric and nutritional efficiency of food animal production, 2) reducing environmental burden, 3) improving animal health and well-being, 4) improving human health, and 5) facilitating communication among industry, academia, and communities.

Our team is diverse, multidisciplinary, and innovative with extensive collaborations in CFANS, CVM, IonE, and ROCs within the UMN, and has an extensive network of strong relationships and collaborations with food and agriculture academic and industry partners in Minnesota, nationally, and internationally. We are well positioned to be a national and international leader in addressing these challenges through research, extension/outreach, and industrial partnerships.

Sustainable Water Use/TC Development Patterns

Lead Submitter: Richard Strong, Center for Sustainable Building Research

The Grand Challenge: To ensure that the current development patterns in the Twin Cities area do not preclude sustainable water use today and into the future. Water is a limited resource for all life and economic growth. Its future availability is critical for both the citizens and business viability in the Twin Cities. The implications of this challenge are reflected in urban developments throughout the world.

Since the University is located in a state with one of the most abundant water resources and a state motto of “Land of Sky Blue Waters,” addressing this challenge is imperative here, and in other urban areas. Change can only happen with a normative, cognitive, and regulative transformation with regard to our relationship to water in the urban areas. A new intrinsic value of water, acceptability of new approaches to water management and bold and futuristic policies will have to coalesce to create the new water development framework for the Twin Cities. This challenge will engage faculty from Water Resources, Engineering, Policy, Design, and Ecology.

Linking Rural and Urban Futures

Lead Submitter: Dewey Thorbeck, Director, Center for Rural Design

In a time of rapid change this challenge is for the University of Minnesota to become a global leader in linking rural and urban futures. Urbanization worldwide has been accelerating as people move from rural areas to urban areas for economic advancement creating urban development that sprawls into the countryside, eliminating much of the best farmland surrounding cities. By 2050 there may be another 2.5 billion people on the planet. Where will these people live and work and how will the land be shaped to accommodate needs today without compromising future generations’ ability to respond to theirs?

Design and design-thinking is a strong University resource to bring multidisciplinary science, creativity, innovation, and entrepreneurship together to find ways that limited rural and urban land and water resources can be better shaped and utilized to resolve critical issues of climate change, food security, renewable energy, and human, animal, and environmental wellness.

Challenges in Our Pathway to Develop Strategies to Feed the Planet: Sustainability and Animal and Human Health in Highly Intensive Food Production Systems

Lead Submitter: Montse Torremorell, Veterinary Population Medicine

Co-Submitters: Andres Perez, Veterinary Population Medicine; Craig Hedberg, Bruce Alexander, School of Public Health; Larry Jacobson, Kevin Janni, Bioproducts and Biosystems Engineering

Feeding the planet responsibly is one of the most important challenges facing humankind today. Animal production is expected to grow to fulfill the global demand. However, to do so there needs to be a balancing act in resource allocation of competing interests including but not limited to intensification of production, environmental impact, economic sustainability, human and animal health, and welfare of the animals. Thus, as demand for animal protein sources increases, there is an increased recognition of the connectivity of production systems, trade at a global scale, higher impact of the spread of diseases and the reliance on intensification.

The University of Minnesota has experts in animal health, public health, economics, policy and agriculture who understand the complexities of these systems at the national and global levels. Our experts engage with national and international public agencies and organizations such as USDA, NIH, CDC, MDA, MBAH, NSF, WHO, OIE, commodity groups, and private companies.

A Private-Public Partnership to Support Swine Health and Production

Lead Submitter: Montse Torremorell, Veterinary Population Medicine

Co-Submitters: Andres Perez, Bob Morrison, Maria Pieters, Peter Davies, Doug Marthaler, Fabio Vannucci, Albert Rovira, Marie Culhane, Veterinary Population Medicine; Larry Jacobson, Bioproducts and Biosystems Engineering; Peter Raynor, Environmental Health Sciences; Bernard Olson, Mechanical Engineering

Food animal production is a major component of the economy of Minnesota, generating \$6.2 billion annually. Food animal production is a complex system that requires a fully integrated, multidisciplinary approach to solve existing and emerging problems. The challenges facing food animal production are not diminishing, but rather they are intensifying with increasing consumer demands regarding how food is produced, global population expansion, and economic and environmental sustainability.

Because these problems are complex, the only way forward is by having a strong integrated multidisciplinary educational and research program with public-private partnerships where synergies are leveraged and promoted. University of Minnesota researchers have been a major partner and an integral component of our state's food animal industry and researchers in this proposal have a long-standing tradition of collaboration with industry partners in solving problems of considerable impact. Industry partners include but are not limited to swine production companies, pharmaceutical companies, biosecurity companies, and genetic companies.



UNIVERSITY OF MINNESOTA

Driven to DiscoverSM

Office of the Senior Vice President for Academic Affairs and Provost

Dear Faculty, Staff, and Students,

I hope these first weeks of the semester have been pleasant and productive. I know everyone is busy, but I'm writing to encourage you to attend some very important campus conversations scheduled for October.

As you may remember, the Grand Challenges Research Strategies Team, composed of and led by distinguished faculty, solicited ideas for "grand challenge" research priorities this University could fruitfully embrace. The Team received 130 submissions (with 350+ faculty identified as leads or co-leads). It grouped the submissions under some broad themes, and it has now planned campus forums to discuss, integrate, and enrich the ideas suggested by faculty in those submissions.

Five forums are planned, each of which will be structured to focus and develop one of the broad themes identified in the submissions. The goal is to cast prospective grand challenge projects in a clearer light and also to foster connections among researchers who have common interests but who may approach research topics from differing disciplinary perspectives.

The campus forums will include short presentations and table discussions. Those discussions will help the team shape recommendations to President Kaler and me for areas of Grand Challenges research strength where the University is well positioned to stake out a claim.

Another equally important aim of these forums is to stimulate conversations among researchers from across this large and complex university-to connect them-in order to enhance opportunities for those interested in interdisciplinary and integrative research.

Please visit the [Strategic Planning site](#) later this week when we will have posted short summaries of all of the ideas submitted by faculty.

continued

Please join me to contribute your ideas and viewpoints to any or all of the upcoming forums:

How will we ensure just and equitable societies?

Monday, Oct. 12, 10:30 a.m.-12 noon, Rec & Wellness Center, Room MP5

How will we foster human potential and well-being across the life course in a diverse and changing world?

Tuesday, Oct. 13, 10- 11:30 a.m., Rec & Wellness Center, Room MP5

How will we advance human health?

