Transforming the University

Recommendations of the Task Force on Research Infrastructure

Submitted on behalf of the Task Force by:

Steve Campbell
Marc Jenkins
Co-Chairs of the Task Force

Date: May 5, 2006

I. Executive Summary

Mission:

Develop a plan to insure that the University's research infrastructure is capable of supporting research and scholarship consistent with realization of the University's goal of becoming one of the top three public research universities in the world.

Deliverables:

- Identification of emerging opportunities anticipated across the research spectrum: which ones are we currently positioned for; which ones represent opportunities where Minnesota can become a world leader; which ones should we develop, with what priority and in what timeframe?
- Recommendations regarding the infrastructure needs required to capitalize on major research opportunities (existing and emerging), including a gap analysis to identify what is needed to meet the short-term and long-term infrastructure to support research.
- Recommendations regarding how to assess the research infrastructure growth needs required to insure future competitiveness within areas of current strength and for areas of emerging importance. How should future infrastructure needs be identified, evaluated, prioritized, and financed?
- Recommendations regarding a plan for supporting (establishing, maintaining, upgrading) the University's research infrastructure.
- Assessment of the adequacy of the current configuration (administrative, location, organization, financing) of critical research support infrastructure.
- Recommendations regarding the relative advantages and disadvantages of centralized research facilities versus smaller, distributed facilities.
- Recommendations regarding current space or building challenges from a research infrastructure perspective.
- Recommendations regarding commercialization of research and intellectual property issues.
- Recommendations derived from an analysis of the practices of our peers and aspirational peers with regard to seeding, supporting, and sustaining a robust research infrastructure.

Task Force Members

Stephen Campbell	Co chair, Department of Electrical and Computer Engineering
Marc Jenkins	Co chair, Department of Microbiology
Mike Autry	Department of Biochemistry, Molecular Biology and Biophysics
Steve Colman	UMD Large Lakes Observatory
Christopher Cramer	Department of Chemistry
Paul Crowell	School of Physics and Astronomy
John Freeman	Department of Political Science

William Iacono	Department of Psychology
Diane Katsiaficas	Department of Art
David Largaespada	Department of Genetics, Cell Biology and Development
Wendy Lougee	University Library
Michael Murtaugh	Department of Veterinary and Biomedical Sciences
Elizabeth Seaquist	Department of Medicine

In order to fulfill their charge, the Research Infrastructure Task Force (RITF) felt that a workable definition of "Research Infrastructure" must be sufficiently broad as to encompass the support needed for all scholarly activity not directly related to teaching, throughout the University. The RITF therefore adopted this definition of infrastructure:

> ***"The facilities (e.g., laboratories, studios, clinics) and services (e.g., libraries, computing services, grants management systems, research safety and subject protection organizations, and secretarial services) needed to produce novel and influential scholarly output (e.g., publications, exhibits, performances)."***

The RITF found that the University's research structure is designed around, and is most suited for, the traditional single PI project. Faculty are housed in departments contained within schools, colleges, or institutes, forming a "silo in a silo" structure. Major new research opportunities that are now on the horizon require the formation of not only cross departmental, but cross collegiate research teams. Current U of M policy of assigning research space by college is therefore not conducive to bringing together cross collegiate research teams in contiguous space. The RITF recommends that an All University Research Space Oversight Group be formed to provide input on the planning and occupation of new buildings to ensure that decisions are based on scientific synergy rather than political expedience. The immediacy of the need for this function cannot be overstated as the AHC Precinct Plan, which provides a golden opportunity for furthering the University's overarching goals of cross-collegiate collaborative research and "big science", is already before the legislature.

Consistent with the growth of large, highly interdisciplinary teams, is the need for the growth of a research infrastructure that goes far beyond the capabilities of a single faculty member, or a department, or even a college to support. A number of small group labs have sprung up and through a process of natural selection some of these have grown into moderately sized Internal Service Organizations (ISOs) that bring in private sector support for fee-for-service work to help underwrite the research enterprise. These labs represent an extremely cost effective way to provide state of the art capabilities and will be critical to the success of the research mission over the next few decades. Yet, a strict reliance on user fees often leads to a death spiral of aging equipment, increasing fees, and decreasing usage. In addition, the association of ISOs with single colleges has led to duplication of services as well as a lack of visibility. The RITF recommends that an All University Research Core Facility Oversight Group be formed to evaluate current ISOs, identify the most important of these for designation as centrally-supported core facilities, and then oversee their performance. A modest baseline of support needs to be provided to all designated core labs and mechanisms for equipment acquisition need to be

developed. One of the most fundamental of the core facilities is the library. Library support for electronic materials access, in particular, must be improved.

The Office of the Vice President for Research at the University is relatively small and has only modest impact on nucleating and fostering research in emerging areas. Given the University's aspirational research goal, the position of the VPR should be elevated to a senior management role, in order to have a direct influence on research decisions and priorities across all schools and colleges. Not having this level of involvement fragments the research effort exactly when cross collegiate work is needed, dilutes the ability of schools to make important and sometimes painful research decisions, and suggests a reduced emphasis on research compared to other large state universities. The OVPR currently has no stake in ISOs, which are funded through the colleges (if they are funded at all). No cross collegiate coordination of research ISOs is attempted. The RITF recommends that the All University Research Core Facility Oversight Group and All University Research Space Oversight Group function under the auspices of the OVPR.

The committee identified five major areas in which it felt that there is both the likelihood of strong external support and a strong competency within the University. These are Nanotechnology; Infectious Disease and Cancer; Neuroscience, Cognition, and Behavior; Climatology, Ecology, and Renewable Energy; and Cyber-infrastructure. Urgent infrastructure needs include flexible space and facilities for nanotechnology, and Biosafety Level 3 (BSL-3) labs appropriate to all University researchers working in infectious disease. The RITF developed a methodology that can provide a reasonably objective assessment procedure for University strengths and funding opportunities. The RITF recommends that this methodology can and should be repeated and the process refined to provide the basis for the senior University leadership team to make informed decisions on research directions.

The Arts and Humanities are not included in the Essential Science Indicators, a primary metric used by the RITF to evaluate University strengths, and large funding initiatives in these areas were difficult for the RITF to identify. Furthermore, in their meeting with the RITF, the faculty representatives from these areas did not suggest any "big research" opportunities. The committee response to charges one and two therefore do not include the Arts and Humanities. The RITF recommends that a separate study be conducted to recommend "big and emerging research" opportunities in these areas. Arts and humanities concerns, however, are reflected in the other deliverable responses.

This report contains many specific recommendations that would improve operations and efficiencies within the U of M research infrastructure system. In order to achieve the University's stated goal of becoming one of the top three public research universities, however, it is clear that major capital investments will be necessary, particularly in the five research areas that this report highlights. Minor new investments and gains achieved by reorganization and increases in efficiency will not be sufficient. Central administration, through its respective Foundations, must improve its solicitation of financial support for major research infrastructure projects from Minnesota-based companies, who are the primary beneficiaries of U of M research both directly, such as

with the Cargill Building for Microbial and Plant Genomics, and indirectly through graduate and professional training.

II. Introduction

The Research Infrastructure Task Force (RITF) felt that a workable definition of "Research Infrastructure" must be sufficiently broad as to encompass the support needed for all scholarly activity not directly related to teaching, throughout the University. It therefore adopted the following definition of infrastructure:

> ***"The facilities (e.g., laboratories, studios, clinics) and services (e.g., libraries, computing services, grants management systems, research safety and subject protection organizations, and secretarial services) needed to produce novel and influential scholarly output (e.g., publications, exhibits, performances)."***

In addition to regularly scheduled task force meetings, 14 informational meetings with faculty representatives and other administrative staff from across the institution were held to gather data the task force could use to formulate responses to address their charge. Each meeting brought together 5 to 10 representatives to discuss the University's research infrastructure. It is worth emphasizing that faculty interviewed by the committee were largely those suggested by the deans of their schools and were therefore generally considered by their college to be knowledgeable representatives about research interests. The information gained in these meetings and subsequent discussions by the task force form the basis for the recommendations found in this report.

III – Deliverables

1. Identification of emerging "big research" opportunities anticipated across the research spectrum: which ones are we currently positioned for; which ones represent opportunities where Minnesota can become a world leader; which ones should we develop, with what priority and in what timeframe?

The Research Infrastructure Task Force (RITF) used the following process to address these questions. Big research opportunities were defined as major new funding initiatives. A guiding assumption was that the U of M is well-positioned to take advantage of an initiative if we have strong faculty in the relevant area. Faculty strength was assessed objectively using the Essential Science Indicators tool from the Institute for Scientific Information. This tool ranks programs in 22 different disciplines based on the citation records of the publications of individuals within those disciplines. The U of M rankings are shown in Appendix A. The programs are ranked based on total citations, which are heavily influenced by the number of individuals in a program, and citations per paper, which is a per capita measure. Because the Arts and Humanities are not included in the 22 disciplines ranked by Essential Science Indicators, and because funding initiatives in these areas were difficult for the RITF to identify, the Arts and Humanities were not covered in this deliverable. Thus, the RITF recommends that a separate study be done to recommend emerging opportunities in the Arts and Humanities. The RITF identified 5 areas where U of M strength and external funding opportunities are particularly well matched. Links to funding opportunities in these areas are listed in the Appendix B.

