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EXECUTIVE SUMMARY

The University Committee on Information Technology (UCIT), the faculty advisory committee to the Vice President for Information Technology, hosted three faculty focus sessions during academic year 2007 to discuss faculty needs for technology to support research, scholarly and creative activity through 2020. The year-long UCIT Vision 2020 initiative was intended to suggest how the University might anticipate change in order to take advantage of the future and recommend how the University might nourish change in order to make its own future. Faculty discussions focused on the changing nature of research and the University infrastructure and culture that supports and encourages this research. These discussions resulted in the following recommendations:

- In order to remain competitive, the University needs to create an advanced high performance central shared facility that can be used to advance technology-enabled research, scholarly and creative activity, prepare projects for large-scale national supercomputing centers, and provide the space, power and air conditioning to integrate faculty equipment.

- In addition to staff to manage the central facility and offer technical consulting, provide technical staff with domain research support experience who can be effective partners with faculty in advancing their research.

- In order to support the changing nature of research, scholarly and creative activity, create a research innovation center that provides research support and technology integration, encourages new efficiencies through collaboration and sharing resources, and is an intellectual crossroads where faculty can meet colleagues from other disciplines, learn from each other and identify opportunities for new partnerships.

For many Vision 2020 participants, the infrastructure and support envisioned in this report is a minimum requirement for a research university and is essential for Northwestern faculty to remain competitive. To accomplish these goals, participants recommend the University take the following next steps:

- Create a standing committee composed of representatives from the technology-enabled research, scholarly, and creative community and appropriate administrative representatives to identify and prioritize infrastructure and support requirements and coordinate establishing central services.

- Develop budget proposal guidelines help to fund the full spectrum of technology needs from equipment and maintenance to software and support and seek donors to help fund the research innovation center.

- In order to more fully leverage and benefit from these investments, become more actively engaged in developing relationships and influencing national priorities.

The issues and concerns identified in the Vision 2020 Focus Sessions are not localized problems for a small number of faculty or departments and are not specific to science and engineering or high-tech professors. The recommendations are strategic to remaining competitive as disciplines continue to evolve and new challenges are identified to expand knowledge and improve the quality of life.
OVERVIEW
In 2006, the University Committee on Information Technology (UCIT), the faculty advisory committee to Mort Rahimi, Vice President for Information Technology and Chief Information Officer, began discussions about faculty long-term technology needs. As a result of these discussions, UCIT hosted three faculty focus sessions during academic year 2007 to discuss faculty needs for technology to support research, scholarly and creative activity through 2020. The target year 2020 is purposely beyond most faculty’s tangible near-term goals, encourages one to look at longer term grand challenges, and is too far in the future not to be affected by unforeseen, disruptive forces.

The year-long UCIT Vision 2020 initiative was intended to suggest how the University might anticipate change in order to take advantage of the future and recommend how the University might nourish change in order to make its own future. The first focus session was for tenure-track faculty who have been at the University for five years or less to look at long-term opportunities for how technology might support their careers. The second focus session was for senior faculty with significant experience using technology to look at the long-term opportunities and needs for their research, scholarly and creative activity. All Northwestern University faculty were invited to attend this third focus session. All focus sessions were facilitated by Bill Decker who has served as Associate Vice President for Research and Chief Information Officer at the University of Iowa, then Program Director at the National Science Foundation for Computer and Information Science and Engineering Advanced Networking Infrastructure and Research (CISE-ANIR) before returning to UI as Senior Associate Vice President for Research, then Interim Vice President for Research.