Wednesday, Oct. 14, 8:30-10 a.m., Coffman Memorial Union-Campus Club, West Wing

How will we develop sustainable cities and resilient communities in a world of climate change?

Friday, Oct. 16, 8:30-10 a.m., Coffman Memorial Union-Campus Club, West Wing

How will we provide secure food, water, and energy today and for the future?

Thursday, Oct. 22, 9:30-11 a.m., Coffman Memorial Union, Mississippi Room

One last point: We know that many who might be interested in these forums will have schedule conflicts that preclude attendance. To address that issue, the committee plans to try to capture the key elements of the discussions and to post those on the Strategic Planning website. We will also then have an online form that members of our university community can use to send questions or comments to the committee.

Again, I hope you will attend these campus conversations-and if your schedule precludes attendance, please look for other ways to join the discussion.

Sincerely,

Karen Hanson
Senior Vice President for Academic Affairs and Provost

Appendix I: Overviews of Themes for GC Research Forums, Oct. 2015

Overviews of the five thematic areas for the forums were posted [online](#) in advance. The themes overarched multiple broadly related ideas submitted by faculty through the Call for Ideas.

Grand Challenges Research Forum

Oct. 12, 2015 | 10:30 a.m.–12 noon | URecCtr, Room MP5

How Will We Ensure Just and Equitable Societies?

Multiple GC ideas clustered around themes of inequality, injustice, and concomitant disparities in health, education, economic or social well-being, peace, and human rights at the level of communities and societies. Addressing violence in multiple forms was a salient theme in this cluster, including intergroup conflicts related to ethnic heritage or religion, violence against women or girls, and the “structural violence” of unequal opportunities to survive or thrive related to poverty, discrimination, and other forms of social disadvantage or oppression. Solutions included broad efforts to conduct research that would advance human rights, trustworthy organizations, vibrant communities, peace, as well as specific initiatives to boost access to healthy food in cities, use simulation tools to improve humanitarian relief efforts, reform the penal system, or invest in early childhood to protect brain development.

Proposals underscored the importance of confronting inequities in order to promote a healthy future for local, state, and international well-being. Global inequalities are fueling instability, political conflict, and a rising tide of migration that is threatening the lives and future of people around the world. Closer to home, in the Twin Cities—arguably a generally healthy and wealthy city—the future is jeopardized by serious disparities in health, economic well-being, and achievement related to poverty and adverse living conditions, with many children and families facing homelessness, food insecurity, school failure, unemployment, illnesses, and a bleak outlook for improvement.

Broad strengths of the University were noted for addressing these challenges, including the following: the urban location of two campuses, the tremendous breadth and depth of faculty and students from multiple disciplines whose research focuses on and who are committed to solving problems of equity, and numerous ties of the University to many people and organizations – regional, national, and international—concerned with equity, human rights, and social justice. Specific University strengths related to addressing equity challenges include deep expertise on human rights, health and human development across the lifespan, indigenous and immigrant peoples and cultures, religion, public policy, reconciliation and restorative justice, violence and peace-making, among numerous other fields that were beautifully articulated in the ideas submitted.

There are exciting possibilities for linking and integrating ideas in this forum to build powerful research-practice alliances for high-impact change. Multiple ideas, for example, would align in a comprehensive effort to confront inequalities in contrasting urban and rural areas of Minnesota as models for addressing inequalities. Solutions could include a combination of equitable access to healthcare, food, housing, education and childcare, transportation, and other essentials for building health and resilience in children and families, while also addressing related problems, such as mass incarceration and exposure to traumatic experiences that impair child and family well-being, and human well-being over the life course. Another possibility is a multi-level peace-building effort to reduce violence at all levels of society (domestic violence to political conflict), promoting human

Appendix I, continued

rights, structural justice, and reconciliation, along with safe families, schools, and neighborhoods, building on the notable diversity of Minnesota people and their ways of seeking peace, as well as faculty expertise in human rights, reconciliation, intergroup relations, mindfulness, and many other strategies for preventing violence and promoting peace in societies.

Of course, there are many other ways to integrate the striking ideas brought forward for this forum on themes of equity on the road to formulating Grand Challenges for the University. Moreover, new ideas may emerge from our discussions, such as tying in equity and social justice in managing water or other resources. Discussions from this forum can profoundly shape one or more Grand Challenges on the broad theme of how we will ensure just and equitable societies.

Summary by members of the Provost's Grand Challenges Research Strategies Team, October 2015

For more on the GC Research process, visit strategic-planning.umn.edu

Grand Challenges Research Forum

Oct. 13, 2015 | 10–11:30 a.m. | URecCtr, Room MP5

How Will We Foster Human Potential and Well Being Across the Life Course in a Diverse and Changing World?

This forum is designed to bring together scientists and scholars from a broad array of disciplines to discuss the creation of a complex research challenge area related to fostering human potential and well-being across the life course in a diverse and changing world. This overarching theme encompasses a multitude of submitted ideas that shared a common thread of improving people's lives within a social, cultural, health, technological, and/or structural context.

This theme incorporates wide-ranging ideas from University of Minnesota faculty reflecting perspectives and approaches that can be grouped into several categories: education and educational equity, health and well-being for individuals at particular points and in transitions across the lifespan, community and social relations. These ideas encompass the diversity of circumstances and experiences in human development and experiences, and incorporate varied solutions.

The education and educational equity category includes research ideas on how to address educational and achievement equity gaps across diverse individuals, schools, and communities to developing a better understanding of mathematics and transforming STEM education. Those ideas grouped into the health and well-being category range from the promotion of child and youth development, especially in at-risk children to preparing for an aging society. Those ideas included in the community and social relations category range from understanding and improving societal identities and social conflicts to harnessing data and technology for health, community, and societal benefit. Ideas for creating vibrant research communities, expanding locality and ethical orientations, and conceptualizing diversity create additional opportunities for this grand challenge.

Participants at this forum will dialogue on the definition of this broad research challenge idea with the goal of identifying innovative solutions or approaches to improving human potential and well-being across the life course. Solutions or approaches with the greatest impact on the state of Minnesota and potential for global impact are especially sought. Discussions should include the provision of greater detail on a reframed research challenge concept related to human potential and well-being across the life course that is broadly inclusive of the unique scholarly talents and strengths from across the University and potential community partners.

Summary by members of the Provost's Grand Challenges Research Strategies Team, October 2015

For more on the GC Research process, visit strategic-planning.umn.edu

Grand Challenges Research Forum

Oct. 14, 2015 | 8:30–10 a.m. | CMU/Campus Club, West Wing

How Will We Advance Human Health?

