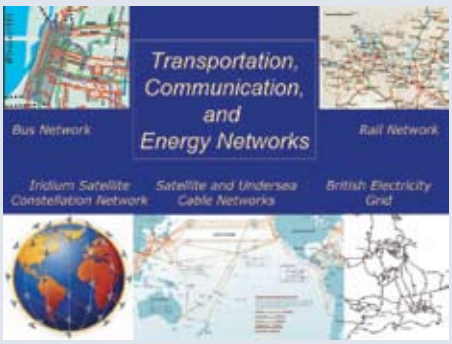
Virtual Center for Supernetworks Targets the Big Issues

It's been seven years since the Isenberg School's *Virtual Center for Supernetworks* debuted in cyberspace and five years since the center opened its own laboratory for computation and visualization in the Isenberg School. The brainchild of *John F. Smith Memorial Professor of Operations Management* **Anna Nagurney**, the center has been the logical but exponential extension of her problem-solving simulations of complex transportation, economic, financial, and telecommunications networks. Nagurney, who was recently named by *The Journal of Operations Management* as the most cited woman researcher in the field of operations management, is the author of nine books and hundreds of journal articles. More recently, she and her students have added computer modeling of utility grids, internet commerce, homeland security, and supply chains—including those for disaster relief—to their repertoire.

Tackling traffic flow. Here's how Nagurney and her students tackle urban traffic flow challenges. To determine, for example, the least time-consuming traffic route from point A to Point B in a transportation network, they might devise an algorithm based on the following strategy: fan out from the starting point and successively identify the next point in the network that offers the most efficient route from the starting point. The researchers feed their instructions to computers, which rapidly simulate alternative routes for comparison. Those comparisons might incorporate such variables as the day and time of the week, the physical quality of streets and roads, and weather conditions. They model the interactions among thousands of commuters/decision-makers interacting on such large-scale networks to determine the expected times of travel. Given the complexity of large-scale transportation networks, they have also been able to identify similarities of such systems with supply chains in which may decision-makers interact and compete for resources.

Why supernetworks matter. What makes Nagurney's center special, however, is its emphasis on *supernetworks*—the interaction of networks from ostensibly different domains. Consider, for example, the August 14, 2004 blackout of much of Northeast America's electrical grid. Recalls Nagurney: "During the blackout and afterwards, the failure of the power grid affected telecommunications networks, including cell phones and email servers. It paralyzed transportation networks, shutting down air and rail travel, which in turn spawned tremendous road and sidewalk congestion. In Cleveland, water distribution collapsed; nationally, the postal service experienced delays. And the blackout froze ATMs, throwing parts of financial systems into disarray."

A system in which havoc in one domain can instantly create cascading dysfunction in others, Nagurney adds, is a system that is especially vulnerable to natural disasters and terrorism. With partial funding from the National Science Foundation,



Nagurney and her former doctoral student Patrick Qiang '08 Ph.D. have addressed that timely concern by developing a computer-based tool that can identify the highest-use, most expensive, and most vulnerable nodes and links in complex networks. The tool has wide-ranging applications both for governments and companies.

Qiang is one of eight doctoral students who have worked as Supernetworks Center associates. Professor Nagurney's Ph.D. graduates continue collaborative research with the center as faculty members at SUNY Oswego, the

Anna Nagurney

University of Connecticut, Central Washington University, the University of Memphis, Penn State Hazelton, and other universities. Fifteen undergraduates have been student associates, three of them recipients of *21st Century Leader Awards*, the UMass Amherst campus's most prestigious campus-wide undergraduate distinction.

The center is the catalyst for the campus's student chapter of INFORMS (the Institute of Operations Research and the Management Sciences), which coordinates an innovative speaker series that brings high-profile academics and practitioners to campus. The chapter, which was honored in 2007 with the international organization's annual *Summa Cum Laude* award, also promotes interdisciplinary scholarship and spearheads community activities.

