s Research

INFORMS President Brenda dietrich (left) presents Edelman Award to Marco Zaider and Eva Lee

O.R.
in the O.R.

Saving lives as well as money, Memorial Sloan-Kettering Cancer Center earns the Edelman with breakthrough modeling and computational techniques for treating prostate cancer.

Saving money is one thing. Saving lives is another. Saving huge amounts of money and an untold number of lives through the innovative application of operations research is the stuff that Edelman Award judges' dreams are made of. Thus, despite a formidable list of finalists loaded with Fortune 500-type companies like Coca-Cola Enterprises, Hewlett-Packard and DaimlerChrysler, the Memorial Sloan-Kettering Cancer Center won the 2007 Franz Edelman Award for Achievement in Operations Research and the Management Sciences by achieving breakthrough success on a human as well as a financial scale.

The award-winning work, entitled "Operations Research Answers to Cancer Therapeutics" for the purposes of the Edelman competition, is expected to improve the survival rate of patients with prostate cancer, reduce the side effects of treatment and, by some estimates, save $450 million a year in health care costs. It marks the first time that INFORMS has awarded the Edelman Award for a medical treatment designed to directly save and enhance human lives. The Sloan-Kettering story, which is about literally putting O.R. (operations research) in the O.R. (operating room), demonstrates how operations research could increasingly bring improvements to health care, not only in the areas of policy, finance and public health, but in diagnosis and treatment as well.

Dr. Marco Zaider, attending physicist in Medical Physics at Memorial Sloan-Kettering Cancer Center in New York and professor in physics (radiology) at Weill Medical College of Cornell University, shared the award with Associate Professor Eva K. Lee, director of the Center for Operations Research in Medicine and HealthCare in the School of Industrial and Systems Engineering at Georgia Institute of Technology.

The award presentation, held in conjunction with the recent INFORMS spring meeting in Vancouver, capped a nearly year-long effort to identify and verify outstanding achievement in operations research, a day-long series of presentations from the finalists and a gala dinner thrown in honor of it all. The Edelman competition, INFORMS' most prestigious award for specific OR/MS applications, is widely considered the "Super Bowl of O.R."

First awarded in 1972, the Edelman Award has traditionally honored projects that demonstrably and dramatically improve a critical component of a corporate or government entity's core business operations, thereby giving the client organization a competitive advantage while saving it enormous sums of money. In an ironic twist, saving money was not even on their radar when Zaider and Lee first began working together on the cancer project in 1996 while colleagues at Columbia University. Their sole focus was on designing an advanced treatment planning system to optimize radiation delivery to prostate patients. (It was only years later that Lee stopped to calculate the money savings based on the number of potential prostate cancer patients multiplied by the expected reduction in treatment costs associated with the new technique.)

The context of this work was a recent development in radioactive seed implantation (pioneered, among others, at Memorial Sloan-Kettering) which required that the treatment plan be calculated intra-operatively, immediately prior to surgery. The sine qua non of this approach is the ability to plan the treatment quickly — within minutes of acquiring relevant patient clinical images — and this is where operations research came to play a critical role.

The problem is relatively simple to understand: Given the presence of a malignant tumor in an organ tissue (in this case, the prostate gland) and a set of possible locations for placing radioactive "seeds" inside the gland to attack the tumor, where precisely do you place the seeds in order to best combat the cancer while simultaneously protecting healthy surrounding tissue?

What makes the problem difficult to solve is the multi-dimensional aspects of it. Traditional location analysis, for example, is generally concerned with two-dimensional problems. The prostate problem is three-dimensional in nature (and possibly four-dimensional, because tumors tend to change in volume over time). The problem is further complicated by the need to solve it in real time in order to be of practical use in an operating room environment, something traditional planning or existing O.R. techniques could not approach.

Protecting surrounding tissue is crucial because, as Zaider explains, prostate cancer is generally slow growing and takes a long time to "do bad things." As the saying goes, most people die with prostate cancer, not of prostate cancer. The major problem is the side effects that arise from traditional treatment, including urinary problems, rectal problems and sexual dysfunction. With the average prostate patient becoming younger due to increased testing, having life expectancies of 20-35 years after diagnosis and obviously desiring to lead a normal life, the need to minimize side effects is key to any solution to the problem.

Working with Zaider and others at Memorial Sloan-Kettering, Lee devised a sophisticated optimization modeling and computational techniques to implement an intra-operative 3-D treatment planning system for brachytherapy (the placement of radioactive "seeds" inside a tumor) that offers a safer and more reliable treatment. The real-time, intra-operative planning system eliminates pre-operation simulation and post-implant imaging analysis.

"We explained the clinical constraints to Eva — for example, we needed an answer in minutes instead of hours — and she designed a number of remarkable programs and software that accomplished all of our goals," says Zaider, who gives Lee the lion's share of the credit for the breakthrough. "In my view, her software is the next generation of intra-operative planning systems. Because her approach is general and flexible in nature, it can be applied to breast cancer and to many other types of cancer.

"One of the interesting things she was able to do in this program was write an object function that contains all the conditions that you are trying to satisfy," Zaider continues. "There are certain parameters that determine the importance of one condition versus another opposing condition, so individual physicians can adjust these constraints until they agree on a plan that is best for a particular situation or patient. In my view, Eva's approach moves the entire problem forward. The techniques are very powerful in any condition I can dream of in terms of when you're trying to solve contradictory questions."