The University of Minnesota has an illustrious history of contributing to improvements in human health and well-being. Today, we possess unique strengths relevant to this challenge, not only in the health sciences, but throughout the University and in our partnerships with government, the private sector, and the nonprofit sector.

Among land grant universities, we possess a rare combination of leading scholars across three core scientific areas: academic medicine, veterinary medicine, and food production and delivery. We have a long and successful tradition of collaboration on medical device development with external organizations located in Minnesota. We have internationally recognized centers for the development of innovative health interventions; outstanding programs in the behavioral and social sciences focused on health risks and health promotion; and vibrant research programs in the humanities and social sciences exploring health in relation to social equity, human dignity, and quality of life.

In response to our Call for Ideas, the Provost's Grand Challenges Research Strategies Team received more than 30 faculty idea submissions focused on advancing human health. Among these submissions, there was a strong consensus that we must not simply adapt to but rather drive and shape the changes that are transforming human health locally and across the globe.

Technological advances are enabling path-breaking approaches to disease prevention and treatment, ranging from nano-based medicine and interventions tailored to individual genomes to innovative models for promoting health and delivering care. At the same time, human health and well-being confront a host of new threats as well as persistent, serious problems of equity in the distribution of health and the organization of care. Interconnections among world populations foster the spread of new infectious agents that must be anticipated. Aging populations strain medical systems as well as the collective infrastructure of social and economic well-being. To respond effectively, we must strengthen our capacities for prevention and treatment; develop more effective ways of promoting physical, mental, and social health; ensure that the benefits of health promotion enhance social equity and human dignity; and develop new training models for health care professionals.

In this research forum, we will discuss key questions raised by faculty submissions, focusing on how to move from these separate and specific ideas to one or more coherent and integrative Grand Challenge Research initiatives to advance human health. The major themes that emerged from idea submissions in this area include:

- Promoting health through food and nutrition initiatives
- Personalizing treatment and prevention, tailoring medically “precise” interventions
- Developing innovative treatments for diseases
- Designing new models for health-related education and training

Appendix I, *continued*

- Investigating and addressing new health risks and emerging challenges
- Strengthening efforts to advance brain health and related neuroscience
- Tackling health challenges related to social diversity, inequality, and inequity
- Preventing and controlling pandemics, outbreaks, new infectious diseases
- Innovating to ensure high levels of care and quality of life for aging populations

Summary by members of the Provost's Grand Challenges Research Strategies Team, October 2015

For more on the GC Research process, visit strategic-planning.umn.edu

Grand Challenges Research Forum

Oct. 16, 2015 | 9:30–11 a.m. | Coffman Union, Mississippi Room

How Will We Develop Sustainable Cities and Resilient Communities in a World of Climate Change?

This question has several parts and requires multidisciplinary expertise. As we review the Grand Challenges ideas submitted by University of Minnesota faculty, we are impressed with the range of fields and subject matter disciplines represented: law, architecture, the landscape and environment, engineering, agronomy and plant genetics, and a host of other subjects and disciplines.

The submitted ideas offered Minnesota as a model for catalyzing growth through low-carbon energy systems, sustaining our physical infrastructures in the face of time and other natural hazards, leading agricultural development in a hotter world, building eco-communities, and being in harmonious relationship with the Mississippi River and its multiple histories. We also learned about groups and organizations that are already formed for stakeholder management—resources now are available within the University—to provide both a theoretical and pragmatic understanding of this Grand Challenge—if we work together.

Review of the Grand Challenge ideas raised the question of resiliency and sustainability in a changing world. What is a resilient community and from whose perspective? *Resilience*, as defined by the Rockefeller Foundation and cited in one submitted idea, is “the capacity of individuals, communities, and systems to survive, adapt, and grow in the face of stress and shocks, and even transform when conditions require it.” The concept of *sustainability*, defined broadly by the World Commission on Environment and Development (United Nations Brundtland report), is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” A resilient community, then, is one that can resonate with ever evolving problems and issues and still flourish—all within the limits of resources of social, economic, and environmental capital.

To be resilient and sustainable, our ecological footprint needs to be relational and include people and processes as well as consideration of environmental impact, both locally and globally. When considering limited resources, a resilient community embraces change, but with a world view. With climate change for example, do we view the phenomenon as evolutionary or disruptive, local or global in its impact? If as stated in another submission, 70 percent of the world population will be living in cities by 2050, we need to remember that cities interface with suburban and rural communities. Innovative ideas are called for that are relational and take into account both local and global perspectives.

Innovative ideas and solutions regarding future products and services require creative responses that are affordable, implementable, and sustainable. The tightly focused submissions for big ideas in this Grand Challenge would benefit from being linked with the multidisciplinary expertise at this University. Stakeholders’ perspectives will be critical as we proceed with implementation of this Grand Challenge—designers, operators, end users, governmental agencies, local and regional policy

Appendix I, *continued*

makers, regulators, faith-based groups, activists, and organizations focused on particular subjects, as well as non-governmental organizations.

Grand Challenges involve bold solutions and multidisciplinary linkages. With our combination of sites and expertise: our location along the Mississippi River corridor as a major land-grant institution with schools of public health, design, law, and public policy, complemented by strong sciences and liberal arts, we, at the University of Minnesota, working together, are positioned to solve this Grand Challenge.

Summary by members of the Provost's Grand Challenges Research Strategies Team, October 2015

For more on the GC Research process, visit strategic-planning.umn.edu

Grand Challenges Research Forum

Oct. 22, 2015 | 9:30–11 a.m. | CMU, Mississippi Room

How Will We Provide Secure Food, Water, and Energy Today and for the Future?

Multiple ideas submitted by University of Minnesota faculty speak to the complex challenges involved in providing secure food, water, and energy to a growing world population while minimizing adverse consequences for people and the environment.

World population has passed seven billion people and is expected to exceed nine billion people by 2050. At the same time the world is becoming wealthier, with global per capita Gross Domestic Product increasing nearly four-fold since 1950. Greater global population and affluence interact to place extraordinary demands on the world's food, water, and energy systems. For example, adequately nourishing everyone on the planet and accommodating a global diet that is richer in meat will require crop production to increase as much as two-fold over present levels by 2050.

Increasing population and affluence are also driving demand for energy: primary energy consumption has increased nearly 25 percent over the past decade, with emerging economies dominating the growth. Demand for water is also increasing, particularly in Asia, where over half of global freshwater withdrawal and nearly three-quarters of freshwater consumption occur. This demand largely supports irrigated agriculture to meet growing needs for food. Increasing water consumption threatens supplies of freshwater from both surface and ground water sources.