Reference materials and background readings collected for the UCIT Vision 2020 initiative as well as summaries of the three UCIT Vision 2020 focus sessions are available on-line at: http://collaboratory.nunet.net/CollabJump/jumpToCybrary.cfm?libID=2228

ISSUES AND CONCERNS
The UCIT Vision 2020 faculty focus sessions were organized around discussions about strategic directions identified by funding agencies, transformations in the disciplines, and disruptive forces that could have direct as well as indirect impact on the University. Participants were asked about their technology needs to accomplish their goals over the next five years and what they will need to have in place in five years to be competitive over the next 5-10 years. Faculty discussions focused on the changing nature of research and the University infrastructure and culture that supports and encourages this research.
The Changing Nature of Research
From history to biology, economics to astrophysics, Northwestern faculty discussed the ongoing impact of technology on their discipline. They reported on how technology is enabling transformations within their fields and new interdisciplinary opportunities at the intersections of disciplines. Of particular interest was how technology is impacting their professional lives, dealing with an explosion of data and information, and new opportunities for collaborative and interdisciplinary work.

Faculty Professional Lives
The faculty described how they are becoming increasingly dependent on Web resources for all aspects of their professional lives. This goes beyond having personal Web pages for sharing publications and describing research to new forms of scholarship that include more collaborative and social engagement with colleagues. For many, the nature of scholarly publication is changing dramatically. It is no longer about just making a paper available electronically. Faculty said they need to be able to share and discuss datasets, code, and experiments from the research being reported, particularly in new fields, such as bioinformatics. Faculty also said they require tools for data mining, collaboration, and resource sharing in order to keep up with the literature in their field, to maintain awareness of related work in other fields, and to find opportunities for new interrelationships among digital materials across disciplines. In addition, attention will need to be paid to the social impact of using technology to create, share and interact as faculty move from a model of publish-to-read to a model of publish-to-collaborate. Northwestern faculty will need the tools and support to establish and maintain a professional Web presence and take advantage of new technologies that can bring a new immediacy to scholarly activity.

The Data and Information Explosion
Faculty pointed to an explosion of datasets and data feeds that is transforming some fields that were once model rich and data poor. They also noted the national push for transformation in clinical and translational research that will have major implications for storage, data management, and data access. Harnessing, preserving and migrating massive amounts of data and information, while addressing security, privacy and regulatory concerns, is driving new technology developments. Faculty said they are making new demands on libraries for services and will need new types of tools that enable them to analyze and manipulate information, work with very large digital collections and coordinate textual, visual and aural information. Visualization tools for very high quality representation of data are also needed to not only share research findings, but to help faculty tell the story that will inform and educate other professionals as well as the general public. Participants noted that some activities, such as decision making, will require different types of access to data and information. A significant challenge will be providing data and metadata in ways that will be useful as new disciplines emerge and materials are used in ways that were never anticipated and the appropriate metadata or tools do not exist.
Collaboration and Interdisciplinary Work
It was widely recognized that the complexity of interdisciplinary research, especially in areas like medical and biomedical science, is pushing the boundaries of and the infrastructure for collaboration. Faculty pointed to both NIH and NSF funding, for example, that often expects collaboration and interdisciplinary methods. Enabling effective collaboration will require very high definition, fast-streaming video to support immersive conferencing and applications. In addition to seamless communication, participants warned that platform-independent data and application sharing, especially desktop-to-desktop across different networks and firewalls, will be essential to avoiding roadblocks to collaboration. They emphasized that anything that can be done to enable seamless and effective collaboration will become even more critical as research communities and their funding agencies adopt a model of large-scale, interdisciplinary, international and inter-agency collaborative projects that will transform research and require effective means of communication and data sharing.

The Northwestern Infrastructure and Culture
Faculty discussions also focused on the resources, support and services required to enable their research, scholarly and creative activity. Faculty were particularly concerned about an inadequate computational infrastructure and support, the resulting impact on faculty productivity and competitiveness, and tendencies in the University computational culture that are counterproductive.

Knowledge and Support
Participants acknowledged that even though some of their colleagues may never become IT experts or understand programming, they need to be well-informed about technologies and methodologies that might benefit their research. In addition to training, support and advice on new research technologies from people with domain specific knowledge and technical expertise, many faculty also need basic training and support for application software and Web-based services, digital media production and publication, and setting up professional Web portals and services. For many faculty, the Library should be considered central to providing enterprise research services that keep up with and anticipate progress in digital technology.