In selecting these areas, the committee recognized that there is an inherent trade-off between faculty consensus that an area is "big science" with concomitant funding potential, and the opportunity to leap over other schools by selecting a major new area that is not yet widely recognized. A successful implementation of the latter would be highly desirable, but carries the risk not only of identifying an area with highly transient support, but also of alienating existing faculty. In its selection process therefore, the committee stressed focus areas that have recently been identified as "big science" by funding agencies and are likely to be strong areas of funding for many years to come. A possible exception is Climatology, Ecology, and Renewable Energy, where funding is not increasing rapidly yet, but the committee believes that it has a good chance of strong funding growth over the next few decades.

Nanotechnology

Major opportunities exist in the science and applications of nanotechnology. The Institute of Technology is recognized as a leader in nanotechnology, principally through its expertise in nano structured materials. Interdisciplinary research has played a key role in programs such as its highly successful Materials Research in Science and Engineering Center, and is expected to be vital to continued success in this field. Strong central nano-related research facilities such as the Nanofabrication Center and the Characterization Facility have allowed these research efforts to thrive. The funding opportunities in these areas from National Science Foundation (NSF), Department of Energy (DOE), Environmental Protection Agency (EPA), and Department of Defense (DOD), particularly in device and system applications of nanotechnology are very strong, ranking second only to cancer research in current federal appropriations. One of the greatest new opportunities for nanotechnology lies at the intersection of physical and biomedical research, the field of nanomedicine. NIH has begun to invest heavily in this area. Great potential exists to build teams consisting of nanotechnologists, material scientists and biologists. Minnesota has a key advantage in this area due to the physical proximity of physical and biomedical researchers and facilities. Collaboration with the Mayo Clinic further strengthens our ability to compete effectively for large Nanomedicine centers. Related to this area of nanomedicine is the area of medical devices. This again represents a close collaboration of medical researchers and engineers, although generally on larger length scale devices and systems. The field is particularly important at Minnesota due to the concentration of medical device manufacturers in the twin cities area. Collegiate barriers to interdisciplinary research and lack of new research space were identified as the major hurdles to the U of M taking advantage of its strengths in these areas.

Infectious Disease and Cancer

Infectious disease and cancer are major areas of funding by the NIH. The NIH will undoubtedly continue to invest in research on HIV, influenza virus, Mycobacterium tuberculosis, and microbes that can be used as weapons, given the public concern about these infections. The recent focus of the Bill and Melinda Gates Foundation, the world's largest charitable organization, on global infectious disease will provide additional

opportunities. The U of M has strengths in the areas of microbial pathogenesis and public health/epidemiology of infectious disease.

Major opportunities also exist in the area of cancer and oncology. The National Cancer Institute (NCI), the largest institute within the NIH, and many major private organizations support cancer research. Local strength in cancer research is focused around the NCI-funded University of Minnesota Cancer Center (UMCC). Within the UMCC, we have a small but strong program in vertebrate DNA transposable elements and a well-established and internationally-recognized program in hematology, oncology and bone marrow transplantation. These programs consist of the type of interdisciplinary teams outlined in the NIH Roadmap, and often involve clinical research that brings in large grants. Another area of strength in the UMCC is the strong central research facilities that are housed there, such as Flow Cytometry, the Mouse Genetics Laboratory, the Tissue Procurement Facility, and the Histopathology Laboratory. These facilities benefit many other areas of biomedical research on campus.

Infectious disease and cancer research both involve immunology. We currently have a strong basic immunology group in the Center for Immunology housed in Nils Hasselmo Hall. Several weaknesses currently limit our ability to take advantage of opportunities in infectious disease and cancer research. Our strong infectious disease researchers are scattered throughout the University and are not unified with the immunologists. Core facilities that support work in these areas are needed. For example, the University currently lacks a Biosafety Level 3 (BSL-3) facility, which is essential for research on dangerous pathogens, and the Biomedical Image Processing Laboratory and the Mouse Genetics Laboratory are under supported and in danger of not being able to provide state of the art services needed for infectious disease, immunology, and cancer research. In addition, although we have pockets of strength, the overall low per capita citation record of our basic scientists in these areas (Appendix A) suggests that the U of M may not be fully competitive for funding opportunities.

<u>Neuroscience, Cognition, and Behavior</u>

The Psychology Department and Institute for Child Development have consistently been ranked among the world's best. Taken together with strengths in Psychiatry, Public Health, Neuroscience, and the Social Sciences (Appendix A), the U of M is well positioned to take advantage of national funding emphases on brain-behavior relationships that have the potential to better human health. The genetic basis of behavior, especially maladaptive behavior (e.g., substance abuse, obesity, antisociality, severe mental illness, and neurodegenerative diseases) and functional brain imaging figure prominently in this endeavor. The U of M has world class facilities in molecular genetics and imaging through the Genomics Center and Center for Magnetic Resonance Research (CMRR). Funding from NIH agencies will be available for interdisciplinary teams that bring together researchers in behavioral/social sciences and quantitative sciences. This emphasis together with an NSF initiative in the Perception, Action and Cognition Program provides a good opportunity for us to capitalize on strengths in Psychology, Political Psychology, Sociology**,** Neuroscience, and Economics in the area of the

neurobiology of decision-making. Again, the challenge will be to bring together key investigators from multiple colleges and produce an environment in which they can work together effectively.

Climatology, Ecology, and Renewable Energy

Environment/Ecology research is very strong at the U of M (Appendix A). In particular, U of M research on climate change is very strong, both as a discipline (climatology) and as a part of a wide range of related disciplines. Major research activities are underway at the U of M in fields such as Ecology and Evolution, Biodiversity, Water Resources, and Earth Surface Processes, many of which are related to the effects of climate change on biological and aquatic systems. Additional efforts are underway to better forecast future climate changes using numerical models and to reconstruct past climate changes and their consequences. The strengths of U of M in climate change and environmental research position it to take advantage of a wide variety of major funding initiatives. Examples include NSF's focus on ecological systems, such as Long-Term Ecological Research (LTER), National Ecological Observatory Network (NEON), and Biocomplexity, and upcoming NSF plans, such as the Ocean Observing System Initiative (which includes the Great Lakes). Public concerns about the environment indicate that the EPA Star Grant program will also be a "big research" opportunity. It is also reasonable to believe that federal funding will increase in the area of renewable energy as fossil fuels become increasingly expensive. These federal opportunities coincide with the University's Initiative for Renewable Energy and the Environment (IREE), which is currently proposing the establishment of the National Center for Biofuels Research (NCBR) facility. Through IREE's $20 million research program, the University has become a recognized national leader in the development of renewable energy technologies. The theme of climate change and environmental science also connects to some of the coordinate campuses, notably through freshwater science and past climate changes (UMD) and renewable energy (UMM).

Although climate change and environmental sciences are real strengths of the U of M, these sciences are inherently interdisciplinary and hence difficult to focus and coordinate. Climatology as a discipline is a major focus of two different departments (Department of Geography and Department of Soil, Water, and Climate). In many cases, quite similar research related to climate change and environmental science is being conducted in several different departments and colleges. For example, past climate reconstructions are being done in Geography (UMTC), Geology and Geophysics (UMTC), and Large Lakes Observatory-Geology (UMD). Integration of research efforts on climate change could maximize U of M potential in this area.

Cyber infrastructure

Cyber infrastructure research has been identified by federal funding agencies as being a critical enabling technology for data mining, simulation, the creation of electronic collaborative environments, bioinformatics, and other high-profile activities identified as priorities for 21st century research. Recently, NSF has appointed leadership for the newly

created Office of Cyber Infrastructure and early funding projections suggest significant new resources for funding research in this area. In addition, safeguarding the nation's cyber infrastructure is a high priority for the Department of Homeland Security. Strengths in Computer Science, Bioinformatics, and the Minnesota Supercomputer Institute (MSI) should put the U of M in a good position to compete for these new sources of funding.

In addition to being a major research area in and of itself, cyber infrastructure underpins many other research areas. For example, the opportunities of e-science and new modalities of research in humanities and social science also require significant investment in cyber infrastructure for large-scale computational and storage capabilities, collaborative tools, and capacity for digitization of documents, manuscripts, and art objects for both access and analysis. In addition, quality cyber infrastructure is critical for collaboration, information gathering, data analysis, and grant and manuscript preparation by faculty members in all fields.

A challenge will be to ensure that the research and support aspects of cyber infrastructure are optimized and integrated across the University for research application as well as production capacity.

2. Recommendations regarding the infrastructure needs required to seize key "big research" opportunities (existing and emerging), including a gap analysis to identify what is needed to meet the short-term and long-term infrastructure to support research.

Many of the "big research" opportunities involve the development of multi-college research teams that are willing to work in a highly multidisciplinary environment. This may involve writing proposals to unfamiliar funding agencies, publishing in nontraditional journals, and perhaps most importantly, developing "intellectual ownership" of problems outside of a faculty member's traditional discipline. Getting top level faculty to participate in these efforts requires substantial inducement and planning. Co-location of faculty research in a project-centered, rather than college or department-centered buildings and the opportunity to use state of the art facilities are two strategies that will play essential roles in the ultimate success or failure of efforts in these areas. While this is expensive, one need only look at the recent announcements by other universities to see that substantial investment of this type will be required even to hold our position in the research rankings, let alone to obtain a top-three status.

