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 will be the basis for five campus forums in October 2015 that are 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. (You can also view an online directory [here](https://strategic-planning.umn.edu)) 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.

More about the GC Research process and the campus forums: [strategic-planning.umn.edu](https://strategic-planning.umn.edu)

---

How will we ensure just and equitable societies?
Forum: Oct. 12 | 10:30 a.m.– 12 noon | Recreation & Wellness Center, Room MP5

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

LeadSubmitter: Elizabeth Heger Boyle, Professor, Sociology
Co-Submitters: Barbara Frey, Global Studies; Lisa Hilbink, Political Science; Joachim Savelisberg, 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

LeadSubmitter: 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

LeadSubmitter: 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

LeadSubmitter: 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. Hether, 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 Ahearn-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, 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; Katherine 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 neomaniacal 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?**

Forum: Oct. 13 | 10:00 a.m.–11:30 a.m. | Rec & Wellness Ctr. Room MP5

**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 Wellbeing 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 wellbeing 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 Hančer, 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 McGeever, 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 healthcare 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 healthcare 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**
LeadSubmitter: 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**
LeadSubmitter: 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**
LeadSubmitter: 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 minorizes 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 smartphones; 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?
Forum: Oct. 14 | 8:30 a.m.–10:00 a.m. | Coffman Memorial Union, Campus Club, West Wing

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 Wellbeing**

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 Wellbeing 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 (>>106) 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
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 support 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**
LeadSubmitter: 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 healthcare 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 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**
LeadSubmitter: 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**
LeadSubmitter: 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 indigenousness.

**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 healthcare 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: Efie 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 Foege, 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 healthcare, 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 University 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 healthcare 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.
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?**
Forum: Oct. 16 | 8:30 a.m.–10:00 a.m. | Coffman Memorial Union/Campus Club, West Wing

**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 is 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


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
LeadSubmitter: 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
LeadSubmitter: 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
LeadSubmitter: 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
LeadSubmitter: 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
LeadSubmitter: 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 wellbeing 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.

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 (PM2.5) 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
LeadSubmitter: 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
LeadSubmitter: 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?
Forum: Oct. 22 | 9:30 a.m.–11:00 a.m. | Coffman Memorial Union, Mississippi Room

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 Mogilevsksaya, 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 in 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, Agricultural 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 multi-faceted 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 on 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 UMN 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, Biotechnology 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.

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 healthcare. 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 agroscience 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


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.