

March 8, 2007

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## Hepburn Fellow Karen Stephenson Brings "Mathematical Magic" to Education Reform

Thanks to the Katharine Houghton Hepburn Center, a pair of Bryn Mawr seniors are learning from a master how mathematics can illuminate the complex human interactions that make or break a school system. Huong Huynh '07 and Priscilla Won '07 are acting as interns to Hepburn Fellow Karen Stephenson in a project that applies Stephenson's innovative, math-based technique called Social Network Analysis (SNA) to two Philadelphia-area school districts.

The study is partially underwritten by the Math and Science Partnership of Greater Philadelphia (MSPGP), a National Science Foundation-funded education-reform project of which Bryn Mawr Professor of Mathematics Victor Donnay is a principal investigator. Donnay and Stephenson hope eventually to expand the study to include many of the 46 school districts and 13 colleges and universities that belong to MSPGP, in a project Stephenson likens to clinical trials of the effectiveness of SNA in an educational setting.



Stephenson, the founder and CEO of the management-consulting firm Netform, Inc., is a corporate anthropologist who exemplifies the Hepburn Center's characterization of Hepburn Fellows as "individuals who bridge academics and practice in nontraditional or unconventional ways." As an undergraduate, she majored in chemistry and art. After a brief career as a professional artist, she entered a graduate program in quantum chemistry at the University of Utah.

"I spent three years there doing heavy-duty math, and I also managed a laboratory to support myself," she says. "One day, as I stood on the mezzanine level of the lab, I saw repeating patterns of interaction among the lab personnel that were not unlike the patterns of interaction among particles that we described in quantum chemistry." Stephenson began looking for ways to apply the sort of computational modeling she had employed in chemistry to the phenomena of human interaction and communication — and, she says, transferred from the chemistry program "on a hunch" to study anthropology.

After earning a master's degree in anthropology, she found herself in Cambridge, Mass., where her then-husband had an appointment at Harvard, and she enrolled in a graduate anthropology course. Her paper for the course outlined an algorithm for mathematically inferring ancient trade routes, and it so impressed the professor that she was invited to join Harvard's Ph.D. program in anthropology. According to Stephenson, the department was reluctant to authorize her dissertation proposal, which involved investigating a corporate culture.

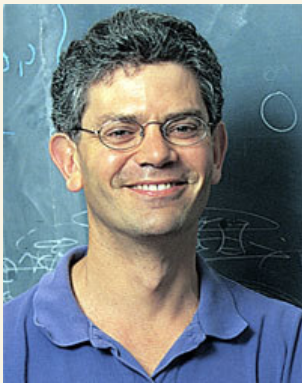
"It just wasn't done," she says. "They had to be convinced that a corporation had a culture worth studying. But all organizations have cultures," she says, "and they all have associated strengths and pathologies."

In the end, Stephenson prevailed. The innovative high-tech company she chose as a research subject had been rejecting requests to conduct a case study from Harvard's business school for

years, she says. But a co-founder of the company who had been a friend of Margaret Mead was more sympathetic to an appeal from an anthropologist, and her department relented when offered a plum long denied to the business school. Stephenson deadpans: "It's always heartwarming when one vice trumps another."

The story is an apt illustration of the power of the structures Stephenson analyzes — social networks that are invisible on organizational charts and transcend divisions like disciplinary boundaries. The fact that critical lines of communication rarely conform to formal hierarchies is hardly unique to Stephenson, of course, but the mathematical rigor with which she studies informal social networks may be.

The algorithm that Stephenson began to develop for her dissertation has been improved, Stephenson says, by years of research on hundreds of organizations. "A physician knows what normal, healthy blood looks like because they've done a whole lot of blood tests. I know what a healthy corporate culture looks like because I am sitting on the world's largest social-network database. I have more than 400 case studies. Certain patterns always emerge from the data. Some of them are impossible to see just by looking at a map of connections — you have to do the math to find them."



Stephenson has taught at the UCLA Anderson Graduate School of Management and the Harvard University School of Design; she now lectures at the Rotterdam School of Management at Erasmus University. Her company, Netform Inc., lists Merrill Lynch, Saatchi and Saatchi, International Paper, the National Institutes of Health and the Defense Advanced Research Projects Agency among its clients. She has recently done work for the National Education Association and is interested in applying her techniques to education. That, says Bryn Mawr's Donnay, made her a perfect fit for MSPGP.

"We've long had what we call an 'infection theory' of educational reform — that people become excited about reform and adopt new practices when they are introduced to them by someone they trust," he says. "So we've been trying to identify 'connectors.' I had heard about Karen's work with the [Philadelphia Connectors project](#), and I was very excited when I learned that she would be a Hepburn Fellow. When we discovered this common interest, we invited school-district administrators to a presentation and solicited participants for a pilot project."

Stephenson, accompanied by Donnay and his students, has visited the school districts to deliver presentations about the nature of the project and to collect survey data.

"The survey asks people a series of questions about their interactions with other people," Huynh explains. "For instance, 'If you have a great idea, whom do you tell? Who gives you advice about career strategies? Who talks to you every day?'" Stephenson, she says, has created computer programs that "do all the mathematical magic" and identify key actors in several different kinds of information networks.



**Huong Huynh**



**Priscilla Won**

Huynh and Won are assisting Stephenson with the analysis of the school districts' administration as part of independent research projects supervised by Donnay. In addition to observing her methods and doing prep work and data entry for Stephenson, they are doing directed readings in network theory and learning about measures of centrality within various kinds of networks. Huynh is writing a senior thesis about how the path of an epidemic can be predicted using such measures; Won is developing computer algorithms to analyze data about social networks.

"Karen is incredibly generous in discussing concepts and explaining the practical aspects of the study with the students," Donnay says. "She's a master, but she's so warm and welcoming that you forget that she's one of the world's top management gurus. While we're getting ready to go interview school administrators, she may be on the phone talking to the government about doing a study of an organization of 10,000 people."

"I've learned so much from this experience," says Huynh, "about how math can be used to identify key actors in a social network — not only for the purposes of analysis, but to help bring about change."