<u>Nanotechnology</u>

New research efforts in areas such as nanomedicine and medical devices will have even greater breadth, requiring infrastructure that supports cross-college programs. Competing for research funds in these areas will require both new physical infrastructures for some of the core programs as well as a new *approach* to managing infrastructure that recognizes the involvement of several different academic units. In particular, facilities that bring together researchers from the Institute of Technology, the Academic Health

Center, and the College of Biological Sciences, are urgently needed. Over the short term, this might involve reassigning existing space; over the longer term, however, new highly flexible research space with state of the art labs and support facilities is badly needed to draw researchers into this collaboration. The RITF recommends that the U of M provide contiguous research space for physical and life scientists working in these fields and by offering educational programs in nanotechnology for both undergraduate and graduate students. In addition, the RITF recommends that investments be made in state of the art nano fabrication and characterization equipment for core labs to be housed in this space to maintain U of M Nanotechnology as a leader in the field.

Infectious Disease and Cancer

The U of M has focal strengths in the areas of microbial pathogenesis, public health/epidemiology, and basic research on the immune response, but these units are scattered throughout the campus. To become a world leader in this area, microbial pathogenesis and public health/epidemiology of infectious disease should be integrated in a Center for Infectious Disease and talented researchers must be hired to complement current strengths. It would also make sense for the Center for Immunology to be located near the Center for Infectious Disease, perhaps in Translational Research Facilities 1 and 2. Success in this area can only be achieved if a fully equipped state-of-the-art Biosafety Level 3 (BSL-3) facility, which is currently lacking, is built in the facilities occupied by infectious disease researchers. To be usable by researchers on the St. Paul campus, these facilities must be agriculturally enhanced; otherwise multiple BSL-3 facilities are needed. In addition, every effort should be made to ensure the success of the Biomedical Image Processing Lab (BIPL), the Mouse Genetics Laboratory, and the Genomics and Proteomics core facilities, on which many infectious disease, immunology, and cancer researchers depend.

The RITF concluded that one way to improve U of M cancer research is via the ongoing effort to create an Institute of Clinical and Translational Research (via a Clinical and Translational Science Award funding mechanism) with the goal of changing our current inefficient system in which individual clinical investigators operate in isolation. This single, comprehensive, cost-effective service would match the research needs of individual clinical research projects with the space, personnel, and equipment necessary for successful study completion. Such a system could go a long way toward improving our clinical research capabilities in infectious disease and cancer.

Climatology, Ecology, and Renewable Energy

A marriage between our very strong groups in ecology, climatology, and materials science would produce a unique coalition that would be very well positioned to take advantage of NSF and EPA funding initiatives. Although we have strong groups in each area, it is not clear that these groups are well integrated.

The RITF proposes a competitive multi-disciplinary climate change research institute along the lines of the Beckman Institute for Advanced Science and Technology at the

University of Illinois at Urbana-Champaign. The proposed Institute for the Environment has the potential to become a similar focus for coordination of climate change and environmental science at the U of M. If implemented carefully, many infrastructural elements might be used more efficiently within the framework of an institute. Examples include climate models and geographic information systems (GISs) along with their sizable supporting infrastructures, which cut across a wide spectrum of disciplines. In addition to infrastructure benefits, the Institute of the Environment may help coordinate and focus the intrinsically interdisciplinary nature of environmental research, as well as raise the profile of U of M's research, teaching, and outreach activities related to the environment.

The RITF supports the proposal from the Initiative for Renewable Energy and the Environment (IREE) to establish the National Center for Biofuels Research (NCBR) facility. This would be the only facility of its kind in the country, housing a bio-fuels research, teaching, technology development and transfer program. The Center for Bio-refining, the Biofuels and Products Innovation Laboratory, the Biofuels Utilization Laboratory/Center for Diesel Research, and the Biotechnology Institute would all be located in the NCBR. The proposed NCBR would contain a new core lab that will offer pilot scale equipment that will be used to scale-up and commercialize emerging biofuel technologies. The NCBR facility will further the U of M's goal of being ranked among the top three research institutions by moving it to the forefront of the nation in biofuels research. It may be desirable for the NCBR and the Institute for the Environment to be located near each other, or at least to work closely together.

Emerging Areas

Two of the proposed emphasis areas, Cyber infrastructure and Neuroscience, Cognition, and Behavior, are at this point insufficiently developed to identify the infrastructure that will be needed as these areas emerge. Because of the long lead times required for planning meaningful levels of support, it is essential that planning for these emerging areas begin as soon as possible. The RITF recommends that meetings of key stake holders in each of these areas should be convened now to identify key needs and directions.

3. Recommendations regarding how to assess the research infrastructure growth needs required to ensure future competitiveness within areas of current strength and for areas of emerging importance. How should future infrastructure needs be identified, evaluated, prioritized, and financed?

U of M success in identification and prioritization of research infrastructure needs will depend on accurate assessment of research strengths. This line of inquiry inevitably leads to the question of how to measure the quality of scholarly work. Since with few exceptions, the output of scholarship is publications, the answer to this question may lie in measuring the quality of publications. Although not perfect, the RITF concluded that citation analysis of publications from the associated faculty members is a reasonable way to measure the quality of research programs. The RITF recommends that similar or

improved objective analyses be used as one technique to assess strengths and to inform future decisions on research infrastructure needs.

The RITF concluded that affordable and easy access to cutting edge technologies and research services are essential for the research productivity of our faculty members. These technologies and services are currently housed within various Internal Service Organizations (ISOs) and core facilities that are scattered throughout the University and administered on an ad hoc basis by individual faculty members or contract directors, usually along collegiate lines. As described below in Deliverable 6, there is currently no central cross-collegiate oversight of these critical facilities, no comprehensive mechanism to coordinate their activities, and no standardized funding mechanism.

The RITF recommends that an All University Research Core Facility Oversight Group be formed. One possibility would be a committee of invested faculty members, another would be a group formed within the Office of the Vice President for Research (OVPR). The responsibilities of this group would be to identify, oversee, and evaluate current ISOs, then identify the most important of these for designation as centrally-supported core facilities, with special emphasis on the five areas identified in Deliverable 1. As mentioned in Deliverable 2, the RITF already recommends augmentation of several key core facilities in these areas. The central support levels for these key labs should scale with the number of faculty users, the centrality to core missions, and the willingness of all of the faculty users to make meaningful contributions to the facility.

The RITF also concluded that seizing research opportunities will often require bringing interdisciplinary teams together in contiguous space. Since new buildings present golden opportunities for this purpose, an optimal process for deciding which faculty members occupy these buildings is critical. The RITF recommends that an All University Research Space Oversight Group be formed to provide input on the occupation of new buildings to ensure that decisions are based on scientific synergy not political expedience. This will be particularly important for the new state bonding financing authority that would provide $330 million for new buildings and biomedical science research infrastructure.

4. Recommendations regarding a plan for supporting (establishing, maintaining, upgrading) the University's research infrastructure.

Again, many of the challenges related to maintaining and upgrading our research infrastructure center on the services provided by ISOs and core facilities. The RITF recommends that the All University Research Core Facility Oversight Group described in Deliverable 3 be charged with the task of ensuring that state of the art, major pieces of research equipment are available to qualified investigators. In addition, the RITF recommends that this group be given the authority to enforce a policy that, in most cases, major equipment purchased with U of M funds, such as start-up funds or retention packages, is housed in relevant core facilities. It will be particularly important to enforce this policy in the five areas identified in Deliverable 1.

Many faculty members interviewed by the RITF complained that their research suffered from "hindering bureaucracy", defined as overly aggressive regulation by Institutional Animal Care and Use Committee (IACUC) or Institutional Review Board (IRB). The RITF strongly supports the current efforts by the OVPR to improve the efficiency of these regulatory bodies and recommends that the OVPR add processes to help faculty members comply with IACUC and IRB regulations. Faculty members also complained of inefficient service from Sponsored Projects Administration (SPA), Patents and Technology Marketing (PTM), and Facilities Management. The RITF recommends that a Facilitator be appointed to the OVPR with the authority to investigate faculty claims of inefficient service and provide solutions. This Facilitator could work together with the new office proposed by the Collaborative Research Task Force that would work to foster research collaborations.

5. Assessment of the adequacy of the current configuration (administrative, location, organization, financing) of critical research support infrastructure.

The RITF interview process revealed problems related to intercollegiate research projects. Grants involving faculty members from more than one college are difficult to route through the internal approval process. More importantly, the current Indirect Cost Recovery (ICR) system can be a disincentive for investigators to participate in these projects. The RITF supports the feature of the new budget model that will return the ICR associated with an individual faculty member's component of a multi-component grant to their academic unit.

A recurring theme during RITF interviews was that faculty members feel that they lack administrative support for manuscript and grant submission. The RITF recommends that the faculty be provided with more department level administrative staff support. A central pool of grant submission specialists, who could aid faculty members on a temporary basis, is worth considering (see Deliverable 9). Alternatively, the RITF recommends that a truly user friendly electronic system for grant submission and accounting be produced. Although SPA and Electronic Grants Management System (EGMS) have improved greatly over the last ten years, they still have a way to go before faculty members will be comfortable using them to prepare grant applications and review grant accounts on their own. One solution will be imposed externally by the upcoming change to Grants.gov as an electronic grant submission instrument for all applications to federal funding sources. Every effort should be made to ensure that EGMS interfaces smoothly with Grants.gov. Effort should also be made to improve the University's financial reporting system such that faculty members can use this tool to access understandable, bottom-line grant account reports. Input from faculty members should be sought on the design of these reports.