With experimenters increasingly relying on computers for sophisticated analyses of large-scale data sets and large-scale computer clusters becoming the laboratories of theorists, the distinction between experimental and theoretical work is blurring. Knowledge and support for different types of computing platforms (e.g. parallel processors, tightly coupled arrays, distributed networked desktops) will be needed for different classes of problems and to develop new algorithms that can distinguish research efforts. As clear boundaries between disciplines begin to fade and new collaborative research teams emerge across disciplines, faculty reported that it is becoming increasingly difficult for them to find the support they need for their research. Faculty said they need support staff who know where to find and how to use data, instrumentation, computational resources and sensor networks at national and international research centers. Meeting this need will require staff who have domain knowledge, perhaps advanced degrees, and research support experience that enables them to be active partners in research.
Faculty Productivity

As research computing has moved from desktop computers and servers to small clusters, technology support is often provided by faculty and their graduate students. Faculty noted that the recent movement to larger 16-64 node, multi processor clusters and the need for larger storage and associated backup requirements are straining this support model and taking even more faculty and graduate student time away from research. To address the growing need for technical support, some researchers reported that when they have funds to increase salaries they have converted administrative positions to technical support. While helpful, a small technical staff can find managing the diversity and sophistication of research technologies challenging and faculty may still not be able to afford staff with the required technical expertise and education. Faculty also reported that they are now finding it impossible to meet the dramatically increased need for space, power and cooling of these larger systems. With the impact of supporting larger, more complex systems on faculty productivity an increasing concern, faculty warned that attracting funding could be come more challenging if they cannot be productive. While not a focus of the Vision 2020 discussions, faculty also stressed that anything that can be done to simplify and streamline their administrative responsibilities will be important in terms of managing the impact on researcher productivity.

Inadequate Computational Infrastructure

There is significant computational power, remote instrumentation and sensor networks available outside Northwestern at national supercomputing centers. However, before faculty can apply for time at these national centers, they need access to midrange resources where they can prepare code and problems they have been developing on their own small clusters. The lack of this type of staging facility for Northwestern faculty will become even more critical as new national petascale computing facilities become available and the gap between local research group and national resources increases dramatically.

Faculty expressed great concern that the lack of central high performance computing resources and collaboration technologies to support research and inadequate staff support is making it increasingly difficult for their grant proposals to be competitive and for programs to attract and retain faculty. Research groups are seeing opportunities for funding new facilities, but lack the required infrastructure to be competitive. Even after competing successfully for grants, faculty said they can find it difficult to establish the infrastructure they need because agencies, especially NSF, will fund computing hardware but not support personnel and space infrastructure. Participants reported that prospective faculty and research staff are turning down positions because the University lacks the necessary computing resources and support. Participant said they feel frustrated because they see no big picture or vision for computational support of research, scholarly and creative activity at Northwestern. They said that the planning and coordination of central resources should be of the highest priority for University strategic planning, given the direct impact of these resources on pursuing research opportunities.
The Northwestern Culture
By limiting computational resources only to what a research group can fund or is familiar
with, participants described Northwestern as having developed a “lab” culture that keeps
researchers more isolated and unaware of what others are doing. They suggested that this
has contributed to a weaker computational culture than might otherwise be the case. Too
often, they said, researchers struggle with a technical problem without knowing or being
able to find out if it has already been solved by someone else. Participants described the
result as a general balkanization of resources and a lack of coordinated support across the
University that results in lost research, scholarly, and creative productivity and an
unnecessary waste of human and financial resources. They suggested that a cultural shift
is needed to encourage interaction across disciplines to identify common interests and
needs and to avoid faculty reinventing solutions to problems that others have already
encountered. As one participant commented “… Either we hang together or we hang
separately.”