The challenges of meeting growing demand for food, water, and energy are compounded by concomitant threats to the environment and human welfare. For example, production of food contributes to climate change and degradation of land, air, and water quality. Food, energy, and water insecurities contribute to social and political conflicts throughout the world. In turn, climate change and its attendant floods, droughts, and heat waves, exacerbate the stresses placed on global food, water, energy, and social-political systems.

Droughts made worse by climate change are causing crop failures and driving depletion of aquifers, threatening long-term food and water security. In other regions, climate change has led to increasing precipitation and extreme rainfall events that are flooding croplands and aggravating the detrimental effects of agriculture on downstream water quality. Food shortages contributed to uprisings across the Middle East and desire for secure energy and water sources has shaped global alliances and conflicts. New technologies, and policies to promote renewable energy, inadvertently have created conflict between food and fuel: grain is being diverted from food to biofuel production, and expanding shale oil and gas production in agricultural regions causes potential conflict between using land and water resources for food versus energy.

Global trade in energy, fertilizer, and agricultural products further threatens the security of energy, food, and water. Movement of animals and crop plants spread pests and diseases. Importation of food hinders control of food-borne illnesses and food adulteration. A rapidly changing landscape

Appendix I, *continued*

in global energy production is altering energy imports and exports, changing world markets, and contributing to global conflict.

Meeting the grand challenges of providing the food, water, and energy to a rising global population and a growing middle class, in ways that minimize harm to humans and the environment, will require integrating expertise across multiple disciplines in new ways as well as innovations in, for example, technology, problem-solving approaches, quantitative tools, policies and institutions, understanding of human values and behavior, and creative harnessing of biodiversity.

Summary by members of the Provost's Grand Challenges Research Strategies Team, October 2015

For more on the GC Research process, visit strategic-planning.umn.edu

Appendix J: Summaries of Five Campus-wide GC Research Forums, Nov. 2015

A series of campus forums in October 2015 brought together faculty, staff, and students to help identify where the University can marshal its research strengths most powerfully to address critical societal challenges.

Forums were organized around broad thematic areas overarching multiple ideas from faculty. The broad themes were **Just and Equitable Societies**; **Human Health**; **Human Potential and Well-Being**; **Sustainable Cities and Resilient Communities**; and **Food, Water, and Energy**.

The purpose of the forums was to cast prospective Grand Challenges in a clearer light and to foster connections among distinct but potentially related disciplinary perspectives. The GC Research Team used the discussions to inform its recommendations to Provost Hanson for a small set of Grand Challenges as well as ongoing strategies to broaden and deepen integrative research opportunities across the University. Following the forums, these summaries, along with a comment form, were posted on the TC Campus [Strategic Plan website](#).

Grand Challenges Research Forum October 12, 2015

How Will We Ensure Just and Equitable Societies?

Introduction

How will we ensure just and equitable societies? The Grand Challenges Research Forum structured around this theme took place Oct. 12, with 130 faculty, staff, and students attending from varied University departments and programs. The [agenda, overview, and discussion questions](#) were posted two days in advance. Five members of the GC Research Team were the primary organizers and “listeners” for this forum: Ann Masten (team lead), Efi Foufoula-Georgiou, Richard Leppert, Fionnuala Ni Aolain, and Karen Seashore.

The following summary synthesizes notes from recorders who were on hand to capture key elements of the discussions. It highlights important points, recurring themes, and potential connections identified through the discussions.

Summary of Discussion

These questions were posed for table discussion.

- In regard to issues of justice and equity, what are the most pressing challenges facing the state of Minnesota? The nation? The globe?
- What are the current strengths and potential of the University to achieve unique and extraordinary impact on these challenges over the next 10 years?
- What will take us there? What gaps must be filled to realize this vision? What new collaborations are vital to this effort? (outside the box, any level)

The discussions were wide-ranging, with some tables focusing more on research ideas related to the overarching theme of ensuring just and equitable societies, while others focused especially on

strategies for the University to transform itself in order to engage more effectively in interdisciplinary collaborations and innovative solutions to Grand Challenges.

There was strong consensus that the broad thematic area of just and equitable societies was one in which the University could draw on many existing research and curricular strengths. The University's large faculty has not only great breadth, but notable depth of expertise and strong networks on issues related to social equity and justice. Additionally, discussions highlighted the exceptional capacity of the University to conduct research, model equality and inclusion, and to leverage its work through collaborations with local and global partners. The University already has many established ties to research, governmental, and nongovernmental organizations relevant to addressing issues of equity and justice at the local, state, national, and international level.

Participants noted that our location brings both special responsibilities and tremendous opportunities, shared by few other institutions, for collaborations with diverse communities to address challenges related to inequality. The location of our flagship campus in a major metropolitan area (with a diverse population of more than 3 million people) is rare for a land-grant public research university, and we have the additional advantage of campuses located in the smaller cities of Duluth and Rochester, as well as in Crookston and Morris.

The Twin Cities and Minnesota are home to richly diverse communities and cultural traditions, including indigenous American Indian cultures, African American communities, refugees from conflicts around the globe, and generations of immigrants. At the same time, participants noted that while Minnesota generally is economically advantaged, healthy, and educated, major disparities (racial, ethnic, cultural, and socioeconomic) leave many behind, impede the vitality of communities, and threaten the state's future.

Participants discussed the responsibility and potential of the University *to lead by example*, making a commitment to embrace diversity and equality of opportunity, showcasing both current and new initiatives. For example, the University could build a model of inclusion, education, and engagement focused on diversity that would create a unique merger of R1 research university strengths with land-grant mission. We could create innovative processes that both address and model equality and diversity. Participants suggested the University has unique opportunities to address critical societal challenges “inwards and outwards” and to partner with communities to foster inclusion and success of diverse residents, including native students and communities, historically disadvantaged groups, recent immigrants, and individuals with disabilities.

Discussions also homed in on the need for the University to align its incentives, cultures, values, and budgets to more readily support collaborative, transdisciplinary research and education. This project of academic transformation, which is reflected in the goals of the Twin Cities campus strategic plan, was identified as “an internal grand challenge.” Reward systems, including promotion and tenure criteria, as well as internal budget practices, currently favor more narrowly focused, short-term, and specialized goals rather than collaborative scholarship, innovation, education, or campus-community collaboration around Grand Challenges.