Since it opened its cyber doors, the center has attracted close to $1 million in grants and awards from the National Science Foundation, the AT&T Foundation, the Rockefeller Foundation, the Isenberg School's John F. Smith Memorial Fund, and other sources.

"Because research is intellectually challenging and socially useful, we've been able to grow steadily as a center," observes Nagurney. "But we've been living from grant to grant, from fellowship to fellowship. To devote our attentions more fully to growing our research, we need

an endowment that will cover our annual operating expenses."

A wealth of research opportunities. For Nagurney and her center, those research possibilities are truly astounding. Her algorithms and computer models—many of them based on variational inequalities—are remarkably robust and adaptable. At the same time, faster and faster computers allow those models to incorporate more variables and greater detail, yielding increasingly nuanced solutions in an increasingly complex society. No surprise then that last May, Professor Nagurney, with assistance from the Rockefeller Foundation, coordinated the international conference *Humanitarian Logistics: Networks for Africa,* which brought together academics and human services practitioners from 12 nations to a retreat in Bellagio, Italy. The conference examined logistics and supply chain research, African field experiences, and logistics partnerships among the academic community, African nations, and relief agencies.

What's next on the horizon for Nagurney and her center? "The more complex the system, the better," says Nagurney. "Our resources are made to order for capturing the complexity of international financial markets, homeland security issues, not to mention the complex socioeconomic effects of global warming. We have the right tool kit. Why not tackle the truly big issues?"

Visit the center's web site at http://supernet.som.umass.edu/

To learn more about supporting the work of the Virtual Center for Supernetworks, contact the Isenberg School's Director of Development, Ed Brozman at 413-545-5607 or at brozman@som.umass.edu

Dr. Mangaliso meets with prospective Ph.D. students in Johannesburg.

Isenberg School Professor Catalyzes Scientific Research in South Africa

"No other country has the equivalent of South Africa's National Research Foundation (NRF)," insists Isenberg School strategy and policy professor **Mzamo Mangaliso**, who served as the NRF's President and CEO from the summer of 2006 through the summer of 2008. The foundation owes its unique status, he emphasizes, to its interdisciplinary breadth, which incorporates support for research in the natural and physical sciences, engineering, the social sciences, and the humanities. It's as if America's National Science Foundation and its National Endowment for the Humanities were one overarching organization.

In his role as the NRF's top administrator, Mangaliso, a dual citizen of the U.S. and South Africa, managed South Africa's grant-based support for academic research and its growth plans for postgraduate research training. He also coordinated a portfolio of large-scale national research facilities, including observatories devoted to optical and radio astronomy, another observatory dedicated to observing the earth's magnetic field, an institute for aquatic biodiversity, a network of environmental observation units, a laboratory for accelerator-based sciences, and South Africa's national zoological gardens.

South Africa's geography and natural resources, Mangaliso emphasizes, offer diverse research opportunities. Its astronomical observatories—optical, radio, and gamma ray (in Namibia)—benefit from the country's absence of light and noise pollution and its scant atmospheric interference. The country is currently involved in beefing up its radio astronomy capabilities to prepare itself for 2012. That's when the international radio astronomy community will award a $1.8 billion contract to a country in the southern hemisphere to develop a square kilometer array (SKA) of radio astronomy observation antennae. South Africa is one of two finalists in the contest that began with seven bidders. The other is Australia. "We're also closer to Antarctica than most nations," he continues. "As a leading researcher there, we and our dedicated research ships investigate the continent's changing thickness due to global warming, its magnetic influence, biodiversity, and other phenomena."

The country's research also targets its rich biodiversity on both land and sea. "We have, for example, very advanced maritime research facilities and extremely sophisticated fishing technologies. Beyond biodiversity, NRF's iThemba LABS (Laboratory for Accelerator Based Sciences), produces accelerated beams of charged particles and neutrons for use in radiation