The research productivity of the faculty is very dependent on other electronic and information services. Although many TC faculty members praised the Libraries for access to e-journals, others expressed concern that essential resources had been reduced or new digital titles were not available. For the Arts and Humanities, library resources represent a fundamental resource for scholarship. Data from a recent survey of CLA

faculty and graduate students, for example, reflected a heavy dependence on electronic resources and significant demand for newly digitized works (e.g., texts, art, linguistic corpora, performance, and manuscript archives). Support for library content and associated technologies for accessing the content is essential to all disciplines.

In addition, access to licensed electronic content is a concern for the coordinate campuses. These sites share in only 15% of the electronic content licenses available to the Twin Cities campus. At UMD, faculty and graduate students affiliated with UM-TC programs have access to resources of the TC that are not available to their colleagues without this affiliation. The RITF recommends that access to electronic content be optimized and supplied, where appropriate, to all U of M faculty, students and staff.

The coordinate campuses are highly dependent on Interactive TV to collaborate efficiently with colleagues on the Twin Cities campuses. Although parts of the current system are state of the art, others are out of date. The RITF recommends that aging Interactive TV systems be upgraded to facilitate the research activities of faculty members at the coordinate campuses.

Although networking services are working well in some units, effective use of computing at the University depends on having sufficient locally funded expertise to provide network and desktop support. Thus, the RITF recommends that the Office of Information Technology's (OIT) services for all units be enhanced and the most effective balance of distributed and central support be determined.

As an urban campus, evening and weekend access is important, particularly for graduate students and postdoctoral researchers. For these researchers, who are not highly paid, the cost of parking is a strong disincentive to coming back to work on evenings and weekends. The RITF recommends that off-peak access to some facilities be granted at no cost to these members of the research community.

6. Recommendations regarding the relative advantages and disadvantages of centralized research facilities versus smaller, distributed facilities.

Large central core facilities have several key advantages including the ability to purchase and maintain major pieces of research equipment. The amortization, maintenance contract or other repairs, and upgrading of this equipment can be spread across many research groups. Furthermore, since these labs operate as ISOs, they can use fees charged for access to the equipment by non U of M entities to spread the costs over a broader user base. Since external users must pay usage costs that exceed actual costs of equipment operation, these fees can be used to underwrite U of M costs. For example, Biodale, an administrative consortium of six ISOs clustered within two adjacent buildings on the St. Paul campus, is a model of academic/industry shared facilities. It is a one-stop shop whose motto is "Minnesota's Shopping Mall for Biotechnology and Life Science Research Support Services". The existence of these facilities is a very powerful motivator when recruiting both faculty and students who see these facilities as key to being able to carry out state of the art research. They also reduce capitalization costs including start-up and retention package costs by avoiding costly duplications of service.

Finally, large central facilities allow the retention of a skilled technical staff that can operate these systems and act as a repository for detailed technical knowledge. Access to this staff is invaluable for new students and for faculty trying to initiate work in a new area.

Another advantage of large core facilities is their increased visibility which increases the likelihood of usage. For all of these reasons, the RITF recommends that central core facilities be the preferred mechanism for delivery of research services that are useful to large numbers of faculty members. Every effort should be made to avoid duplicating these facilities in various colleges across the U of M, at least on the same campus. Recommendations with regard to identification, oversight, and maintenance of core facilities are provided under Deliverable 4.

When thinking of large, central research facilities, one must also consider the role of the library. For some of the social sciences, the arts, and other disciplines within the College of Liberal Arts, the library **is** the laboratory. Insufficient support for library resources directly impacts the ability of faculty in these areas to carry out research. This is a critical research issue that was raised by nearly every group of researchers with whom the RITF met. The RITF recommends that the Libraries be considered core research facilities whose resources are available to all University faculty, and that Central Administration find ways to improve library support.

7. Recommendations regarding current space or building challenges from a research infrastructure perspective.

Numerous examples were presented to the RITF where the age and design of some buildings make them completely inadequate to the research needs of the faculty. The Physics building is a primary example of this problem. It is completely unsuited to supporting Biophysics research, an area that the Physics Department has identified as a priority in the coming years. Furthermore, nearly all faculty feel that they have little or no input into the process by which building priorities are determined. This will become even more of a problem as disciplines evolve. Finally, buildings typically do not have enough space for meetings, such as conference and seminar rooms. This is a key problem and negatively impacts our ability to effectively conduct collaborative research.

As with the concern regarding aging space, there is a strong concern that a bad situation may become even worse under the new budget model when meeting space is counted as a financial liability to departments and colleges. The RITF recommends that the U of M develop a research space allocation and retention policy that takes into account the needs of individual faculty members and their funding level. The All University Research Space Oversight Group proposed in Deliverable 3 could be charged with periodically adjusting space allocations within academic units according to established rules and guidelines.

Inefficient service from Facilities Management was another common faculty concern. The University cannot become one of the top three institutions if the attitude of excellence is not shared by rank and file members of the support staff. While some

buildings receive adequate services from Facilities Management, faculty members also reported examples of extremely poor maintenance. Such sub-standard service will have a strong negative impact on recruiting faculty and students, reduce safety, and lower morale in general. The Facilitator operating out of the OVPR recommended in Deliverable 4 should have the authority to investigate faculty claims of inefficient service from Facilities Management. Laboratory renovation and set-up is a significant concern to some research faculty. The RITF encourages the administration to develop mechanisms to improve accessibility and strengthen the level of service, such as job-by-job performance review of Facilities Management personnel signed by faculty, or allowing the use of union contractors outside of U of M for specific set up and renovation situations.

8. Recommendations regarding "big research" and commercialization of research and intellectual property issues.

To meet this charge item, the RITF met with representatives of Patents and Technology Marketing (PTM), Office of Business Development (OBD), and a group of faculty inventors. The group had considerable criticism of PTM for the way that commercialization has been handled at the University. In general these criticisms relate to a perceived failure of PTM to employ best practices related to commercial and academic technology transfer. The group specifically discussed problems such as the development of adversarial relationships with faculty inventors, ineffective prospecting for intellectual property (IP) with faculty, and ineffective marketing efforts. Furthermore, since PTM traditionally stressed short term licensing income, it is not surprising that the success rate for Minnesota spin-offs is much lower (~3%) than best practices schools such as Stanford and MIT (18%), which emphasize longer term value indicators. Finally, IP agreements have been structured such that even successful spin off companies such as Medtronics, do not provide substantive long-term funding to the University.

The recently developed OBD and some changes in PTM address many of these concerns. OBD is intended to help start ups and to be a "front door" to University technology development. The changes in PTM are recent and OBD has only been in existence for 18 months. Since the University appears to be taking the fundamentally correct step of shifting the primary metric of success toward the proper recognition of value, or lack thereof, a correspondingly appropriate commercialization strategy, and the gathering of critical resources for the technology, including both money and people, it will take several years before one can begin to meaningfully assess the success of this effort. The RITF recommends that the development of the OBD be closely monitored, but does not have any additional recommendations at this time.

Academia introduces its own barriers to commercialization. Scientists that do translational research are looked down upon by those that are considered "scholarly" researchers and suffer in the promotion and tenure process, where publications are much more important than patents. The RITF recommends that translational research, patents, and other intellectual property activity of research scientists be recognized and included as a category in the tenure review process.

9. Recommendations derived from an analysis of the practices of our peers and aspirational peers with regard to seeding, supporting, and sustaining a robust research infrastructure.

The RITF analyzed research practices at peer institutions using web searches. Novel practices were identified at top public institutions. Here we focus on institutional research practices specifically targeted to fulfilling "Big Research" opportunities identified in Deliverable 1. In every case, universities have had to make substantial investments, often in cooperation with the state, to be able to make significant changes in ranking in a specific area. This has typically included new buildings, new core labs, and an increment in faculty hiring focused in some specific area.

Nanotechnology – Many schools including Stanford, Harvard, Purdue, Cornell, Georgia Tech, University of California Santa Barbara, and Michigan have opened new facilities or expanded existing ones to support nanotechnology research. The University of Maryland at College Park is a good example of a state university with a highly successful nanotechnology program. The Maryland Center for Integrated Nanoscience and Engineering (M-CINSE) includes 100 University of Maryland investigators from Engineering, Computer, Math and Physical Sciences, and Chemical and Life Sciences. M-CINSE infrastructure includes the new $63 million Jeong H. Kim Engineering Building. Like the new $150 million center at Harvard, the new $150 million building at UW Madison, and many of the newest nanotechnology facilities, the building houses not only Maryland's core nano labs, but is also designed to bring together researchers from multiple colleges and disciplines, especially bio and physical researchers/engineers.