Participants expressed striking enthusiasm for opportunities to engage in meaningful cross-disciplinary dialogue on Grand Challenges and a larger vision for the University. At the same time, participants acknowledged the challenges inherent in fostering collaboration and inclusiveness. Many participants expressed keen interest in opportunities that would afford time and space for meaningful discussion; facilitate connections with colleagues across the University; and open up opportunities for cross-disciplinary collaborations in research, education, and engagement. Additionally, there was discussion

on ways to ensure an inclusive dialogue that engages community and multi-disciplinary voices from the outset.

Key Areas of Strength

Among the many topics and themes that cluster under the broad umbrella of just and equitable societies, participants identified a number of areas of notable strength.

- **Human Rights**

Table discussions routinely underscored University strengths, commitments, and collaborations related to advancing human rights and dignity. Participants noted the richness of activities already firmly in place on human rights that are interdisciplinary in nature, as well as significant related community strengths and commitments. Identified cross-disciplinary strengths include research and scholarship on reconciliation and restorative justice, civil rights, the penal system, violence towards women and girls, human trafficking, and peace-building.

- **Inclusion and Equity for Voluntary and Involuntary Minorities**

There was considerable discussion of the University's strengths and unique opportunities related to addressing issues of inclusion and equity among individuals and communities facing historical injustices, structural racism, and discrimination in Minnesota and beyond, including Native American Indian indigenous populations, African Americans, Latinos, recent immigrants from around the globe, war refugees, and others. Participants identified numerous collaborative efforts already under way to foster equity, understanding, trust, opportunities, scholarship, and partnerships with diverse racial/ethnic/cultural communities in the Twin Cities region and throughout the state. Addressing these issues also draws on strengths of the University's location, students, faculty, and history.

Participants identified tremendous potential to expand related work for greater impact. Potential areas of focus include the relationship of the state and the University to Indian nations; addressing the challenge of not only welcoming immigrants and refugees (an area in which Minnesota has been a leader), but also ensuring equity and inclusion for newcomers; and challenges of equity and inclusion for people of color and ethnic and cultural minorities who are long-term residents. Work in this area could also leverage and develop a broader range of University capacities—for example, recruiting and hiring to boost the diversity of the University and extend its capacity to address these issues through example and deeper engagement.

- **Equity in Access to Resources for Life**

Many participants noted that a broad focus on resources for life as an equity/disparity issue draws on major University strengths and existing multidisciplinary programs. Existing research strengths in related areas include work across multiple departments addressing challenges related to equitable access to resources, particularly water and food; these issues overlap with issues of human rights, focusing on physical necessities.

Research pertaining to water access, distribution, and usage was especially notable as a recurrent theme across the discussions, linked to issues of wealth inequality, resource management, structural racism, and the disparate impact of climate change, as well as to issues of identity and community that affect community vitality. Other areas of focus in which the University has notable strengths include sustainability of human-environmental systems; housing; food insecurity; and addressing issues of disparate access and impact related to technological advances.

- **Healthy Lives**

Discussions focused on the University's exceptional capacity related to multidisciplinary approaches to health. Minnesota is a leader in research and businesses related to human health and well-being, as well as agriculture and animal life. Participants highlighted unique potential for the University to be a leader in a unified or integrative study of health—the “one health” approach focused on the interdependence of human, plant, and animal life. Integrative approaches highlight the interdependent nature of living systems for understanding and promoting health. This could achieve powerful impact in addressing intersecting variables that lead to disparate health outcomes. Participants also highlighted particular University strengths in addressing issues related to disabilities and the challenges of those with special needs.

- **Children and Youth**

Participants noted the University's research strengths related to the development of children and young people and its particular salience to issues of inequality. Several participants noted that the well-being of children is a powerful barometer for both assessing and intervening in socio-economic and racial disparities, i.e., using the lens of “How are the children—*all* of the children?” Across multiple disciplines and levels of inquiry, the University has both broad and deep expertise in addressing disparities in health, income, justice, education, and achievement. Areas of strength mentioned range from epigenetics and neuroscience to economics and public policy.

Participants also noted many connections with state and local efforts to address inequalities of opportunity (as well as issues of racism and discrimination) that have lifelong consequences for the health, well-being, and human capital of communities and societies. Participants noted that addressing challenges in this area is particularly appropriate for a land-grant research University and also is well-aligned with regional, state, national, and international priorities.

Grand Challenges Research Forum October 13, 2015

How Will We Foster Human Potential and Well-Being Across the Life Course in a Diverse and Changing World?

Introduction

How will we foster human potential and well-being across the life course in a diverse and changing world? The Grand Challenges Research Forum structured around this theme took place Oct. 13, with 100 faculty, staff, and students attending from varied University departments and programs. The [agenda, overview, and discussion questions](#) were posted two days in advance. Five members of the GC Research Team were the primary organizers and “listeners” for this forum: Jean Wyman (team lead), Bruce Blazar, James Bradeen, Deborah John, Phyllis Moen, Gary Muehlbauer, and Steve Ruggles.

The following summary synthesizes notes from recorders who were on hand to capture key elements of the discussions. It highlights important points, recurring themes, and potential connections identified through the discussions.

Summary of Discussion

Forum participants engaged in a wide range of discussions pertaining to the Grand Challenge question. Some groups focused on how to best define a Grand Challenge and what steps would be needed to foster interdisciplinary research to address these challenges, while other groups focused on specific topics that would best meet the criteria for a Grand Challenge.

Although the content of these discussions was quite varied, several themes were discussed across multiple groups at the forum. These themes pertained to how we should define Grand Challenges and what we need to do to address these challenges:

Defining Grand Challenges: Forum participants discussed how we should think about the nature and scope of Grand Challenges. Opinions were expressed that Grand Challenges should have a common objective of “helping people to live better,” but that norms for what is “better” or “successful” may vary across differing cultural/ethnic groups. Several groups recommended that we view the process of defining Grand Challenges using POEM (Problem-Oriented Evaluation that Matters) to identify problems and design research of tangible importance.

Interdisciplinary Focus: A common theme across multiple table discussions was that addressing Grand Challenges would require an interdisciplinary effort, in which we bring together people from different schools/departments, instead of a silo-based approach in which only one school/department would take ownership. Participants noted the need for greater collaboration between departments, especially between STEM/Physical Sciences and the Humanities.

Facilitating Interdisciplinary Research: Several discussions centered on overcoming hurdles to integrating researchers and disciplinary knowledge as needed to address Grand Challenges. We need to establish mechanisms to improve communication between researchers from differing disciplines, provide resources for communication and integration to occur, and think about incentives for making these conversations an ongoing part of our research agendas.

