skulematters

UNIVERSITY OF TORONTO APPLIED SCIENCE & ENGINEERING

VOLUME 8
ISSUE 2
DECEMBER 2006

Ideas. Innovation. Impact.

UofT Engineers Reshaping Our World

Our distinguished new dean, ***Cristina Amon***

insideskule

On the Cover:
Dean Cristina Amon, the 13th Dean of UofT's Faculty of Applied Science and Engineering.

www.engineering.utoronto.ca

Dean's Column and SkuleNews

Features

Volume 8, Issue 2, December 2006
Editor: Ruth Weinstock
Editorial Board: Dean Cristina Amon, Kate Brand, Sonia De Buglio (Chem. 9T4; MASc 1998), Dr. Greg Evans (Chem. 8T2; MASc 1984; PhD 1988), Jackie Isaac, Barry Levine (Ind. 8T4), Dr. Javad Mostaghimi, Andrew Stelmacovich, Ruth Weinstock
Contributing Editors: Kate Brand, Ruth Weinstock
Contributing Writers: Kate Brand, Zoe Cormier, Megan Easton, Marlena McCarthy, Kelly Robertson, Christine Ward, Ruth Weinstock
Design: Avi Dunkelman Design + Communications Inc.
Principal Photographer: Stephen Frost
Contributing Photographers: Kenneth Andreyo (Courtesy Carnegie Mellon), City Idol Volunteer Team, (Courtesy Dr. Elizabeth Croft), Camelia Linta, A. Makushenko and R. Ruslan (Courtesy Element 21), Lisa Sakulensky, Rahul Sarugaser, Greg Tjepkema, Andrew Wong
Printing: General Printers
Published biannually as a service to alumni, students and friends of the Faculty of Applied Science & Engineering, University of Toronto. Concerns research partnerships, alumni news, continuing education, internships and student activities.
Circulation: 40,000

Please contact:
Dean Cristina Amon,
Faculty of Applied Science & Engineering,
University of Toronto
35 St. George Street
Toronto, Ontario M5S 1A4
Telephone 416-978-3131
Fax 416-978-4859
e-mail: dean@ecf.utoronto.ca

Respecting Your Privacy:
The University of Toronto respects your privacy. We do not rent, trade or sell our mailing lists. If you do not wish to receive this publication, please contact us at **416-978-2139, 1-800-463-6048,** or **address.update@utoronto.ca**

Stay in Touch:
To give us your new address, visit us online at **www.skulealumni.ca** and click on Register Information, send an e-mail to info@skulealumni.ca or call us at **416-978-4941.** To see our online archives, visit the alumni website and click on *Skulematters*.

Taking Pride in Our Tradition of Innovation

Dear Alumni and Friends:

In July 2006, I was delighted to begin my tenure as Dean of UofT's Faculty of Applied Science & Engineering.

During my visits to UofT from Carnegie Mellon University, where I was Director of the Institute for Complex Engineered Systems, I saw a flourishing centre of engineering invention and interdisciplinary research. I learned of the long-standing and strong traditions that have gone into forging the Skule™ of yesterday and today and of the deep affection this institution has inspired for more than a century. I met first-rate faculty, staff and students drawn from around the globe, industry partners, and alumni who are respected as university and community leaders.

I was also struck by the remarkable community this Faculty has created from diversity – the diverse engineering disciplines taught here, as well as diversity in culture, gender and language. As a comprehensive and large university, UofT is a centre of intellectual fusion, offering engineers opportunities to exchange ideas with colleagues in other engineering disciplines, other Faculties, and other universities, as well as to forge links to industry and government. I believe innovation often occurs at the interface of disciplines, where knowledge overlaps and interconnects. This diversity and this synergy offer UofT faculty members and students an enormous competitive advantage in a world where knowledge is borderless.

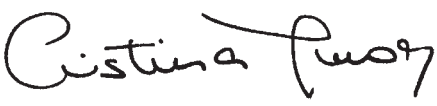
These are among the many compelling reasons that drew me to UofT. In my view, they are also indicators of an academic institution with unlimited potential. On behalf of the engineering community, I'd like to thank my predecessor, former Dean Tas Venetsanopoulos, for his role in helping this Faculty develop its potential. We all wish him well in his new role with Ryerson University (see story p. 4).