Researchers see the need to be able to quickly learn about the expertise and instruments
in other disciplines and be able to more easily develop partnerships that take advantage of
new applications for existing resources. For example, medical imaging tools are being
used to look at materials and develop mathematical models; and, molecular dynamics
software, sophisticated Monte Carlo computation, and manipulating of data will bring
people together from many different fields. Faculty suggested that new organizational
models may be needed in order to better coordinate resources and faculty needs and to
bring people together from different disciplines.

RECOMMENDATIONS: INVENTING/PREPARING FOR THE FUTURE
Vision 2020 participants were asked what technology planning and investments need to
be made to prepare for anticipated as well as unanticipated opportunities. They were also
asked what strategic planning and investments should be made that might enable the
University to nurture opportunities and invent its own future. Discussions focused on
technologies such as computation, storage, networking and applications such as
visualization that cross disciplines. The fast pace of change in these technologies was
recognized as a critical factor in defining the need for shared support and facilities.
Faculty felt that investments in collaborative technologies that reduce or eliminate the
impact of distance or lack of proximity on working together, and increase opportunities to
enhance faculty productivity would be equally important. There was agreement that
finding ways to maximize effectiveness and innovation while bringing people together to
share experience, pool resources, learn from each other, and find new interdisciplinary
partnerships would be an important strategic investment for inventing the future and
addressing cultural issues participants found troubling.

Faculty recommendations fall into three areas: create a shared central high performance
computing facility, provide shared technical support staff with domain expertise, and
establish a shared research innovation center to coordinate resources and bring faculty
together from across the University. It is important to note two common themes across
these recommendations. The recommended resources are shared across the University.
and faculty *investments* can play a key role in the expansion, renewal, and success of these resources to establish a new culture of cooperation.

- **Create a Shared Central High Performance Computing Facility**
  In order to remain competitive, the University needs to create an advanced high performance central facility that includes clusters of computers, large-scale flexible and extensible storage, shared software licenses and applications, collaboration resources, visualization tools, and data backup/preservation services. This facility will enable faculty to develop new algorithms and simulations, run data analysis tools on very large datasets, query digital archives, take advantage of advanced simulation and visualization software and leverage collaboration services. It will require the resources necessary to serve as a staging facility where faculty can prepare research code and datasets that will run on existing large-scale national supercomputing centers and the planned NSF, DoE and other agency-funded petascale facilities that will dramatically scale up the research problems that can be addressed.

  A central facility would also provide opportunities to consolidate existing resources from across the Evanston and Chicago campuses and expand as research grants are awarded in ways that enhance overall services and performance. For this to occur, the facility needs to provide physical space with racks, electrical power, air conditioning, networking and security for faculty research clusters and storage. As much as possible, faculty investment in new hardware, storage and applications should be integrated into these central resources so they can be made available to others when they are not needed by the research group making the investment. The campus network must provide the necessary bandwidth from research labs to make effective use of these central resources and provide robust connections to national and international research facilities.

- **Provide Shared Technical Staff with Domain Research Support Experience**
  In addition to staff to manage and maintain the central facility and provide technical consulting and support services, faculty need assistance from technical staff with domain research support experience and perhaps a graduate degree. They must be able to work collaboratively with faculty to evaluate and adopt new research applications and parallelize code to leverage cluster technologies. They must also be able to help faculty develop new algorithms, understand the potential of emerging search and analysis technologies for all media. And, they must be able to work with faculty to take advantage of advanced visualization capabilities, explore new collaboration services and adapt Web resources to meet their professional needs. Staff will also need to be liaisons with national supercomputing facilities and collaborative GRID initiatives to prepare research projects for scaling up to address much larger problems.
Establish a Research Innovation Center

In order to support the changing nature of research, scholarly and creative activity, faculty recommended that the University establish a resource and support center, much like the UIUC/NCSA Innovation Center. More than a place for technical advice and support for hardware installation and application configuration, a research innovation center would be a place where faculty can receive help that advances their research. This would include help in parallelizing code, using applications, developing new algorithms, working with data analysis tools, taking advantage of visualization software with advanced display technologies, and learning how to use virtual collaboration environments.

