For Your Information

Santosa Appointed IMA Director

In July 2008 Fadil Santosa took the position of director of the Institute for Mathematics and its Applications (IMA) at the University of Minnesota. He succeeds Douglas Arnold, who had been director for IMA since 2001.

Santosa received his bachelor's degree in mechanical engineering from the University of New Mexico in 1976, and a master's degree and Ph.D. in theoretical and applied mechanics from the University of Illinois at Urbana-Champaign in 1977 and 1980, respectively. He was on the faculty of Cornell University in the theoretical and applied mechanics department before spending ten years at the University of Delaware in the mathematical sciences and mechanical engineering departments. He joined the University of Minnesota in 1995 as professor in the School of Mathematics. Santosa also serves as director of the Minnesota Center for Industrial Mathematics and has been involved with the IMA, first as associate director for industrial programs from 1997 to 2001, and later as deputy director from 2001 to 2004.

Santosa's research interests are in the areas of photonics, inverse problems, optimal design, and financial data analysis. Many of the problems he investigates are those that arise in industrial applications or in other areas of science and engineering. Santosa has served as a consultant for a number of companies and holds a 2006 patent for a spectacle lens design method.

Notices senior writer Allyn Jackson carried out the following email interview with Santosa.

Notices: *The IMA was founded more than twenty-five years ago. What do you see as the institute's main accomplishments in that time?*

Santosa: I credit the IMA's founding director, Hans Weinberger, with the vision of creating an institute that looks outside of mathematics for new opportunities for mathematicians. As a result, the IMA has had an impact on the direction of mathematical research, especially in fostering interdisciplinary research and education. Its accomplishments include establishing communities—networks of mathematicians and scientists—that work on mathematical problems arising in diverse applications such as materials science, biology, imaging, applied dynamical systems, wave phenomena. This kind of activity not only increases the impact of mathematics but also enriches mathematical research.

Fadil Santosa

Another accomplishment is the postdoctoral program. Over the twenty-five years, the IMA has had more than 270 postdoctoral fellows. Many of our former postdocs are established leaders in their fields, holding prestigious appointments in universities or high-ranking positions in companies. The sum of their influence on the mathematical landscape and on the national economy is tremendous.

IMA has been fortunate to have had visionary directors such as Avner Friedman, Willard Miller, and Douglas Arnold. They have each increased the importance of the IMA to the mathematical community, from development of industrial mathematics programs to training programs aimed at the mid-career university professoriate, as well as outreach activities to industry and the general public.

Notices: *There are nowadays many more math institutes than at the time of the IMA's founding. Does the IMA have a special or unique role or niche in the international landscape of math institutes?*

Santosa: Yes, I think the IMA does have a special niche. Unlike the other NSF math institutes, it runs yearlong programs. By focusing on a topic over a longer period, the IMA is able, through its programs and activities, to make a deeper impact in a field. It also makes a lot of sense in terms of postdoctoral training. A year is enough time to be immersed in a new area and to start contributing to that area. A typical annual program brings over one thousand visitors to the IMA. For a postdoc it is a great opportunity to network with the best and the brightest from the topical area.

The other unique aspect is that the IMA, through its very scientifically broad and strong board of governors and its academic and industrial advisory boards, has a pulse on the hottest areas of applications. More often than not, the focus area of the year becomes "red hot" partly because it is well timed and partly because of the intense activities around the area at the IMA. The other aspect that makes the IMA somewhat different is its active outreach to industry and government labs. We have become the math institute for one-stop shopping for industry, whether it is for mathematical expertise or talent.

Notices: *What do you see as today's role for mathematics in industry? Are the problems different than in the past?*

Santosa: I think mathematics is increasingly important and valued in industry. Mathematical training brings a unique perspective to industrial research. A mathematician can usually take apart a very complex problem and answer very fundamental questions by building simple models that capture the complexity of the problem. Companies appreciate mathematicians for their problem-solving abilities. In some ways, it's not what mathematics you are trained in; it is the way our training allows us to approach the problem that makes us particulary useful. I think it is for this reason that mathematicians continue to find employment in industry.

Over the years I have had the opportunity to talk to, and work with, people in industry who develop products such as implantable defibrillators, imaging systems, barcode readers, photolithographic devices, etc. I have first-hand information about how mathematics is used in each instance and often refer to mathematics as industry's secret weapon.

There has also been a major change in how companies do R&D in the past fifteen years or so. There are very few companies with large centralized research groups that serve as consulting units to the corporations. Today, companies form smaller research groups that support a particular product or service. There has also been a trend towards "crowd sourcing". This is where you pose your problem online and seek submissions from problem solvers. The best example of this is NetFlix's challenge. This is both a challenge and an opportunity for mathematics—a challenge because there is no longer a single place to go to talk to mathematicians in a company and an opportunity because mathematics can have a greater influence in the outcome of a product's development.

Notices: *Can you describe a particularly striking example of how mathematics made a real difference in an application area, an example that captures what the IMA is about?*

Santosa: I think one of the most compelling stories is how the IMA had a hand in creating new ferromagnetic shape memory alloys. Back in 1990, Donald Lord, who was then at Ford Motor Company, gave a talk at the IMA in which he showed beautiful and mysterious domain patterns in an alloy called Terfenol. The material exhibits a change of shape when a magnetic field is applied. In the audience were Dick James and David Kinderlehrer. They began working on a mathematical theory for this type of material. They conjectured that if a material could be found with both martensitic and ferromagnetic properties, such a material could be made to undergo much larger field-induced strains than Terfenol.

In the mid-1990s their theory led directly to the discovery of a new family of alloys of nickel, magnesium, and gallium, which are now termed ferromagnetic shape memory materials or FMSAs. A decade later these materials have been developed to the point of exhibiting magnetic field-induced strains one hundred times those of Terfenol, so that a magnetic field of less than 1 Tesla can induce shape changes of up to 10%.

This is a developing story, because people are discovering uses of FMSA's in microdevices such as valves and pumps for biomedical applications and microactuators and sensors. In fact, there have been several small businesses around the world based on products built out of FMSAs.

While we cannot plan for this sort of synergy to happen, we do set up the IMA to maximize serendipity like this. We are not alone with success stories like this. Similar ones from all the NSF math institutes can be found at `http://www.mathinstitutes.org`.

Notices: *How do you see the IMA developing in the future?*

Santosa: I am fortunate to be the director of a healthy and strong math institute, thanks to the tireless work of my immediate predecessor, Doug Arnold. I would like to continue to bring innovations to the IMA. I would like to see us reach further into new application areas. I would like to see the IMA grow in its role as a catalyst to increase the impact of mathematics in science, technology, and society. I would also like to see us engage an even greater portion of the mathematics community. I think we are poised to directly contribute to American competitiveness through our research and educational programs.

Correction

The September 2008 issue of the *Notices* carried the article "Old and new on the exceptional group G_2", by Ilka Agricola. This is an expanded translation of an article by the same author, "Zur geschichte der ausnahme-Lie-gruppe G_2", which appeared in the *Mitteilungen der Deutschen-Mathematiker-Vereinigung* **15** (2007), 242–248. The original appearance of the article in the *Mitteilungen* should have been indicated in the *Notices* translation. The *Notices* regrets this oversight.

—*Allyn Jackson*