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Carrier Wave

The Great Communicator*

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Special points of interest:

- The Great Communicator
- Winnipeg International Space Apps Challenges 2013
- Check our website regularly for upcoming event information

A recipient of 2011 year's prestigious Killam Prize, Lotfollah Shafai's research into antenna and satellite technologies has placed Canada in the forefront in developing new forms of both celestial and earthly communications – Lotfollah Shafai and Canada have enjoyed a mutually beneficial relationship.

As the second largest country in the world, yet one of its most sparsely populated, Canada has relied heavily on the University of Manitoba engineering professor's large catalogue of research and inventions in the field of antenna and satellite technologies to, among other things, connect remote communities and explore vast uninhabited terrain.

Late nights in the lab deserve a lot of the credit, but Shafai has become an international leader in his field partly because his experimental backdrop has been the uniquely difficult geography and demography of Canada.

And it is not just remote, rural Canadians who are affected daily by Shafai's communications research.

Because of advancements he has made in the connectivity and miniaturization of antennas, the modern-day cell phone no longer requires an antenna protruding out of its top. And those oversized television satellite dishes that were common backyard lawn ornaments a couple decades ago have been replaced by smaller rooftop dishes designed by Shafai.

"People just see the hardware, they don't see all the knowledge behind it," said Shafai.

Over the last 35 years, the Canadian Space Agency has frequently looked to Shafai for help in solving its communications conundrums.

Shafai is a Tier 1 Canada Research Chair in Applied Electromagnetics since 2002.

The lofty, Government of Canada posting provides Shafai with $200,000 in research funding annually.

April 2011, Shafai was recognized for his contributions to the engineering field. He was one of five prominent Canadian researchers awarded the $100,000 Killam Prize, which is one of Canada's most distinguished science awards, presented annually by the Canada Council for the Arts.

Born in Iran, Shafai completed a bachelor of science degree in mechanical engineering at the University of Tehran in 1963. The next year, following the advice of his brother, Shafai emigrated to Canada to attend the University of Toronto. He arrived in Canada with $35 in his pocket and no English vocabulary. For the first six months of his studies he required an English dictionary beside his textbook.

His decision to pursue an electrical engineering degree instead of continuing with his mechanical engineering studies was a surprisingly arbitrary one: he considered his language skills over any career motivations.

"There was only one professor I could understand and he was kind enough to listen to me," said Shafai.

That professor happened to be in electrical engineering; Shafai had found his calling.

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In 1969, shortly after completing a PhD in the Faculty of Applied Science and Engineering at the University of Toronto, he accepted a job as a lecturer in U of M's department of electrical and computer engineering. In 1978, shortly before being named a professor in the department, Shafai made his first major scientific breakthrough: designing the ground terminals for the Hermes satellite, which was at that time Canada's most ambitious space project. Canada, in a partnership with NASA, used the Hermes satellite to test satellite television signals over a network of ground terminals across the country.

The ground terminals were each the size of a small house.

As a result, to distribute them to points across Canada, they needed to be cut into smaller pieces, shipped by truck and then reassembled at their destination. Shafai designed a ground terminal a fraction of the standard size. His picoterminals, which were less than 2 feet wide, were installed in locations across Canada and used in the Hermes program to conduct experiments in teleconferencing, telemedicine and remote television distribution.

An oft-told story about Shafai's work involved him conducting final tests on the first Hermes picoterminal atop the roof of Shirleys Bay Communications research centre near Ottawa. Shafai was having scant success finding a clear signal through the dish so, on a calculated whim, he placed his wedding ring on top of dish's antenna.

Over his walkie-talkie, Shafai's colleagues from within the lab below immediately and enthusiastically confirmed that the picoterminal had found a signal.

As a last-minute design tweak, a signalconducting ring the exact size of Shafai's wedding ring was bolted to the top of each picoterminal antenna.

"His presence in this field can be seen throughout Canada in many ways, not just from his technical contributions," said George Eleftheriades , an electrical and computer engineering professor at the University of Toronto.

As an example, he pointed to the make up of the staff at the Communications Research Centre in Ottawa, which is the federal government's largest lab for telecommunications research.

"You get the impression when you're there that most of the antenna group are PhD graduate student of Shafai's," said Eleftheriades.

He noted that Shafai is also known prominently both nationally and internationally because of his leadership in bringing researchers together to share ideas at major technology conferences like ANTEM. Shafai established ANTEM in 1986 and it has grown to become Canada's foremost conferences on antenna and eletromagnetics research.

Perhaps ironically, given that his life's work has revolved around creating better communications systems for people, Shafai is a shy, understated man. He's most at home in the lab.

"I like building things," he said. The University of Manitoba's Applied Electromagnetics Lab—Shafai's main workspace—is largely made up of three echo-free, or anechoic, chambers.

Shafai, other researchers, and students use the chambers to design, test and characterize antennas, electromagnetic sensors and microwave components for a plethora of applications.