Staff at the center could also identify and integrate a common set of Web and application services that will meet faculty evolving professional needs. They could play an important role in coordinating software and support in ways that cuts across departments and disciplines and avoids the problems caused by independent, incompatible approaches to providing the same services. A research and innovation center could also provide a home for developing a common set of instructional materials on technology-based research techniques for students from different disciplines, as well as provide basic training and support to faculty. Staff could also help faculty bring research technologies into their courses and seminars to invigorate the curriculum and improve learning.

Faculty see a research innovation center as being an intellectual crossroads where they can bump into each other not only for causal interactions, but to meet colleagues from other disciplines, learn from each other and identify opportunities for new partnerships. There would be a focus on supporting collaboration and interactions among faculty and with students, both face-to-face and on-line, synchronous and asynchronous. Much as researchers might share computer nodes and storage in a common computational facility, faculty see the potential benefits of coordinating support staff through a center, thus gaining access to technical expertise they might not otherwise be able to them or in areas they know little about. The center could also provide “studio spaces” for project work and collaborative initiatives or to showcase accomplishments for funding agencies, foundations or corporate partners. As a nexus of innovation for using technology to advance research, scholarly and creative activity, a research innovation center could play an important role in encouraging new efficiencies through sharing resources, developing competitive grant proposals and in attracting and retaining faculty.

NEXT STEPS

For many Vision 2020 participants, the infrastructure and support envisioned in this report is a minimum requirement for a research university and is essential for Northwestern faculty to remain competitive. Significant investments in infrastructure and support will be required to transform the University culture from one where faculty feel they are on their own to one where faculty assume all things are possible and where
strategic incremental investments can open new possibilities. Critical to this cultural change will be creating a new research innovation center that can act as a change agent for identifying and promoting new technologies across the disciplines and provide an inviting meeting place for new partnerships to develop. To accomplish these goals, the University should take the following next steps:

- **Create a Standing Committee to Set Priorities**
  Identifying common interests and needs for the recommended technology infrastructure and support across disciplines, while balancing personal, local and centralized responsibilities, will be challenging. The University should bring together representatives from the technology-enabled research community in science, engineering, social science, humanities and the creative arts with appropriate administrative representatives as a standing committee to identify and prioritize common software, hardware architecture, storage requirements and support needs and coordinate establishing central services that will meet these requirements.

- **Develop Guidelines for Grant Proposals**
  Even with University investments and more effective use of existing resources, financing the necessary infrastructure and support will be another challenge. The University should work with faculty to develop budget proposal guidelines for funding agencies and foundations that can be used, as much as possible, to fund the full spectrum of technology needs from equipment and maintenance to software and support. The University should also seek donors to help fund the research innovation center.

- **Explore New Relationships and Influence Policy**
  In order to more fully leverage and benefit from these investments, the University should become more actively engaged in developing relationships with national research centers and become more proactive in influencing national priorities, initiatives, and policies that are of critical importance to the research enterprise.

**STRATEGIC BENEFITS**

The issues and concerns identified in the Vision 2020 Focus Sessions are not localized problems for a small number of faculty or departments and are not specific to science and engineering or high-tech professors. The recommendations are strategic to remaining competitive not only as disciplines continue to evolve and new challenges are identified to expand knowledge and improve the quality of life, but to assure that the University has the community and culture required to meet these challenges. Even though instruction was not a focus of the Vision 2020 discussions, many faculty commented on the significant impact these changes will have on their teaching and providing students with new research opportunities.
APPENDIX
UCIT Vision 2020 Participants

Focus Session Facilitator
Bill Decker, University of Iowa

Faculty Focus Session #1, Tenure-track Faculty (November 14, 2006)
Jose Andrade, Assistant Professor (MEAS Civil & Environmental Engineering)
Darren Gergle, Assistant Professor (SoC Communication Studies: Center for Technology & Social Behavior)
Xu Li, Assistant Professor (MEAS Biomedical Engineering, Electrical Engineering & Computer Science)
Yu Nie (Marco), Assistant Professor (MEAS Civil & Environmental Engineering)
Bryan Pardo, Assistant Professor (MEAS Electrical Engineering & Computer Science)
Neelesh A. Patankar, Assistant Professor (MEAS Mechanical Engineering)
Andrew Roberts, Assistant Professor (WCAS Political Science)
Russ Joseph, Assistant Professor (MEAS Electrical Engineering and Computer Science)
Suzan van der Lee, Asst Professor (WCAS Geological Sciences)