In my first few months here, I have also been heartened to meet so many enthusiastic and engaged alumni. Your input and support is critical to our growth, to renewing our Faculty, to delivering education of the highest quality and to creating a greater global presence. I hope to keep alumni well informed, tap your insights and expand the varied roles alumni play. Alumni are extremely well positioned to act as our ambassadors and raise our profile internationally. In my experience, alumni can also play a central role in recruiting and supporting top students.

This issue of *Skulematters* focuses on just a few of the recent and remarkable innovative activities of our faculty, alumni and students. Innovation makes us a force, not just a place. It is the key to sustaining our technological leadership. In an era of increasing budgetary constraints, it is critical to find the resources and build the infrastructure needed to attract and retain the professors and students who are driving the innovative research you will read about in these pages.

Though recent advances can be astonishing, we must not forget that in our 133-year history, UofT engineering alumni have set the bar high for excellence in innovation. To cite just a few examples: Edward S. Rogers Sr. (Elec. 1919-21) invented the world's first alternating current radio tube (see p. 4), and Gerald Heffernan (Metal. 4T3) pioneered the mini-mill steel manufacturing process. The forerunner of the "energizer" battery, invented by Lew Urry (Chem. 5T0), is honoured in the Smithsonian Institution beside Edison's light bulb. Bill Shaw (Mech. 6T1) won an Oscar for his role in the creation of the IMAX projection system. Jeffrey Skoll (Elec. 8T7) is renowned as co-founder of eBay. A complete list of alumni achievers would fill a book.

Our goal is to educate young engineers to make their own mark as leaders, innovators and engines of transformation, so that our tradition of pride continues. I welcome your comments and look forward to meeting many more members of our worldwide community.



Farewell to Former Dean Venetsanopoulos

Professor Anastasios (Tas) Venetsanopoulos, Dean of the Faculty of Applied Science & Engineering at the University of Toronto from 2001-2006, was appointed to the newly created position of Vice President, Research and Innovation, at Ryerson University in Toronto, as of October 1.

Photo: Lisa Sakulensky

Venetsanopoulos' five-year term as the Faculty's 12th Dean ended June 30. On June 28, a large crowd gathered to thank the Dean for his extensive contributions to the Faculty. During his 38-year tenure at UofT, the former Dean was a member of The Edward S. Rogers Sr. Department of Electrical and Computer Engineering, serving as Chair of its Communications Group, as its Associate Chair, its Associate Chair of Graduate Studies, and Acting Chair. He also held the Bell Canada Chair in Multimedia. Among the many accomplishments of Venetsanopoulos' term as Dean was his leadership of a Strategic Plan for 2004-2010 that set the direction for Faculty-wide revitalization and undergraduate curriculum renewal.

New Fellows of the Canadian Academy of Engineering

The distinguished achievements of four people associated with our Faculty led members of the Canadian Academy of Engineering (CAE) to induct them as CAE Fellows this past June. The four are: philanthropist Pierre Lassonde, President and Director of leading gold producer Newmont Mining Corporation, who has been an exceptional friend to the Faculty and a supporter of the Lassonde Institute for Engineering Geoscience (see p. 22); Professor Douglas Reeve, Chair of the Department of Chemical Engineering and Applied Chemistry; Professor Emeritus James W. Smith of the same department; and alumnus Larry Seeley (Chem. 6T6), founder of Recapture Metals.

Scholarship Recipients Thank Ted Rogers

Photo: Greg Tjepkema

The spirit of Edward S. Rogers Sr., one of Canada's most accomplished technological pioneers, was evident in a March 27 event held to recognize the 2006 Rogers' Scholars. In 2002, Edward Rogers' son, Ted, President and CEO of Rogers Communications Inc., and his wife, Loretta, honoured the 100th anniversary of his father's birth with a transformative $25 million gift. The couple stipulated that the majority of the landmark gift, $18 million, be used to create scholarships for students studying electrical and computer engineering at UofT, as Rogers Sr. did from 1919 to 1921. The remainder created two endowed research chairs, a laboratory in wireless communications and a new departmental name: The Edward S. Rogers Sr. Department of Electrical and Computer Engineering (ECE).