Community Engagement: Table discussions stressed the importance of engaging communities in Grand Challenge research, both to understand the problems in community settings and to leverage our location within a diverse and changing population. We need to look for partners in the community (e.g., organizations, businesses, individuals) and embrace the idea of our communities as an urban laboratory.

Areas of Potential Focus

Forum participants also discussed areas in which the University could productively leverage research strengths for greater impact in enhancing human potential and well-being across the life span. The following are areas of strength and/or potential focus discussed across multiple tables:

- **Children’s Well-Being and Education**

A common theme in discussions was that we can have great impact focusing on children because even small changes can lead to long-lasting outcomes. The challenges of closing the achievement gap among children, and addressing inequities and educational access, were frequently discussed as areas where the University had both significant cross-disciplinary strengths and opportunities for expanded Grand Challenges impact. Participants discussed the importance of K–12 research

collaborations aimed at fostering the full potential of children across diverse communities, including attention to STEM education, healthy lifestyles, and creativity as essential to human potential and well-being.

- **Coping with Change/Diversity**

Across table discussions, participants noted that accelerating societal changes have far-reaching consequences for individual and social well-being. Related issues include technological advances reshaping all aspects of society as well as the increasing urbanization, globalization, and shifting population demographics. The challenges and opportunities of communities reshaped by increasing diversity and by immigration changes were also mentioned. University research collaborations to help individuals and society meet these challenges is crucially important.

- **Life Transitions**

Many discussions focused on the importance of helping people manage pivotal transitions in life (childhood → young adulthood → adulthood → retirement years). Participants noted that helping individuals realize their full potential also is fundamental to broader economic and social well-being, from ensuring an engaged citizenry to building vibrant communities to meeting workforce needs. The discussions noted that societal changes are shaping and reshaping life transitions in significant ways. Related issues include career transitions at a time of great technological change, changing self-identities as people move through the life course, transitions of and among immigrant populations, and the transitions associated with aging and the profound impact of the aging of populations for communities and governments.

- **Inequality/Social Justice**

Participants across the multiple tables talked about reducing inequality as a unifying theme to enhance human potential and promote well-being. Income inequality was most discussed. Specific issues discussed included how inequality affects educational opportunities, social justice, and access in the digital world.

- **Strengthening Communities**

Forum participants discussed topics related to how we can create communities that build on the strengths of diverse populations, engender civic engagement, and benefit from the research expertise of University faculty across our range of disciplines. Several discussions focused on how faculty and students can participate in community education programs.

Interconnected Issues

Table discussions highlighted the complex interrelationships among the variables important to fostering human potential and well-being across the life span.

Issues of life transitions melded with discussions of income inequality and the needs of diverse racial/ethnic/immigrant populations. The challenge of ensuring children's education and well-being interconnects with issues of inequality and achievement gaps. And the multiple challenges posed by rapid social and technological changes intersect fundamentally with education, especially the need to educate children, teens, and college students to be lifelong learners to cope with these changes.

Participants noted that the University has opportunities to integrate a broad range of strengths to address these intersecting issues.

Theme: How Will We Advance Human Health?

Introduction

How will we advance human health? The Grand Challenges research forum structured around this theme took place Oct. 14, with 132 faculty, staff, and students attending from varied University departments and programs. The [agenda, overview, and discussion questions](#) were posted two days in advance. Five members of the GC Research Strategies Team were the primary organizers and “listeners” for this forum: Joe Soss (team lead), Gunda Georg, Matt McGue, Thomas Molitor, and David Pui.

The following summary synthesizes notes from recorders who were on hand to capture key elements of the discussions. It highlights important points, recurring themes, and potential connections identified through the discussions.

Summary of Discussion

Multiple discussions at the health forum raised issues related to aging populations, racial and economic inequities, health care costs, and barriers to accessing to quality health care. Equal attention focused on questions of preventive medicine, especially as they relate to food and nutrition, physical activity, and increases in obesity.

A wide range of participants highlighted the need for innovative approaches to chronic diseases, brain and neuropsychiatric disorders, and other challenges. Across topics, participants emphasized the importance of health innovations that draw on the strengths of multiple disciplines to generate advances in disease treatment and prevention. To have maximum impact, such innovations must also be sustainable, affordable, and accessible to all.

Forum discussions identified health and wellness challenges that span the needs of Minnesota’s urban, rural, and indigenous populations and connect them to communities around the globe (e.g., as they relate to chronic diseases, infectious diseases, and epidemics). Significant advances will require new approaches to education and training (for students, faculty, and health care providers) as well as investments of time and resources needed to understand local differences in cultures, priorities, practices, and languages. Training could also be provided to local community members who could then become more effective bridges between their communities and health care systems.

An overarching goal is to help people before they become patients. Research and knowledge creation can help build a culture of health and contribute to effective behavior changes among individuals. Fostering opportunities for people to participate in health research through “citizen science” and other strategies can lead to active engagement of individuals and a focus on personal health and well-being.

Participants routinely noted the need for University support in reducing barriers to collaboration and fostering opportunities for interdisciplinary research. Suggestions included the creation of a “research without borders” initiative to connect researchers who have similar goals across departments. A suggested platform for collaboration included engagement with partners in the public and private sectors as well as across the breadth of campuses and departments.

Key Points

Discussions among those in attendance placed particular emphasis on the following themes:

- **The importance of a broad conception of health**

On a range of different issues, forum participants stressed the need to avoid overly narrow conceptions of health. “Health” should not be reduced to the absence of disease or to a question of biological functions. The University should seek to advance health broadly—giving equal attention to social and mental health and recognizing their deep interconnections with physical health.

The importance of equity-minded, culturally informed community engagement: Forum participants placed great emphasis on social equity and cultural diversity, both as arenas of health-related challenges and as sources of strengths and opportunities. Locally, nationally, and globally, we must work self-consciously to address stark health disparities and social inequities. To do so, we will need to forge stronger bases for two-way communications, build (and merit) deeper bonds of trust, and give explicit attention to longstanding injustices and questions of power. These efforts will need to draw extensively on University strengths in the humanities and social sciences.

- **The importance of education, training, and workforce development**

Health-related priorities need to have a significant educational component. Challenges related to aging populations provide just one example: Successful responses will require both expansion and change in workforce development, guided by shifting needs for health care provision and for the remaking of physical and social environments. More broadly, we should prioritize forward-looking education and training models that can shift course to meet the needs of a changing future.