For her efforts in ushering O.R.'s entry into the real-time medical treatment arena, Lee says, "I feel really good that we are doing something quite different. Hopefully, by winning the Edelman Award, this will open other opportunities for what operations research can do in a medical setting. Most of all, we are happy with the results in terms of quality of their lives."

Lee notes that while O.R. has been applied to health care issues for at least 30 years, most of that work has involved hospital management, particularly scheduling and logistics. "We've scheduled operations, but we've never been inside the operating room," Lee says. "We've never really helped with the surgery itself."

Thanks to the Edelman Award-winning work, operations research is now scrubbing in.

"This is about O.R. in the O.R.," Lee says. "It really is operations research inside the operating room setting, where we are actually impacting the procedure. We're not just giving hospitals a schedule so they can best utilize the emergency room or operating room; we are actually helping doctors with the procedure. That is quite new for operations research."

As reported in a recent article by Dr. Michael Zelefsky and his colleagues at Sloan-Kettering, "real-time intra-operative planning consistently achieved optimal coverage of the prostate with the prescription dose with

concomitant low doses delivered to the urethra and rectum. Biochemical control outcomes were excellent at five years and late toxicity was unusual. These data demonstrate that real-time planning methods can consistently and reliably deliver the intended dose distribution to achieve an optimal therapeutic ratio between the target and normal tissue structures."

Resulting reduction of complications (up to 60 percent) due to plans that deliver less radiation to healthy structures improves the quality of life for patients and has a profound impact on the cost for interventions to manage side effects. Lee and Zaider also report that the procedure uses significantly fewer seeds and needles compared to current best-practice procedures. Thus, the procedure time is shortened and less invasive, and there is less blood loss. As a result, patients experience less pain and recover faster.

Zaider, who readily admits that the only O.R. he was familiar with before collaborating with Lee was an operating room, says, "It really means a lot that for the first time to my knowledge the Edelman Award is recognizing work associated with medical treatment. The other unique thing about our winning this award is that Memorial Sloan-Kettering's sponsorship of the work done by Eva was not related to any financial aspects. We did not at any point consider money savings or whether it would be more expensive. The issue never came up. Our main purpose was not to save money, but to save lives. It just so happens that Eva later figured out that patients having less morbidity, taking less medicine, seeing fewer doctors and having less imagining studies done on them resulted in quite substantial savings."

Based on the range of costs of these procedures, Lee estimates conservatively that their elimination nationwide could save $450 million a year for prostate cancer care alone. If the technique is applied to breast, cervical and other cancers for which it is also well-suited, the total savings will be in the billions of dollars a year, according to Lee.

National distribution of the system will allow achievement of consistent treatment planning across different clinics, thus reducing the variability in the quality of treatment plans. The resulting plans limit urethral dose, decrease the operator-dependency and reduce the influence of the learning curve associated with prostate brachytherapy. These all have important consequences for the outcome of treated patients.

While neither Lee nor Zaider are involved in the marketing and distribution of the software that drives the breakthrough cancer procedure, they both maintain that simply knowing they are helping save countless lives and hundreds of millions if not billions of dollars — to say nothing about winning the Edelman Award — is award enough.

Edelman Award:
Names & Notes

Along with the Memorial Sloan-Kettering Cancer Center, the other Edelman Award finalists for 2007 included:

- **Coca-Cola Enterprises**, for a project entitled "Optimizing Distribution at Coca-Cola Enterprises"

- **U.S. Coast Guard**, for "Maximizing Aircraft Availability by Managing Aircraft Maintenance Throughput at the U.S. Coast Guard Aircraft Repair and Supply Center"

- **Hewlett-Packard**, for "Procurement Risk Management at Hewlett-Packard Company"

- **DaimlerChrysler and J.D. Power**, for "PIN Incentive Planning System: A Decision Support System for Planning Automobile Manufacturers' Pricing and Promotions"

Complete details of all the 2007 Edelman finalists, including the Memorial Sloan-Kettering Cancer Center, will appear in the February 2008 issue of *Interfaces.*

- **Doug Samuelson** of the Homeland Security Institute and **Steve Strauss** of AT&T served as coaches of the award-winning team from Memorial Sloan-Kettering Cancer Center for the competition, which included a presentation before judges at the INFORMS meeting in Vancouver.

- This year's Edelman judges included: **Brian Denton** (Mayo Clinic College of Medicine), **Srinivas Bollapragada** (General Electric), **Jeff Camm** (University of Cincinnati), **Mary Crissey** (SAS Institute), **Peter Norden** (Columbia University), **Graham Rand** (University of Lancaster, U.K.), **Anne Robinson** (Cisco) and **Bob Smith** (Monmouth University).

- **Gerald G. Brown**, a three-time Edelman Award Laureate and professor of operations research at the Naval Postgraduate School, served as host for the gala awards presentation. "I can tell you from my own experience that the competition for this award is unique, intense and rigorous," Brown said in his opening remarks.

- **John David Power III**, founder of J.D. Power and Associates, best known for its customer satisfaction research, was on hand as part of the DaimlerChrysler-J.D. Power joint entry.

*Peter Horner is the editor of OR/MS Today. **Barry List**, the director of marketing and public relations for INFORMS, contributed to this article.*