At the event, a speech by Ardalan Shojaei (ECE 0T6; in photo above), one of the 66 graduate and undergraduate scholarship recipients in attendance, related how dramatically and directly the scholarship has affected his life, as well as the lives of hundreds of his peers. Since the program began, more than 300 scholarships have been awarded to assist bright young students, inspiring some of our country's best electrical and computer engineering talents to strive for excellence.

Donegan Scholarships Aid Top Students

After graduating from the University of Toronto with degrees in Electrical Engineering (5T7) and Law (6T0), Ted Donegan built a distinguished legal career, culminating in the post of Chair of the Toronto-based law firm Blake, Cassels & Graydon.

To ensure that others benefit from a UofT education free of debt, the 70-year-old alumnus, who retired in 1994, donated $2 million to the Faculties of Applied Science & Engineering and Law. His gift to Engineering includes $600,000 to create scholarships for top high school students who have been accepted into UofT Engineering and later plan to study law, and $100,000 for a student design and study facility.

Convocation 2006

Photo: Lisa Sakulensky

Dr. Adele Buckley (UTIAS PhD 1974), Vice President, Technology and Research at the Ontario Centre for Environmental Technology Advancement and a distinguished advocate for environmental protection and nuclear disarmament, received an honorary doctor of science degree at Convocation on June 15. The research that launched Sciex was based on her PhD thesis.

Professor Douglas Perovic, Chair of Materials Science and Engineering, addressed graduates in the morning Convocation.

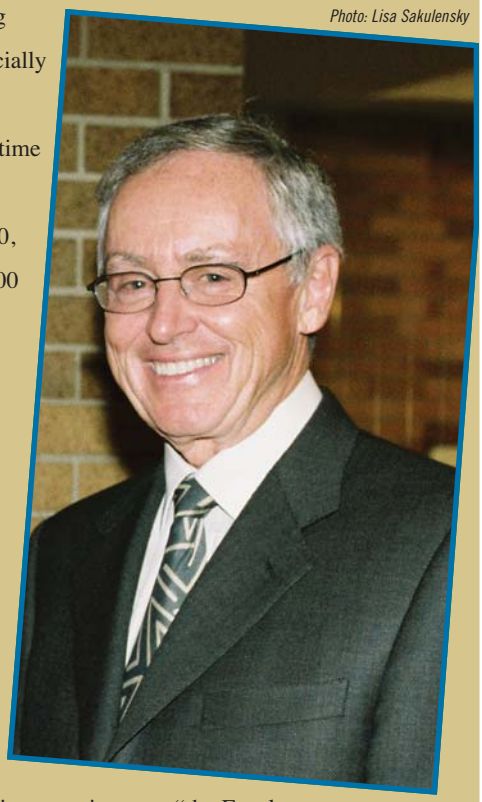
As well, Frank Dottori (Chem. 6T3), former President and CEO of Tembec Inc., received an honorary degree from the Faculty of Forestry.

Leading by Example

Ask Dr. David Colcleugh if the Faculty's undergraduate engineers are ripe for leadership training and you get a no-nonsense answer.

"There are no born leaders," stated the former Chairman, President and CEO of DuPont Canada Inc. "Anyone can learn how to be a better leader." But young minds, he said, are especially fertile ground.

Photo: Lisa Sakulensky



The respected, three-time UofT Engineering grad (Chem. 5T9, MASc 1960, PhD 1962), who led 4,000 employees at DuPont, should know.

He was recently appointed by Dean Cristina Amon as the Faculty's Leadership Development Professor, responsible for launching a multidisciplinary leadership curriculum. With the newly created three-year, part-time appointment, "the Faculty is well on its way to instilling leadership components into all aspects of its curricular, co-curricular and extra-curricular programming," said Greg Evans, Vice Dean, Undergraduate, and one of the bright minds behind the initiative. This new step in the Faculty's leadership strategy builds on the successful "Leaders of Tomorrow" Program, launched in 2002 in the Faculty's Department of Chemical Engineering and Applied Chemistry.