Infectious Disease – The city of Boston, one of the leading areas in the country for infectious disease research, has twelve BSL-3 labs and 800 BSL-2 labs at over thirty institutions. The first university-based BSL-4 was opened at the University of Texas Medical Branch in Galveston in 2003, funded by NIH as part of the Western Regional Center of Excellence for Biodefense and Emerging Infectious Diseases. Construction of a second NIH-funded university-based BSL-4 lab is currently underway at Boston University. NIH awarded each institution $128 million for BSL-4 construction, providing key infrastructure necessary to enhance US research into lethal microbes. The lack of a BSL-3 facility at Minnesota puts us in a position that is highly uncompetitive with peer institutions.

Neuroscience, Cognition, and Behavior – Understanding brain function and human behavior requires coordinated interdisciplinary approaches. The University of California at Los Angeles (UCLA) hosted the first international conference on Social Cognitive Neuroscience in 2001, with a key theme of bridging disciplines. This type of coordinated research can be facilitated at the university level through administrative assistance. For instance, the University of California at Berkeley facilitates interdisciplinary research using the Research Futures Grant Program, which provides up to $50,000 in seed funding for faculty who are willing to apply for external funding as lead Principal Investigator of an interdisciplinary application. UCLA facilitates interdisciplinary research using the

Strategic Positioning Initiative Program, where the Office of the Vice Chancellor for Research provides four staff members dedicated to interdisciplinary research opportunities. The interdisciplinary staff team is responsible for identifying research opportunities, developing faculty teams, and coordinating grant applications. It is clear that staff support and seed funding would enhance interdisciplinary research in Neuroscience, Cognition, and Behavior at the University of Minnesota.

Climatology, Ecology, and Renewable Energy- This is a new area and leaders among academic institutions are just beginning to emerge. One early leader in Climatology and Renewable Energy is at Stanford with the Global Climate and Energy Project (GCEP). Launched in December 2002, their mission is to conduct fundamental research on technologies that will permit the development of global energy systems with significantly lower greenhouse gas emissions. GCEP is supported by four international companies—ExxonMobil, General Electric, Schlumberger, and Toyota, who will invest a total of $225 million over ten years as GCEP explores energy technologies that are efficient, environmentally benign, and cost-effective when deployed on a large scale. Clearly Stanford's strategy of partnering with industry is a good way to become a major player in this field as federal funding is ramped up. Another example, though less innovative than the one above, but nonetheless effective, is at Columbia University with its Lamont-Doherty Earth Observatory, Earth Institute, and their partnership with NASA Goddard.

Cyber infrastructure - The University of Illinois at Urbana-Champaign hosts the National Center for Computational Studies (NCSA), a leading NSF-supported supercomputing center that developed the TeraGrid system with the San Diego Supercomputing Center (SDSC). The University of California at San Diego offers a Bioinformatics Graduate Program leading to the Ph.D. degree. Currently, the U of M Graduate Program in Bioinformatics only offers a graduate minor, and receives no funds from indirect costs generated by its faculty. It is clear that expanded availability of advanced computational resources such as those at the Minnesota Supercomputing Institute would provide better user services and support for researchers at U of M. Expansion of Bioinformatics and Computational Biology educational capabilities at U of M would also facilitate cyberinfrastructure and graduate research.

Other Top Practices – Many leading institutions assist faculty with the granting process. In general, university resources can be improved in identifying, obtaining, and educating researchers on funding opportunities. Top universities often monitor funding announcements and offer seed grants as incentives to respond to Requests for Application and Program Solicitations by federal funding agencies. The University of North Carolina at Chapel Hill obtained a NIH "Roadmap" training grant which they used to offer a laboratory course on "Major Challenges in Clinical Medicine: An Overview for Basic Scientists". The purpose of the program is to educate young investigators on Roadmap opportunities. The University of Wisconsin offers limited seed support to NIH proposals that are highly ranked, but narrowly miss funding, in an effort to improve chances on the resubmission. Administrative support and focus is also essential to university research. Pennsylvania State University (PSU) has a coordinated research office with a defined strategic plan. In the last five years, PSU added four new Institutes in targeted areas

(environmental research, life science, materials science, social science), and hired 129 new faculty using co-funds from paired College/Institute.

IV. Recommendations for prioritizing deliverables

1. The following recommendations should receive the highest priority because they involve already organized strong research groups and have the potential for large returns on investment in the near future.

- Provide contiguous research space for physical and life scientists working on Nanotechnology and invest in state of the art equipment for core labs to be housed in this space.
- Build a fully equipped, agriculturally enhanced Biosafety Level 3 (BSL-3)facility in facilities occupied by infectious disease and immunology researchers (Translational Research Facility 1 or Translational Research Facility 2).
- Create a competitive cross-collegiate climate change research institute to take advantage of strengths in Climatology, Ecology and Renewable Energy.

2. The following recommendations involve cross-collegiate change that could improve research productivity by removing administrative barriers.

- Develop and use objective metrics to make future decisions on research infrastructure needs.
- Form an All University Research Core Facility Oversight Group within the OVPR to oversee essential research infrastructure facilities.
- Form an All University Research Space Oversight Group within the OVPR to provide input on the occupation of new buildings.
- Appoint a Facilitator to the OVPR with the authority to investigate faculty claims of inefficient service and provide solutions.
- Add a process within the OVPR that will help faculty members comply with regulations related to human and animal research.
- Return the indirect cost recovery (ICR) associated with an individual faculty member's component of a multi-component grant to their academic unit.

3. The following recommendations involve strong research groups in emerging areas with a large potential return on investment but will require considerable integration and reorganization to be maximally effective.

- Bring together key stakeholders in Cyber infrastructure and Neuroscience, Cognition, and Behavior to identify key needs and directions.

- Support the development of Institute of Clinical and Translational Research to gain economies of scale and efficiency in our clinical research operations.

4. The following recommendations should receive a high priority because they involve institutional change at the level of individual researchers.

- Perform a study to identify high impact opportunities for scholarship in the Arts and Humanities.
- Provide faculty members with more department level administrative staff support and produce a truly user-friendly electronic system for grant submission and accounting.
- Provide all faculty members access to relevant e-journals.
- Update aging Interactive TV systems to maximize efficiency of faculty members on coordinate campuses.
- Enhance central Office of Information Technology (OIT) support services for all units.
- Provide off-peak parking to some research facilities at no cost to graduate students and postdoctoral researchers.
- Closely monitor the development of the Office of Business Development (OBD) and changes in Patents and Technology Marketing (PTM).
- Recognize patents and licenses as valued scholarly work in the tenure review process.

APPENDICES

Appendix A -- UMN Program Rankings Based on Citations of Publications

Appendix B -- Web sites for funding opportunities information

Appendix C -- Research Infrastructure - Methodology

Appendix D -- Consultation Plan

Appendix E -- Schedule of Consultation Meetings

Appendix F -- Charge letter

Appendix G – Research Expenditures by College

Appendix H – Alignment of Recommendations with the Five Action Strategies

Appendix A

University of Minnesota Program Rankings Based on Citations of Publications.

	Citations/Paper UM % Rank	Total Citations UM % Rank
Materials Science	4	4
Chemistry	5	2
Physics	6	7
Mathematics	7	4
Clinical Medicine	8	2
Environment/Ecology	10	1
Social Sciences	13	3
Neuroscience/Behavior	15	9
Computer Science	16	8
Economics/Business	17	11
Geoscience	17	12
Engineering	19	3
Psychiatry/Psychology	25	6
Immunology	33	17
Plant/Animal Science	36	2
Agricultural Science	37	4
Molecular Biology/Genetics	41	20
Biology/Biochemistry	50	10
Microbiology	59	22
Pharmacology/Toxicology	69	9
Space Science	71	78

Citation data for these rankings were taken from the Thomson ISI Essential Science Indicators (ESI) web site (U of M access provided at http://www.lib.umn.edu/cgi-bin/esi.cgi). ISI's data is gathered from the citations published in a large range of scholarly journal publications.

"Institutional" citation rankings in ESI are primarily based on the gross number of citations of papers authored or co-authored at a given institution; in ESI, the top 1% of all institutions publishing in a given subject category are reported. Because for a given paper each contributing institution is counted equally, a core criticism of ISI's methods is that papers with authors at multiple institutions are "counted" in ISI institutional data multiple times, and hence these publications can have a disproportionate effect on the rankings.

The 22 subject categories in ESI represent distinct sets of scholarly journal titles; inclusion of a given paper in a category is based on the assignment of the journal title to a category, and not on the home department of the paper's author. Because of this and the relatively small number of subject categories, there is not necessarily an intuitive and

firm correlation between the reported ESI subject category and a given academic department. For example, a substantial proportion of papers included in the "Social Science" category come from the AHC, particularly from Public Health and School of Medicine; there are many other crossovers such as papers reported in the "Materials Science" category published by Dept of Chemistry faculty.

Use of raw, non-normalized ISI citation data for comparisons across disciplines – e.g., comparing a Journal Impact Factor for a Biology journal against one for an Engineering journal -- is frequently criticized, as patterns of citation are very different between disciplines. Hence, rather than comparing raw citation metric data, the statistics shown report the numerical rank of the U of M, compared to the other institutions in a given subject area.

One major source of inconsistency amongst the 22 subject areas was the variable prevalence of non-university institutions in the rankings. Some subject areas include a large number of corporations, government agencies, independent research institutions, hospitals, and other institution types; this heterogeneity between subject areas had significant potential to affect the comparison of one subject area to another. We chose therefore to manually select from the ESI institutional rankings only universities and other institutions which have authority to independently grant undergraduate and graduate-level degrees, and constructed rankings based only on these sets of universities.

