

Regional

Mathematician improves cancer treatments

How does a medical doctor know how much, how frequently, and for how long a patient should receive a medical treatment like chemotherapy? Urszula Ledzewicz, distinguished research professor of mathematics and statistics at Southern Illinois University Edwardsville, knows. Her research in mathematics can help medical doctors prescribe more effectively a regimen for cancer therapy.

Ledzewicz's research centers on optimal control theory, a branch of mathematics that was born in the 1950s from the military needs of the Cold War. "It is basically how to control the spaceship or how to control the trajectory of a missile to obtain optimal performance," she explained. Ledzewicz is one of the pioneers who have applied optimal control theory to the biomedical war against diseases. More specifically, through optimal control modeling, she is able to help physicians and biomedical researchers understand the optimal use of pharmaceutical protocols and therapies for cancer treatment.

In cancer treatment, for example, more is not always better. More chemotherapy or radiation is not always the right answer. Through optimal control, Ledzewicz has learned that the frequency and amount of therapy of cancer treatment is not linear. There are points when the treatment should be lessened and the frequency should be reduced. Her research, consequently, helps physicians design more effective cancer therapy treatments.

"I realized that with the tools of optimal control, I could answer some of the questions that concerned how to design protocols for giving cancer treatments to patients," she said. "This can all be translated into a mathematical problem."

Explaining to medical doctors how mathematics can help them can be a challenge, Ledzewicz added. "You make it very basic and put mathematics in the focus," she said. "When you go to the doctors you turn the table around and you try to explain to them how mathematics can help. You don't focus on technicalities. You focus on what they can take along and use on the patient. If you just show them mathematics, you've lost them."

Given the implications of her research on human health, Ledzewicz said that she plans to construct a complete solution to the chemotherapy models in the form of a synthesis of optimal controls. The analytical results obtained for the model will help in the analysis of existing chemotherapy proto-



Professor Urszula Ledzewicz

cols – what drug dose has to be administered at what time with what length of rest periods in between to achieve the desired goals.

Ledzewicz earned her Ph.D. in mathematics from the University of Lodz in Poland and came to the United States as a one-year visiting professor at Louisiana State University in Baton Rouge. She said that the decision to leave Poland was a big gamble. She knew she could leave Poland, but once gone, she wouldn't be able to return as long as the Communist regime remained in

power.

"The political atmosphere in Poland at the time was not very nice and that was somewhat a contributing factor," said Ledzewicz about her decision to leave. The gamble for her was that she had no guarantee that after her appointment at LSU ended that she would be able to stay in the United States. It was at LSU that she first had the opportunity to lecture in English.

"I spoke basic English and read mathematical papers in English," Ledzewicz said.

"While I probably couldn't go shopping, I certainly could give lectures on differential equations." Fortunately for her and for SIUE, she applied for a position and was accepted. SIUE helped her obtain her permanent visa.

While at SIUE, Ledzewicz has received nearly every major research award the university has to offer. She received the Hoppe Research Award in 2002, the title of distinguished research professor in 2008, the William Going Endowed Professor Award in 2009 and the Paul Simon Teacher Scholar

Stephen Hansen College Talk

Award in 2010. In different ways, each of these awards recognizes the outstanding teaching and scholarly activity of Ledzewicz. Together, these awards celebrate the accomplishments of Ledzewicz as an outstanding teacher and scholar.

Ledzewicz is a nationally and internationally known scholar. In addition to her many publications, she has presented more than 180 papers at professional conferences on every continent in the world, with the exception of Antarctica. Ledzewicz has also received research grants from the National Science Foundation nearly every year since 1990.

And her students testify to not only the quality of instruction in Ledzewicz's courses, but also the hands-on research experience that has given them an edge in the job market. They speak of her persistent encouragement and her willingness to involve them in her own research, publications and conferences. And while students call her classes "rigorous" with "cutting-edge topics," they also call her instruction "interesting," "engaging" and "inspiring." She has been called a "fantastic and dedicated teacher, researcher, leader and role model."

Ledzewicz said that she developed her interest in mathematics because she was attracted to the "finality" of it. "The answer was either right or wrong," she said. "There was no ambiguity." Her first passion, however, is writing fiction. She has published three novels in Polish. Her latest novel recounts the life of a woman emigrating from Poland to the United States. Although not autobiographical, she did draw on many of her own experiences. After retirement, she said that she plans to continue her writing.

"Writing is very different from mathematics," she said. "You never know if the sentence is correct or not, and you keep writing and re-writing hoping to make it right. Math is much cleaner because you know if the answer is right or wrong."

Ledzewicz's innovative mathematical research on medical therapies has broad application. As future researchers explore how her work applies to other medical protocols, Ledzewicz said that she will be working hard on her next novel.

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