- **The importance of proactive innovation**

Forward-looking innovation must be prioritized and may require a fundamental paradigm shift in health-related research and education. The University should aim to get out ahead of looming challenges and reduce the need for “reactive problem-solving” at later stages. Key examples here included caring for aging populations, preventing the emergences and spread of infectious diseases, pharmaceutical innovations, and reconfiguring health care for rural populations.

- **The importance of collaboration**

To raise the impact of its health-related strengths, the University should intentionally engage external partners. Forum participants made specific mention of partners in the broader health care community, device manufacturers, health care delivery specialists, community organizations, food-related private industries (e.g., Land O’Lakes, Cargill, and General Mills), nonprofit health organizations (e.g., Mayo Clinic), and state and federal organizations (e.g., Minnesota Department of Health and the Center for Disease Control).

- **The importance of ethics and earning public trust**

Questions of ethics and trust loomed large in a number of forum discussions, with some suggesting they should be a focus of research in their own right. The University should work deliberately to move “research involving human beings in the direction of being more ethical, more responsive, [and] more engaged.” In making such comments, participants stressed, on one side, the need to meet a variety of ethical and moral obligations and, on the other side, the potential for even the best-designed health initiatives to be undermined by public distrust and alienation. Health

advancements should be seen as “co-produced” with publics, and these publics must be given good reasons to believe they are working with ethical and trustworthy partners.

Grand Challenges Research Forum October 16, 2015

Theme: How Will We Develop Sustainable Cities and Resilient Communities in a World of Climate Change?

Introduction

How will we develop sustainable cities and resilient communities in a world of climate change? The Grand Challenges Research forum structured around this theme took place Oct. 16, with 118 faculty, staff, and students attending from varied University departments and programs. The [agenda, overview, and discussion questions](#) were posted two days in advance. Five members of the GC Research Strategies Team were the primary organizers and “listeners” for this forum: Marilyn DeLong (team lead), Sonja Kuflinec, Abel Ponce de Leon, Donald Simone, and Ann Waltner.

The following summary synthesizes notes from recorders who were on hand to capture key elements of the discussions. It highlights important points, recurring themes, and potential connections identified through the discussions.

Summary of Discussion

Although all discussion points cannot be captured in this brief summary, the following themes were raised at multiple tables:

Climate change will have notable effects on existing infrastructure. Existing and aging infrastructure will not bear up under increasing temperatures, drought, rains, and flooding. Research is needed to support ways to adapt to changing environments and develop strategies to mitigate risk and threats. New “green” infrastructure and buildings will reduce energy needs and help ensure that populations are prepared to face some of the outcomes of climate change. New technologies must be assessed to determine whether they are solutions or only temporary fixes. Economic research is needed to assess future adaptation costs. Adaptation and new infrastructure could lead to economic development.

Climate change is an umbrella challenge that can be a way to address food production, energy, air, water, land, and biodiversity issues. Cities will face the need to provide citizens with adequate food, clean water, and energy. Addressing energy needs, for example, necessitates research on transportation and infrastructure, as well as energy specifically. The impacts of climate change also include equity, human and ecological health, and immigration. Further studies of the interactions of humans on the landscape are needed, including rural areas as well as metropolitan areas.

Climate change will generate varying effects on communities, and may be most challenging to resource-poor and/or underrepresented communities. Research addressing social justice and equity must be included in approaches to solutions. Who are the most vulnerable, and how can research collaborators address inequities? It is difficult to be concerned about sustainability when the main challenges for families are food, clothing, and shelter. Limited resources can cause social fractures,

tension, and competition. There is a need for research on economic implications of climate change and related issues, and how solutions can provide benefit to all.

Solutions to sustainability will advance through research on human behavior and on policy.

Innovation in science and technology will continue to occur but are insufficient to address issues of sustainability—environmental, economic, and social. The involvement of citizens and organizations in the public and private sectors will be essential to reaching solutions. Citizens may not be well informed about how issues of sustainability—climate change, limited resources (water, quality soils for food production, forests, and others), needs for fuel, transportation—affect human health, maintaining a livelihood, and overall quality of life.

Creative endeavors in the arts and humanities may more effectively communicate information about sustainability to the public and focus individuals and groups on needed action. Research could also support the development of new systems and infrastructure that might influence citizen behaviors.

A cultural shift that emphasizes the value of sustainability includes a change in behaviors and perspectives, from: (1) anti-intellectual doubt to conviction, (2) apathy to urgency; (3) perceptions of “free” resources to limited resources; and (4) the time line of years to centuries. While human behavior must be addressed, it will be useful to reframe climate impacts in terms that are ecological and not just anthropocentric. This could mean a shift in thinking around relationship to resources as “property” or a relationship to land in terms of what is “extractable,” towards more eco-systemic thinking about place.

Cities provide ways to model sustainability, with approaches that could be scaled up to states, larger regions, and nations. Issues of fossil fuel emissions, pollution, food distribution systems, waste management, and others intensify with the population densities found in the world’s cities. Research collaborations with “sister cities,” possibly through relationships with other higher education institutions across the United State and in other countries, could result in comparative data and best practices to address sustainability goals.

The University of Minnesota campus itself is a “city” on the banks of the Mississippi River that could be used to model best practices, including the river ecosystem. Research in design and land use planning can make key contributions. Different scales, including physical, governance, and time, represent different problems. At what scale will interventions in cities be most effective? Adaptation and the strategies for addressing future sustainability challenges will vary by location, the physical environment, resources, and political will.

Additional Key Points

In addition, the structure of the University was a key area of discussion. To advance work on Grand Challenges, interdisciplinary communications to leverage achievable goals must be incentivized. Involvement in creative problem solving using the process of design thinking could be a means for thinking outside the box.

Engaging in the faculty-based Grand Challenges Research process to identify key ideas and potential Grand Challenges was considered a positive step toward campus engagement. Forum participants noted the need to create a mechanism to continue to convene faculty, students, and staff for interdisciplinary discussions and the intersections of research, teaching, and outreach. University connections poised to solve this problem are many and diverse—including library resources for collecting data; centers already working on the issues related to cities, sustainability and climate change from a focused perspective; and disciplinary units within the university. To move forward will

require continued discussion by the diverse community we find at the University so that intersections can be created to insure a holistic view of the issue.

In addition, the importance of community engagement was routinely highlighted by participants. Engagement with community stakeholders, identified broadly, was considered essential to the solution. But individual shareholders were also considered important in directing the effort. Both stakeholders and shareholders need to be brought to bear on this issue.