Two core metrics were used to assess output in the 22 subject areas. Rank based on gross influence, defined as the total number of citations of papers in the subject area by U of M authors, assesses the bulk influence of the institution's publications in the subject. Rank based on weighted influence, defined as the average number of citations **per paper** published in the subject area by U of M authors, assesses the relative importance of those publications. (Weighted influence has the same units (citations/paper) as the journal Impact Factors familiar to many researchers.)

These metrics were normalized to the total number of universities represented in the ESI subject category, resulting in a percentage ranking in the field. For example, U of M ranks in the top 1% (4/298) of universities in the Environment and Ecology subject area, and in the top 10% (41/399) in Biology and Biochemistry based on total citations.

It should be noted that the weighted influence (citations/paper) metric is subject to the phenomenon that institutions producing a large publication output in a subject area tend to have a lower citations/paper ranking than institutions with a small (but important) research output in the subject. Hence, in some cases there are significant discrepancies between rankings by gross influence compared to weighted influence, and large institutions like U of M tend to have lower rankings by the weighted influence measure.

Rankings for Harvard University, University of North Carolina, and Ohio State University were also analyzed (data not shown). Significant differences in the absolute and relative strengths in the various subject areas are seen amongst these four test cases,

lending some confidence that the method has utility in comparison of different subject areas, and is not inherently biased for or against some subject areas.

Appendix B

Web sites for funding opportunities information

Nanotechnology

NSF: http://www.nsf.gov/crssprgm/nano/
NIH: http://www.becon.nih.gov/nano.htm
DOE: http://www.sc.doe.gov/bes/brochures/files/NSRC_brochure.pdf
DOD: http://www.nanosra.nrl.navy.mil/
EPA: http://grants.gov/search/search.do?mode=VIEW&oppId=7405

Infectious Disease/Cancer

http://www.niaid.nih.gov/ncn/budget/opps.htm
http://www.gatesfoundation.org/GlobalHealth/Grants/default.htm
NCI: http://www.cancer.gov/
NCI Cancer Centers: http://www3.cancer.gov/cancercenters/
NIH roadmap: http://nihroadmap.nih.gov/
ACS: http://www.cancer.org/docroot/home/index.asp
DOD: http://cdmrp.army.mil/
LLSA: http://www.leukemia.org/hm_lls

Neuroscience, Cognition, Behavior

http://www.nsf.gov/pubs/2003/pd037252/pd037252.html

Climatology/Biodiversity

http://www.usgcrp.gov/usgcrp/Library/ocp2006/ocp2006-priority.htm
http://www.nsf.gov/pubs/2004/nsf04201/FY2003-2008.pdf
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=6197&org=OCE
http://www1.umn.edu/systemwide/strategic_positioning/tf_final_reports/cnr_coafes_che_final.pdf

Cyberinfrastructure

http://www.nsf.gov/pubs/2004/nsf04201/FY2003-2008.pdf
http://www.nsf.gov/publications/pub_summ.jsp?ods_key=cise051203

Appendix C - Methodology

The Research Infrastructure Task Force (RITF) was charged with developing a plan to ensure that the University's research infrastructure is capable of supporting research and scholarship consistent with realization of the University's goal of becoming one of the top three public research universities in the world. The RITF represents a broad cross section of the University, with an emphasis in science and technology. This was deemed essential to avoid undue bias from any subset of disciplines. Participants represent clinical and biomedical research, engineering, the physical sciences, the social sciences, the behavioral sciences, and the arts. Representatives come from east and west bank, St. Paul, and the Duluth campus. The committee also includes a post-doctoral fellow.

The first task of the committee was to define "Research Infrastructure". The committee felt that a workable definition must be sufficiently broad so as to encompass the support needed for all scholarly activity, not directly related to teaching, throughout the University. The committee therefore adopted the following definition of infrastructure:

> ***"The facilities (e.g., laboratories, studios, clinics) and services (e.g., libraries, computing services, grants management systems, research safety and subject protection organizations, and secretarial services) needed to produce novel and influential scholarly output (e.g., publications, exhibits, performances)."***

Based on an analysis of the level of research expenditures by college, and by the number of faculty per college (Appendix G), the task force agreed to divide the University into the following seven areas for purposes of consultation:

- Clinical Sciences,
- Basic Sciences,
- St. Paul Campus units,
- Institute of Technology
- College of Liberal Arts
- Professional schools of Law, Management, Architecture, Education, & Public Affairs
- Duluth Campus units

To determine the invitation list for these information gathering sessions, two processes were used:

1. Each task force member was assigned an area and asked to supply names of professors, associate professors, and assistant professors based on their experience.
2. An email was sent to all the deans and associate deans for research of these colleges asking for their recommendations.
3. The committee developed the following five questions to be addressed at these meetings:
    - In your College's fields, where is the University of Minnesota particularly strong and what are the areas that should be targeted for growth? Why?
    - How do other leading schools nurture the development of these areas?

- With regard to the University of Minnesota, which infrastructure components are the most essential for your College's scholarly activities in general and your activities in particular?
- Of these essential infrastructure components, which work well?
- Of these essential infrastructure components, which work poorly and how would you improve them?

4. Each session brought together 5 to 10 representatives from each of these groups to discuss the University's research infrastructure, along with representatives from the Task Force. Summary notes of the sessions were prepared and shared with the entire Task Force.

Additional meetings were held with invited Internal Service Organization (ISO) directors regarding their issues and concerns with respect to Research Infrastructure.

The Task force also interviewed staff from the Office of Patents and Technology Marketing and Office of Business Development in order to inform their recommendations regarding the commercialization of research and intellectual property issues deliverable. Faculty inventors were invited to a separate meeting to provide their input in this important area of research infrastructure. The task force also reviewed summaries from 2 recent surveys that the OVPR had conducted relative to this topic.

Dr. Jas Alhuwalia, Executive Director of Clinical Research in the AHC met with the task force to give input regarding infrastructure needs to support clinical research and an ITV session with faculty from campuses at UM- Morris and UM- Crookston was held to get input regarding the specific issues from these campuses.

After this data gathering stage, the committee began the process of assembling, synthesizing, and prioritizing the comments that it obtained and using that information to address the deliverables in the task force charge and formulate recommendations.

Regarding Deliverable #1, identification of "big research" opportunities anticipated across the research spectrum, task force interpreted "big research" opportunities as new funding initiatives. A guiding assumption was that the U of M is well-positioned to take advantage of an initiative if we have strong faculty in the relevant area. Where possible, faculty strength was assessed objectively using the Essential Science Indicators tool from the Institute for Scientific Information (ISI)
(http://esi01.isiknowledge.com.floyd.lib.umn.edu/home.cgi). The group also reviewed web sites for major funding areas to determine the landscape for external funding opportunities and how they matched with the areas of faculty strengths (appendix xx). The task force was particularly conscious of reflecting the infrastructure needs of the arts and humanities disciplines, although they did not necessarily fit with the "big science" model.

Email to Deans and Associate Deans for Research requesting names of research faculty

Dear ---,
I am writing to ask your help in the University Strategic Positioning Process currently underway to catapult us into the top 3 public research universities in the world. As a first round in the information gathering process, the Research Infrastructure Task Force wishes to solicit faculty and staff input on major infrastructure issues and opportunities for the St. Paul research community (as well as many other research communities). During later rounds, the committee will seek input from both the administration and the largerUniversitycommunity.

The Task Force would like you to suggest the names of 5 esteemed research faculty or other individuals who are regarded as visionary, distinguished, creative, essential to the research enterprise, or are special in other ways, within your college. These representatives should include at least one Assistant Professor, one Associate Professor, and one staff member. We also ask that they commit time to a single 90 minute meeting during the week of November 7, and that they take time to consider the attached list of questions beforehand on behalf of your unit. In return we, the Task Force, will consider carefully the comments, return a summary of the session to the participants, and return the final committee report to them. The meeting will consist of invited participants (about five), a subgroup of about three to five Task Force members, and a note taker. It will be informal and scheduled as best as possible for the convenience of the participants. To ensure a broad representation, the committee may select some participants from the St. Paul campus who are not on the list that you provide.

On behalf of the entire Task Force, I thank you for your time and effort in this important process. Information on this Task Force in particular and the Strategic Positioning Process in general can be found at http://www1.umn.edu/systemwide/strategic_positioning/.

Email to Faculty Invitees:

Professor XX:

We are writing to ask your help in the University Strategic Positioning Process currently underway to catapult us into the top 3 public research universities in the world. As a first round in the information gathering process, the Research Infrastructure Task Force wishes to solicit faculty input on major infrastructure issues and opportunities.

To help our work, the task force has prepared the following definition of Infrastructure Supporting Research and Scholarly Activity:

> The facilities (e.g., laboratories, studios, clinics) and services (e.g., libraries, computing services, grants management systems, research

safety and subject protection organizations, secretarial services) needed to produce novel and influential scholarly output (e.g., publications, exhibits, performances).

Members of the Task Force and deans of colleges were asked for suggestions of esteemed faculty who are regarded as visionary, distinguished, creative, essential to the research enterprise, or are special in other ways. Because you were recommended as having these qualities, we are inviting you to participate in one 90 minute meeting to give us your input on this topic. It is hoped that as a selected invitee to this meeting, you will be able to represent the concerns of your unit and discipline, not just your individual issues.