Faculty Participants #2, Senior Faculty (February 28, 2007)
Ted Belytschko, Professor (MEAS Mechanical Engineering)
Dan Garrison, Professor (WCAS Classics)
Franziska Lys, Associate Professor (WCAS German)
Martin Mueller, Professor (WCAS Classics)
Fred Rasio, Professor (WCAS Physics & Astronomy)
Allen Taflove, Professor (MEAS Electrical Engineering and Computer Science)
Mel Ulmer, Professor (WCAS Physics & Astronomy)

Faculty Participants #3, Northwestern Faculty (March 14, 2007)
Greg Beitel, Assistant Professor (WCAS Biochemistry, Molecular Biology and Cell Biology)
S. Hollis Clayson, Professor (WCAS Art History)
Mark Danskin, Professor (MEAS Industrial engineering and Management Sciences)
Tracy Davis, Professor (SoC Theater & Performance studies; WCAS English)
Hope Ehrman, Adjunct Senior Lecturer (WCAS International Relations and Political Science)
Susan Gapstur, Associate Director for Cancer Prevention and Control Research, Robert H. Lurie Comprehensive Cancer Center
Ahmad Hadavi, Adjunct Professor (MEAS Civil and Environmental Engineering)
Kemi Jona, Research Associate Professor (Learning Sciences and Computer Science)
William Kath, Professor (MEAS Engineering Sciences and Applied Mathematics)
Prem Kumar, Professor (MEAS Electrical Engineering & Computer Science; WCAS Physics & Astronomy)
Robert McDonald, Professor (KSM Finance)
Chris Riesbeck, Associate Professor (MEAS Electrical Engineering and Computer Science)
George Schatz, Professor (WCAS Chemistry)
Joshua Schnell, Assistant Chair (WCAS Biochemistry, Molecular Biology and Cell Biology)

Other Participants
Craig Bina, Professor (WCAS Earth and Planetary Science)
Sandor Mussa-Ivaldi, Professor (FSM Physiology/MEAS Biomedical Engineering)
Tamar Seideman, Professor (WCAS Chemistry)
Anup Shirgoankar, Postdoctoral Associate (MEAS Mechanical Engineering)

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University Committee on Information Technology (UCIT) 2006-2007
Chuck Dowding, Professor (MEAS Civil & Environmental Engineering), UCIT Chair
Susan Mango Curtis, Assistant Professor (MEDILL Clinical)
Gary Kendall, Associate Professor (MUSIC Music Technology)
Jim Houk, Professor (FSM-Physiology)
Jim Ibers, Professor (WCAS Chemistry)
Vicky Kalogera, Associate Professor (WCAS Physics & Astronomy)
David Liebovitz, MD, Assistant Professor (FSM General Internal Medicine)
Jen Light, Associate Professor (SoC Communication Studies)
Tom Simpson, Lecturer (WCAS French & Italian)
Chris Taber, Professor (WCAS Economics)
David Tolchinsky, Associate Professor (SoC Radio, Television & Film)

Gary Greenberg, Executive Director NUIT Teaching & Research Initiatives – ex officio
Sarah Pritchard, University Librarian (NU Library) – ex officio
Mort Rahimi, Vice President for Information Technology, Chief Technology Officer – ex officio

NU Information Technology
Jerry Goldman, NUIT Research Scholar (WCAS Political Science)
Joe Paris, Research Systems Engineer, Academic Technologies
Bill Parod, Scholarly Technologies Architect, Academic Technologies
Bob Taylor, Director - Academic Technologies