Gelpi: Beware unintended consequences in Iraq action

by Keith Lawrence

Despite its repeated warnings about the risk posed by Iraq, the Bush administration has yet to make a compelling case that Saddam Hussein is a central threat to American security interests, says a Duke political science professor.

"Saddam Hussein is undoubtedly a violent and ruthless individual, but is the enormous attention the U.S. has paid to him justified?" asked Christopher Gelpi, an associate professor of political science whose primary interests include international militarized conflict and strategies for international conflict resolution.

"If the departure of Hussein creates areas of Iraq that are essentially beyond the boundaries of state control, then our action might create more safe havens for Al-Qaeda to operate."

Christopher Gelpi

Gelpi said while it is true that Hussein may be developing weapons of mass destruction, "so are a number of other countries around the world — Iran, North Korea and others. Is it going to be U.S. policy to preemptively destroy weapons of mass destruction?"

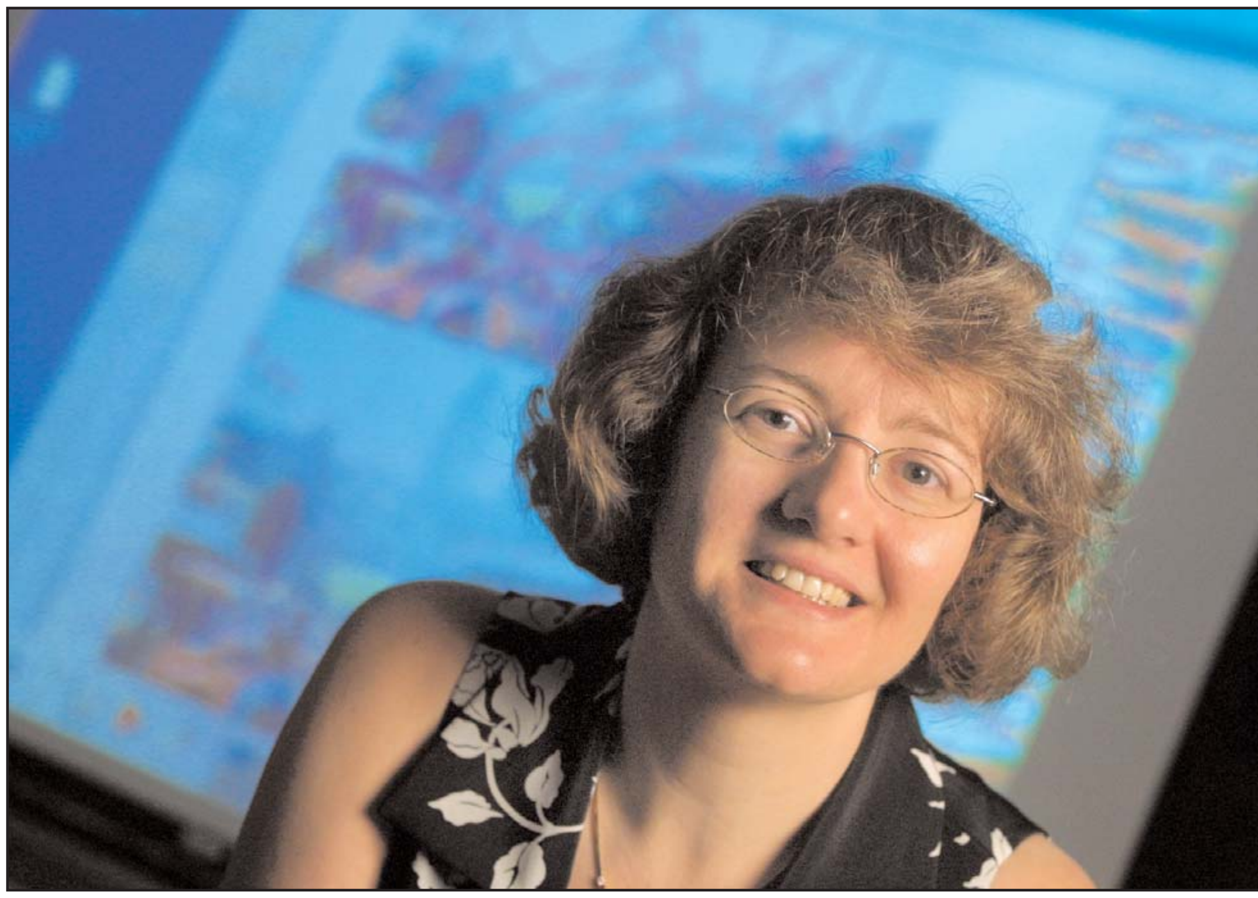
It is also true that Hussein is a ruthless leader who has killed his own people, Gelpi said, "but once again there are many other leaders that would match this description. Is it going to be U.S. policy to topple violent tyrants?"