The meeting you are being invited to attend will be held on November 8, 2005, from 1:30 to 3:00 in 101 Walter Library. Attendees at the meeting will include the invited faculty from Basic Science units, a subgroup of three to five Task Force members, and a staff person to document the meeting. Attached to this email is a copy of the questions that we will be discussing.

Please RSVP to Kerri Barrett at barr0332@umn.edu your availability to attend this meeting. If you are unable to attend but would like to provide written comments, we would be happy to receive them.

On behalf of the entire Task Force, we thank you for your time and effort in this important process. Information on this Task Force in particular and the Strategic Positioning Process in general can be found at http://www1.umn.edu/systemwide/strategic_positioning/.

Appendix D –
Research Infrastructure Task Force Consultation Plan

1. Initial input sessions with faculty groups

- Starting with the list of colleges and their corresponding research expenditures, the task force agreed to divide the colleges in the following way:
  - Basic Sciences
  - Clinical Sciences
  - Institute of Technology
  - College of Liberal Arts
  - Professional Schools (Law, Humphrey, Carlson, Architecture, Education)
  - St. Paul Campus units
  - UMD units
  - Other - if necessary
- Members of the task force are developing a list of 15 names for each group. Deans are also being asked to suggest faculty and/or staff to include in these meetings
- Questions have been developed by the Task force to be used in these meetings
- 5-7 people will be invited to a 90 minute session with subgroups of the Task force to get their input to these questions. These will not be formal focus groups but rather listening sessions.
- Notes will be taken at these meetings. They will be compiled at the conclusion of these sessions and be included in the December progress report.

2. Brief status reports are given monthly to the Senate Research Committee by Tim Mulcahy. Chris Cramer, Task Force and SRC member will also report regularly. An interim report based on analysis of information from these initial sessions will be given to SRC and other constituent groups, as described in #5.

3. Consideration will be given to the need for additional input from specific groups after this initial round is completed. Open invitations to comment either through a questionnaire tool or open forums will also be considered, but not before January 2006.

4. Requests to meet directly with the Task Force will be handled on an individual basis, but in most cases will need to fit into this established structure. For example, a request by the CLA Council of Department heads to meet with the Task Force has not been granted, however, they are being asked to provide names for the initial input sessions and also invited to provide written comments to the Task Force. Requests from individuals to speak to the Task Force will be asked to send written comments through the feedback loop of the Portal. These comments will be addressed by the Task Force co chairs and/or members and responses returned to the appropriate individual.

5. Internal Stakeholder groups:

Work products from the task force will be provided to different groups of interested stakeholders in an ongoing manner as there are reports to distribute. This method will allow for ongoing feedback from internal groups, increasing the acceptance and quality of the final report. Initial stakeholder list is as follows:

- Twin Cities Deans Council
- Faculty Consultative Committee
- Council of Research Associate Deans
- AHC faculty consultative committee
- Senate Research Committee
- Public Engagement (Vic Bloomfield)
- CLA Council of Department Head
- IT and other dept heads groups?
- Coordinate Campuses (Duluth, Morris, Crookston)

6. External Stakeholders:

Per discussion at Steering Committee meeting, feedback from external groups, of which there may be many, should be considered after the initial ideas and plans have been formulated.

7. Other Task Forces

Acknowledging that there are task forces to coordinate with, no specific action has been identified at this time. It is hoped that visits to the coordinate campuses can be coordinated with some of the other task forces. Input from executive staff people will be required to make this method be successful.

Appendix E

Stakeholder Consultation Meetings

Group	Venue	Date/Time
Basic Sciences	Walter Library Room 101	Nov. 8th 2005 1:00-2:30pm
St. Paul Campus	St. Paul Students Ctr. Room 202	Nov. 11th 2005 1:00-2:30pm
Professional Schools	Walter Library Room 101	Nov. 18th 2005 10:00-11:30am
IT Faculty	Coffman Union Room 302	Dec. 1st 2005 10:00-11:30am
CLA Faculty	Morrill Hall Room 248	Dec. 12th 2005 2:30-4:00pm
Clinical Research	Coffman Union Room 323	Dec. 15th 2005 9:30am-11:00am
Duluth Campus	Kirby Student Center Room 268	Dec. 16th 2005 10:00-11:30am
Council of Research Associate Deans	Walter Library Room 101	Jan. 19th 2006 1:30-3:00pm
ISO Directors	Johnston Hall Room 433	Jan. 25th 2006 2:30-4:00pm
PTM/OBD	Johnston Hall Room 433	Feb. 2nd 2006 11:30-1pm
U Budget Office	Johnston Hall Room 433	Feb. 16th 2006 11:30-1pm
Morris/Crookston	Rarig Center Studio C	Feb. 28th 2006 3:00-5:00pm
AHC Clinical Science Enterprise Task Force	Johnston Hall Room 433	Mar. 2nd 2006 11:30-1pm
U Inventors	Johnston Hall Room 433	Mar. 10th 2006 11:00-12:30

Appendix F

September 14, 2005

To: Research Infrastructure Task Force Co Chairs and Members

From: R. Timothy Mulcahy, Vice President for Research

Subject: Task Force Charge Letter

Thank you for agreeing to serve on the Research Infrastructure task force. This task force is assisting with the implementation of the University's 2005 strategic positioning recommendations entitled, "Transforming the University of Minnesota," endorsed by the Board of Regents on June 10, 2005. Stephen Campbell and Marc Jenkins have agreed to serve as task force co-chairs.

Task Force Charge

The Research Infrastructure task force is charged with developing recommendations that will enhance the conduct of interdisciplinary, inter-professional, inter-institutional and team-oriented research at the University of Minnesota. A specific set of tasks intended to serve as a guide for the task force in fulfillment of this charge is appended to this letter. The recommendations should be designed to help position the University as one of the top three public research universities in the world within ten years and should support the following five strategic action areas identified in the strategic positioning report:

1. Recruit, nurture, challenge and educate outstanding students who are bright, curious, and highly motivated.
2. Recruit, mentor, reward, and retain world-class faculty and staff who are innovative, energetic, and dedicated to the highest standards of excellence.
3. Promote an effective organizational culture that is committed to excellence and responsive to change.
4. Exercise responsible stewardship by setting priorities, and enhancing and effectively utilizing resources and infrastructure.
5. Communicate clearly and credibly with all of our constituencies and practice public engagement responsive to the public good.

For all areas, the President has asked that each task force assess critical and relevant trends. Your task force will not be responsible for on-the-ground operational and implementation decisions. Rather, it is expected that your team will function at a high level of visioning and strategic thinking, focusing on the long-term viability and future success of the University of Minnesota.

During the development of the University's strategic positioning plan, certain common themes have been identified that informed the goal to become one of the top three public research institutions in the world. These themes are important to keep in mind as we begin our work. The themes are:

- Strong academic programs and leadership.
- Improved access to success for students demonstrating that a better education leads directly to better results.
- Excellence in research.
- Lowered economic costs through improved services and strengthened core investments.
- Greater alignment across all programs and services.

Broad consultation with stakeholders is crucial to the strategic positioning effort. The task force is encouraged to consult widely with all segments of the University community during its analysis and development of recommendations. Consultation should include faculty, staff, students, deans, administrators, internal and external stakeholders, alumni, internal or external "experts" and any others the team deems appropriate.

Task force Retreat

One of your first assignments as task force co-chairs and members is to attend the strategic positioning task force retreat and work day scheduled for Friday, September 16th. The retreat and work day will be held at the North Star Ballroom in the St. Paul Student Center. Task force co-chairs are expected to attend from 8:30 am-5:00 pm. Task Force members are expected to attend from 1:00 pm-5:00 pm. An agenda and more detailed information will be forth coming.

Reporting Deadlines

The expected date for completion of your final report is **May 1, 2006**. The task force will also be expected to submit to me by **December 10, 2005,** a progress report summarizing the progress to date. I will also want you to establish regular and open communication with me throughout this process and would like to meet with you at 4-6 week intervals to review progress and to determine what, if any, resources the task force might need to satisfy its charge.

Resources Available to the Task Force

As you begin your work, I want to alert you to the resources and support available to your team. These include the Resource Alignment Team, a toolkit of documents and templates, and the professional staff of University Relations appointed to facilitate internal and external communication of progress through the strategic positioning process. The Resource Alignment Team is a consulting group charged with providing support to all task forces in areas of cross-functional alignment, change management, and

subject matter expertise as needed. Two additional sources of support are the Steering Committee for our area and the Executive Strategic Positioning Team.

Win Ann Schumi will serve as Task Force coordinator representing the Office of the Vice President for Research and will work directly with the task force co-chairs to help manage and coordinate the activities of the group. In addition, Kerri Barrett will staff the task force and will be responsible for recording of minutes, maintenance of data and records used by the Task Force, scheduling of meetings and collation and preparation of report drafts.