The lab was funded by the Natural Sciences and Engineering Research Council of Canada, the Canada Foundation for Innovation and the Manitoba Research and Innovation Fund. Shafai and his team finance the lab's ongoing development primarily through contract work—antenna testing, sensor development and so forth—for companies like Bristol Aerospace Ltd., Nortel Networks, Manitoba Hydro and InfoMagnetics Technologies Corp., Canadian Space Agency and other government departments, European Space Agency and U.S. interests. Various types of radio wave frequency and hardware testing occurs in each of the three chambers, which vary in size, but are each roughly 300 square feet.

In one chamber, researchers and students can test near-field signals like those that swirl around your head while speaking on a cell phone. In the other two chambers, far-field signal testing is done in which radio waves are bounced off of parabolic, reflective surfaces in order to mimic the effects of distance on radio waves. The far-field tests allow researchers to understand how radio waves behave after travelling distances of anywhere from two kilometres to to infinite.

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Thousands of blue, carbon triangles jut out of every spot of wall in each testing chamber. The triangles absorb radio waves, preventing them from reflecting and skewing test readings.

There are now a number of electromagnetics labs in Canada, although none as large or as equipped as the University of Manitoba's.

"I haven't seen a better antenna lab in any university anywhere in the world," said Eleftheriades. Shafai's work has also taken him and fellow researchers outside the lab to remote places like Canada's arctic.

In recent years, much of his focus has been on novel electromagnetic devices and interactions, such as electromagnetic mapping of Arctic sea ice. This study will help in understanding how the different characteristics of Arctic sea ice—its density, thickness, age—appear in satellite readings.

Other researchers can benefit from this study to understanding things like the seasonal behaviour of sea ice and how it is being effected by climate change.

"Lot is very much in demand,"said Frank Franczyk, a former student of Shafai's and founder of Persentech Inc., a small Winnipeg-based firm that is developing satellite technology for gathering vehicle travel data. Franczyk became keenly interested in electromagnetics 30 years ago while taking a third-year course taught by Shafai.

"It's a very abstract science and very mathematically intense," he said. "You really have to be a thinker, and Lot really is a thinker."

While contract work for industry has helped fund the development of the Applied Electromagnetics Lab, students have priority use of it, followed by researchers, then the private sector.

Franczyk noted that Shafai's day-to-day schedule reflects that hierarchy. "He would do his required classes and student interfaces during the day, then he would head home, maybe have something to eat, sleep a little bit, and then come back to the university and work on research through the night," said Franczyk.

"I in fact changed my habits to sleep during the day like Shafai and come to the lab at night."

Shafai, who remains an unpaid advisor with Persentech, gets particularly excited when he sees his research, or the research of students like Franczyk, applied in industry or in everyday life.

And while Shafai's research is grounded in abstract mathematical equations, radio frequencies and high-tech hardware, many of his contributions to the communications field have been driven by needs the layman can understand: the need, for example, for smaller communication devices that have better connectivity.

Another need the layman can understand: saving lives. Computational code he created has not only played a large role in modernizing antenna design, but has been key to the design of hardware for detecting land mines and undetonated bombs.

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A glimpse at some of his more recent research suggests that Shafai's future contributions to the field will increasingly seem like the stuff of science-fiction.

For example, through the clever manipulation of electromagnetic waves, he's exploring the concept of using a single antenna to create a series of virtual, or phantom, antennas that don't require a physical form to pick up signals.

"Most of my work is for something in the future," said Shafai. But that's how research is – it's looking at something you don't know about yet."

Announcement:

2013 IEEE AP-S Award Winner (John Kraus Antenna Award)

IEEE newsletter would like to extend warmest Congratulations to Prof. Lot Shafai on the prestigious 2013 IEEE Antennas and Propagation Society's John D. Kraus award. The award was established in 2003 to honor a team or an individual, such as Prof. Shafai, who devoted his professional career to make significant advancements in antenna technology.
Our Heartiest Congratulations!

Winnipeg International Space Apps Challenge 2013

Winnipeg International Space Apps Challenge**

Date: April 20-21, 2013

Location: University of Manitoba, Winnipeg

Sponsor: IEEE Winnipeg Section

In this event, UMSATS is partnering with NASA to participate in a 48hr hackathon to solve problems with people from all over the world. Go to http://spaceapps.umsats.ca for details.

There are four major categories of challenges:

- Software – APIs, databases, and other tools for managing data collected from space
- Open Hardware – technologies for space exploration
- Citizen Science – why we explore space presentations
- Data Visualization – visualizing data already collected by others

This event is free and open to anyone ages 16+. The top two solutions will receive prizes and be entered into the worldwide competition where they will be judged by a panel of NASA judges.

For more information please contact Dario Schor at dario_schor@umanitoba.ca.

***Reprint from the IEEE Winnipeg Section website: http://sites.ieee.org/winnipeg/2013/02/12/winnipeg-international-space-apps-challenge/*

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"The most beautiful experience we can have is the mysterious. It is the fundamental emotion that stands at the cradle of true art and true science."

Albert Einstein (1879-1955)

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Message from the Editor

I would like to thank Ms. Janine Harasymchuk, Client Relations Coordinator, Office of VP Research & International, for her extensive help to make this news available to IEEE newsletters.