Gelpi, author of the forthcoming book, *The Power of Legitimacy: The Role of Norms in Crisis Bargaining* (Princeton University Press), said the most powerful argument for toppling Hussein is he is likely to sell weapons of mass destruction to terrorists.

"But despite a great deal of effort, the Bush Administration has presented no evidence that Hussein has transmitted anything to Al-Qaeda. Also, one might think that after having invested so much time and effort into gaining a weapons-of-mass-destruction capability, Hussein might want to keep the weapons as a deterrent to enemies internal and external."

Gelpi said he worries that toppling Hussein might have unintentional consequences for the United States.

"The tapes obtained by CNN showed Al-Qaeda operating in Iraq, but in the Kurdish controlled area of Iraq. This raises serious questions about the implications of toppling Hussein. If the departure of Hussein creates areas of Iraq that are essentially beyond the boundaries of state control, then our action might create more safe havens for Al-Qaeda to operate."



Duke mathematics and physics professor Andrea Bertozzi on applying fluid dynamics to digital restoration: "The challenges in this problem are that you don't know what the solution is."

Photo: Jim Wallace

Applying math to digital restoration is an issue for fluid dynamics

by Monte Basgall

Andrea Bertozzi, a Duke professor of mathematics and physics, has borrowed from classic equations that describe flowing fluids to bolster the mathematical underpinnings of digital "in-painting," a computer technique to automate the restoration of damaged images.

As described on Web sites such as <http://www.math.duke.edu/~bertozzi/inpaint/inpaint.html> and publications such as *Science News* <http://www.sciencenews.org/20020511/bob10.asp>, Bertozzi and collaborators Guillermo Sapiro and Marcelo Bartalmio at the University of Minnesota in Minneapolis-St. Paul have used versions of the "Navier-Stokes equations" to help make marred images seemingly as good as new. The set of Navier-Stokes equations is ordinarily used by physicists and engineers to describe the motion of a fluid, which changes over time.

To date, their seemingly magical work has included automatically eliminating defacing scratches from a color view of a street scene, resurrecting pixels "lost" during digital compression of a still-life portrait of peppers, and electronically air-brushing out the safety harness from a photo of a plunging bungee jumper.

Traditional art restoration is a laborious process that involves using clues from the damaged part's surroundings to fill in by hand what is missing. Right now, the digital version is also time-consuming.

"Today, industry mainly uses manual tools," Sapiro said. "They use sophisticated computer programs to work with images, but the restorer interacts with the program." He described the process as "a very sophisticated, computer-based cut-and-paste."

Automating the digital restoration process is something different. "This is all work in the last year or two," Bertozzi said. "This is incredibly new. It's fun getting in on the ground floor and really trying to develop a field."

The collaboration began when Sapiro, who is an image-processing expert, showed Bertozzi what she called a novel "partial differential equation" that his group was trying to use to design an algorithm — a set of mathematical rules — to automate in-painting.

A partial differential equation (PDE) is one that addresses more than one changing condition, certainly the case with in-painting. But there was a problem with Sapiro's group's PDE. "They didn't have a lot of understanding of how it should behave" she said. "If you're trying to design a stable algorithm for image processing, the method underlying the algorithm is important."

An applied mathematician, Bertozzi was struck by the similarities between the Minnesota group's equation and another set of PDEs, the Navier-Stokes equations. In this case, she and her colleagues realized, the mathematics of fluid flow could describe the transport of images of variable intensities from the surrounding region into the in-painted area.

The beauty of using the Navier-Stokes PDEs is they describe conditions that "are very well studied," she said. "We were able to draw on decades of research already in place for fluids."

As with the changing conditions in fluid flow, "the challenges in this problem are that you don't know what the solution is," she continued. "You have to come up with an answer in the in-painting region and there might be more than one answer.

"One of the things about using a method like this for image processing is that we're not necessarily trying to reproduce reality. We're trying to produce something that looks realistic," she said.

In the case of the scratch-marred street scene, for example, the in-painting algorithm's goal would be "to fill in from the surrounding region what should go in the damaged region," she said. "So basically the algorithm has to automate the process that artists would do if they were to pick up a paint brush.

"What we do is use some ideas of how an artist works to construct a partial differential equation that would describe how you flow different colors into the damaged region."

The group's work has been supported by the U.S. Office of Naval Research and National Science Foundation.