Managing Change

The University has entered an era of transformational change. Organizational change of this magnitude requires effective management, and the task forces being charged to bring the vision forward play a crucial role in change management. Open and timely consultation with the key stakeholders in your area is essential in this process. This includes recognition of potential barriers to change and thought toward overcoming areas of resistance. Attention to announced timelines for work completion and effective communication of progress toward goals are also vital to managing change at this level. There are resources available throughout the University community that can provide you with support in the area of change management. As task force coordinator, Win Ann Schumi is assigned this responsibility and will provide you with assistance in accessing that support as needed.

Thank you again for your willingness to assume this important role on behalf of the University community. Your participation is vital to the successful implementation of the 2005 strategic plan and to achieving the goal of becoming one of the top three public research universities in the world. Please feel free to contact me with questions, for clarifications or to request any other assistance you might need, now or during the course of the task force's work.

Your leadership and enthusiasm for this process are greatly appreciated.

Attachment

Cc: Frank Cerra, Senior Vice President for Health Sciences
E. Thomas Sullivan, Provost
Win Ann Schumi, Assistant Vice President for Research

Attachment

Research Infrastructure
Report due: May 1, 2006

Mission:

Develop a plan to insure that the University's research infrastructure is capable of supporting research and scholarship consistent with realization of the University's goal of becoming one of the top three public research universities in the world.

Deliverables:

- Identification of emerging opportunities anticipated across the research spectrum: which ones are we currently positioned for; which ones represent opportunities where Minnesota can become a world leader; which ones should we develop, with what priority and in what timeframe?
- Recommendations regarding the infrastructure needs required to capitalize on major research opportunities (existing and emerging), including a gap analysis to identify what is needed to meet the short-term and long-term infrastructure to support research.
- Recommendations regarding how to assess the research infrastructure growth needs required to insure future competitiveness within areas of current strength and for areas of emerging importance. How should future infrastructure needs be identified, evaluated, prioritized, and financed?
- Recommendations regarding a plan for supporting (establishing, maintaining, upgrading) the University's research infrastructure.
- Assessment of the adequacy of the current configuration (administrative, location, organization, financing) of critical research support infrastructure.
- Recommendations regarding the relative advantages and disadvantages of centralized research facilities versus smaller, distributed facilities.
- Recommendations regarding current space or building challenges from a research infrastructure perspective.
- Recommendations regarding commercialization of research and intellectual property issues.
- Recommendations derived from an analysis of the practices of our peers and aspirational peers with regard to seeding, supporting, and sustaining a robust research infrastructure.

Appendix G

Research Expenditures by College

Sorted by number of faculty

	2004 Faculty	2004 Spons Funding	2004 Funds/faculty
CLA	512	$17,291,589	$33,773
Med School	439	$168,806,030	$384,524
Inst Tech	367	$94,750,219	$258,175
UMD	301	$9,796,983	$32,548
Ag Food Env Sci	199	$22,857,277	$114,861
Educ Hum Dev	116	$25,793,256	$222,356
Morris	110	$533,414	$4,849
Carlson	99	$1,332,892	$13,464
CBS	89	$17,429,592	$195,838
Veterinary Medicine	73	$17,429,592	$195,838
Public Health	70	$59,026,499	$843,236
Human Ecol	66	$8,634,620	$130,828
Dentistry	54	$12,370,817	$229,089
Crookston	47	$1,074,105	$22,853
Pharmacy	43	$5,570,689	$129,551
Nat Res	39	$8,831,132	$226,439
Law School	39	$2,487,310	$63,777
Nursing	35	$3,087,093	$88,203
Gen College	33	$1,223,606	$37,079
Duluth Medicine	29	$3,877,498	$133,707
Architecture	24	$1,414,870	$58,953
Ag Station	22	$1,914,516	$87,023
Hunphrey Inst	19	$5,148,146	$270,955
Extension	2	$1,914,516	$957,258
Continuing Ed	2	$252,747	$126,374
Bell Museum	1	$0	$0

Sorted by amount of funding per faculty

	2004 Faculty	2004 Spons Funding	2004 Funds/faculty
Extension	2	$1,914,516	$957,258
Public Health	70	$59,026,499	$843,236
Med School	439	$168,806,030	$384,524
Humphrey Inst	19	$5,148,146	$270,955
Inst Tech	367	$94,750,219	$258,175
Dentistry	54	$12,370,817	$229,089
Nat Res	39	$8,831,132	$226,439
Educ Hum Dev	116	$25,793,256	$222,356
CBS	89	$17,429,592	$195,838
Veterinary Medicine	73	$10,144,148	$138,961
Duluth Medicine	29	$3,877,498	$133,707
Human Ecol	66	$8,634,620	$130,828
Pharmacy	43	$5,570,689	$129,551
Continuing Educ	2	$252,747	$129,551
Ag Food Env Sci	199	$22,857,277	$114,861
Nursing	35	$3,087,093	$88,203
Ag Station	22	$1,914,516	$87,023
Law School	39	$2,487,310	$63,777
Architecture	24	$1,414,870	$58,953
Gen Coll	33	$1,223,606	$37,079
CLA	512	$17,291,589	$33,773
UMD	301	$9,796,983	$32,548
Crookston	47	$1,074,105	$22,853
Carlson	99	$1,332,892	$13,464
Morris	110	$533,414	$4,849
Bell Museum	1	$0	$0

Source: OIRR baseline collegiate profile data

Appendix H Alignment of Recommendations with Five Action Strategies

Deliverables	Recommendations	Action Strategies				
		Students	Faculty and Staff	Organizational Culture	Resources and infrastructure	Public Engagement
Identification of emerging opportunities anticipated across the research spectrum: which ones are we currently positioned for; which ones represent opportunities where Minnesota can become a world leader; which ones should we develop, with what priority and in what	1. A separate study be done to recommend emerging opportunities in the Arts and Humanities. 2. Five areas of UMN strength and external funding opportunities - nanotechnology; infectious disease and cancer; neuroscience, cognition and behavior; climatology, ecology and renewable energy; and cyber infrastructure.	x	x	x		x
Recommendations regarding the infrastructure needs required to capitalize on major research opportunities (existing and emerging), including a gap analysis to identify what is needed to meet the short-term and long-term infrastructure to support research.	**Nanotechnology** 1. Contiguous research space for physical and life scientists working in these fields and by offering educational programs in nanotechnology for both undergraduate and graduate students. 2. Investments be made in state of the art nano fabrication and characterization equipment for core labs to be housed in this space. **Infectious Disease and Cancer** 1. Microbial pathogenesis and public health/epidemiology of infectious disease should be integrated in a Center for Infectious Disease and talented researchers must be hired to complement current strengths. 2. a fully equipped state-of-the-art Biosafety Level 3 facility be built in the facilities occupied by infectious disease researchers. **Climatology, Ecology and Renewable Energy** 1. a competitive multi-disciplinary climate change research institute 2. supports the proposal from the Initiative for Renewable Energy and the Environment (IREE) to establish the National Center for Bio-fuels Research (NCBR) facility. **Neuroscience, Cognition and Behavior and Cyber**	x	X	x	x	X

Appendix H Alignment of Recommendations with Five Action Strategies

Recommendations regarding how to assess the research infrastructure growth needs required to insure future competitiveness within areas of current strength and for areas of emerging importance. How should future infrastructure needs be identified, evaluated, prioritized, and financed?	1. objective analyses, similar to process used by RITF in their report, be used as one technique to assess strengths and to inform future decisions on research infrastructure needs. 2. All University Research Space Oversight Group be formed to provide input on the occupation of new buildings to ensure that decisions are based on scientific synergy not political expedience.	x	x	x	x	
Recommendations regarding a plan for supporting (establishing, maintaining, upgrading) the University's research infrastructure.	1. An All University Research Core Facility Oversight Group be charged with the task of ensuring that state of the art, major pieces of research equipment are available to qualified investigators and that this equipment be housed in relevant core facilities. 2. a Facilitator be appointed to the OVPR with the authority to investigate faculty claims of inefficient service and provide solutions.				x	
Assessment of the adequacy of the current configuration (administrative, location, organization, financing) of critical research support infrastructure.	1. faculty be provided with more department level administrative staff support of .grant submission specialists, who could aid faculty members on a temporary basis. 2. a truly user friendly electronic system for grant submission and accounting be produced. 3. access to electronic content be optimized and supplied, where appropriate, to all U of M faculty, students and staff. 4. aging Interactive TV systems be upgraded to facilitate the research activities of faculty members at the coordinate campuses.		X	x	x	
Recommendations regarding the relative advantages and disadvantages of centralized research facilities versus smaller, distributed facilities.	1. central core facilities be the preferred mechanism for delivery of research services that are useful to large numbers of faculty members.2. the Libraries be considered core research facilities whose resources are available to all University		X	x	x	

Appendix H Alignment of Recommendations with Five Action Strategies

Recommendations regarding current space or building challenges from a research infrastructure perspective.	1. the U of M develop a research space allocation and retention policy that takes into account the needs of individual faculty members and their funding level and that All University Research Space Oversight Group be charged with periodically adjusting space allocations within academic units according to established rules and guidelines.				x	
Recommendations regarding commercialization of research and intellectual property issues.	1. that translational research, patents, and other intellectual property activity of research scientists be recognized and included as a category in the tenure review process. 2 the development of the OBD and changes being implemented in PTM be closely monitored		x			x
Recommendations derived from an analysis of the practices of our peers and aspirational peers with regard to seeding, supporting, and sustaining a robust research infrastructure.			x	x	x	