To summarize, as a large, urban, land grant university with a mission that includes research, teaching, and outreach, the University of Minnesota is well positioned to address the question “How will we develop sustainable cities and resilient communities in a world of climate change?” Examples of intersections that could be made included providing a sustainability core curriculum. Students would receive training in sustainable best practices that grow out of the research, with a learning process focused on out-of-the-box thinking to solve problems and engage the citizens of Minnesota and stakeholders in the process. Then research can transcend solutions that are ivory tower in scope to a broad base that includes all three prongs of the land grant mission.

We must continue to find ways to engage the University community in an integrative approach to solving the problem—offering incentives for crossdisciplinary engagement in projects that involve faculty, staff and students from centers and disciplinary units.

Contributions of social sciences and the arts in this collaboration may be more critical than technological solutions. Current research funding is focused on solving narrow issues rather than viewing a broader problem from a big picture perspective. If disciplines collaborated and pooled funding, the challenges of cities, sustainability, resiliency, and climate change could be viewed more holistically.

Grand Challenges Research Forum October 22, 2015

Theme: How Will We Provide Secure Food, Water, and Energy Today and for the Future?

Introduction

How will we provide secure food, water, and energy today and for the future? The Grand Challenges Research forum structured around this theme took place Oct. 22, with 139 faculty, staff, and students attending from varied University departments and programs. The [agenda, overview, and discussion questions](#) were posted two days in advance. Five members of the GC Research Strategies Team were the primary organizers and “listeners” for this forum: Sarah Hobbie (team lead), Tom Clayton, Marc Hillmyer, Apostolos Georgopoulos, and Peter Reich.

The following summary synthesizes notes from recorders who were on hand to capture key elements of the discussions. It highlights important points, recurring themes, and potential connections identified by the discussions.

Summary of Discussion

A growing global population with increasing affluence is placing extraordinary demands on the world's food, water, and energy systems. For example, adequately nourishing everyone on the planet and accommodating a global diet that is richer in meat will require crop production to increase as much as two-fold over present levels by 2050. Primary energy consumption has increased nearly 25 percent over the past decade, with emerging economies dominating the growth. Demand for water is also increasing, largely driven by increases in irrigated agriculture in Asia, and threatening supplies of freshwater from both surface and ground water sources.

The challenges of meeting growing demand for food, water, and energy are compounded by and contribute to climate change and degradation of land, air, and water quality and to social and political conflicts throughout the world.

The table discussions at the Food, Water, and Energy Forum were energetic, collegial, and highly engaged. There was clear consensus that achieving sustainability related to food, water, and energy is critical for the state, the nation, and the world. However, these are serious problems, and finding solutions will require new models of interdisciplinary collaboration, creative approaches and tools, and partnerships with those from outside of academia. Tackling these challenges is essential, given their disproportionate impact on the world's most vulnerable populations.

Key Points

Solving grand challenges will require understanding and overcoming the barriers to interdisciplinary collaboration and innovation. This need was articulated repeatedly at forum tables: many attendees recognized that the University of Minnesota can only make progress addressing grand challenges if such barriers (“silos”) are broken down; indeed, increasing innovation and interdisciplinary collaboration is a grand challenge in itself.

Solutions to grand challenges need to be framed within specific cultural, historical, and political contexts and should be socially just: they should benefit all members of society, including those who are economically, politically, or socially disadvantaged. These members of society are disproportionately burdened by lack of access to adequate and nutritious food and clean water and by threats associated with climate change. Thus, when the University of Minnesota asks the question of how we will provide secure food, water, and energy now and in the future, it should also be asking “for whom?”

The University of Minnesota is particularly well positioned to address the interconnections between food and water, but should explore such connections at multiple scales, from local to national and global.

Solving grand challenges related to food, water, and energy will require a systems approach that considers the interconnections between them. Given the complexity and multitude of issues at hand (e.g., technological, institutional, behavioral) and the placement of actors in a variety of decision-making contexts (e.g., industry, academia, government, citizenry), a systems approach is necessary.

The University of Minnesota should model the sustainable use of secure food, water, and energy on campus and in the state. For example, the University should reduce its own consumption, by

increasing efficiencies, promoting public transportation, increasing its use of renewable energy, and promoting sustainable water use.

The University of Minnesota's grand challenges should be integrated into classroom learning. Students need to begin thinking about grand challenges early in their education and training, to prepare them to be the future teachers, researchers, and citizens that find solutions to these challenges.

Understanding the psychology of how to effect human behavioral change, especially related to consumption patterns, will be necessary to address grand challenges related to securing food, water, and energy. Changes in attitudes and behavior will be just as important as technological advances in addressing grand challenges.

Solving grand challenges related to food, water, and energy will require moving beyond the generation of knowledge to the translation of that knowledge into action. This will require identifying applications for research and translating them to potential users so that they are implemented. Partnerships are needed among the University and, for example, practitioners, designers, business and industry leaders, civic groups, resource managers, policy makers, and citizens.

Solving grand challenges related to securing food, water, and energy will require addressing climate change, unsustainable growth of population and affluence, and lack of access to education for many people in the world. Climate change will be a challenge to almost all aspects of sustainability, and will likely result in major disruptions of human societies, including to food and water systems. Achieving sustainability in a world with a growing and more affluent population will require decoupling economic growth from carbon emissions and producing more food without harming the environment.



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Dear Colleagues,

Many of you participated in the series of recent Grand Challenges Research Forums to help shape core components of the University's scholarly future. In all, the five forums drew about 600 faculty, staff, and students to discuss our wide-ranging research strengths. The discussions brought into sharper focus the **130 ideas submitted by faculty during our Call for Ideas process**--and potential opportunities to integrate and expand the impact of work to address critical societal challenges.

Recorders captured key elements of these invigorating conversations. We have **posted summary notes online**, alongside the overviews and discussion questions posted in advance of each forum. The notes capture ideas and insights across multiple table discussions. For those who were unable to make it to one or more of the forums, we hope the trove of online information (along with a **comment form**) will provide a way to join the continuing conversation.

Your ideas and perspectives continue to be important to the work of the **Provost's Grand Challenges Research Strategies Team**. Over the next few weeks, this team of 30 senior faculty will carefully review all that we have learned from the forums, the submitted Grand Challenge ideas, and additional consultations.

In mid-December, we will provide recommendations to Provost Hanson for a small number of Grand Challenges that exemplify the eight criteria in the **Twin Cities Campus Strategic Plan**. Provost Hanson has also asked our team to identify strategies to continue to expand interdisciplinary research connections and opportunities across the University.

Thank you for engaging with this campus-wide process that is so important to the future of our University.

Sincerely, Raymond Duvall, chair
Provost's Grand Challenges Research Strategies Team

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