Together with faculty and students, Colcleugh is working to set the mission and vision of a leadership development curriculum, drawing on his 30 years of business experience. He is also setting out learning objectives and experiential learning opportunities for a new course — "Technology Leadership and Public Policy" — set to launch in September 2007. But don't expect the new course to be all stories and reminiscences.

Said Colcleugh: "I'm a great believer in disciplined, systematic processes. Even the really good leaders have to work at developing the right skills and processes."

Alumna Studies Long-Term Benefits of Green Roofs

Recent research by Susana Saiz (Civ. MASc 2004), civil engineering professors Christopher Kennedy and Kim Pressnail, and Brad Bass of Environment Canada's Adaptation and Impacts Research Division (part of the University's Centre for Environment) was published in *Environmental Science and Technology* and later reported in *The New York Times*. Saiz, an architect who did her MASc with Kennedy, designed the eight-story apartment in Spain that was investigated. Part of the research modeled the environmental impact of a green roof over the life of this building, illustrating several benefits in comparison to a conventional roof, in this location, including energy savings of 6% in the summer and 1% overall.

Fostering Alumni Relations

Photo: Lisa Sakulensky

Sonia De Buglio (Chem. 9T4, MASc 1998) has been appointed as the Faculty's new Associate Director, Alumni Relations. She joined the Faculty's Advancement Office on Sept. 18. As Manager of External Relations for the Department of Chemical Engineering and Applied Chemistry for the past 11 years, Ms. De Buglio played a key role in fostering a close-knit Chemical Engineering community. Ms. De Buglio looks forward to interacting with alumni and engaging many more in the life of their alma mater.

Alumna Dr. Elizabeth Croft Honored by CCPE

Courtesy Dr. E. Croft

The Canadian Council of Professional Engineers (CCPE) chose alumna Dr. Elizabeth A. Croft (MIE PhD 1995), a professor of mechanical engineering at the University of British Columbia (UBC), as this year's recipient of its Award for the Support of Women in the Engineering Profession. Just one example of Croft's commitment to increasing the participation and retention of women in engineering was a mentoring program she launched at UBC. It proved so successful it was later opened to male students and tripled in size in its second year.

Enhancing Student Life with the Atrium Campaign

Student leaders are working with the Faculty to renovate the Atrium in the Sandford Fleming Building. The Student Atrium Project campaign began this fall.

When long overdue upgrades are completed, the 29-year-old space will be poised to attract Canada's top students. The multipurpose space has long been a hub of student activity. It is used for studying, as a cafeteria, for meeting friends, band practice, construction projects (such as building the concrete canoe), group project work, and much more.

NSERC President Announces New Chair for Professor Paul Gauvreau

Dr. Suzanne Fortier paid her first visit to UofT, after her January 2006 appointment as President of the Natural Sciences and Engineering Research Council (NSERC), to announce a grant of $1 million to Professor Paul Gauvreau, Dr.sc.techn. P.Eng., of the Department of Civil Engineering. Gauvreau, who led one of the world's top bridge engineering design firms, now holds the new NSERC Chair in Design Engineering for the Urban Environment, a teaching chair intended to enhance the quality of the student experience.

Photo: Camelia Linta

In her speech at the April 27 event, Dr. Fortier stated that the results of Professor Gauvreau's work will benefit Canada by fostering better, more cost-effective and longer-lasting infrastructure, as well as improving students' education.

Collaboration — across engineering disciplines, across the University, with key urban stakeholders, practicing designers, builders and other universities — is a key element in Gauvreau's plans to raise standards of excellence. His industrial partners include: Brown and Co. Engineering, Delcan Inc., Halsall Associates Ltd., Invar Building Inc., Morrison Hershfield Ltd., Schaeffers & Associates Consulting Engineering, Stantec Consulting Ltd. and Rand Worldwide.

The new Chair-holder stated, "I see teaching as central to my mission and a means of helping to renew the practice of design."

Top Teachers

(l.-r.) Profs. Sheikholeslami and Kschischang

Photo: Lisa Sakulensky

An aptitude for making classes unforgettable propelled two outstanding professors in The Edward S. Rogers Sr. Department of Electrical and Computer Engineering (ECE) to win teaching awards on May 31, 2006. Professor Frank Kschischang received the Faculty Teaching Award – the honour reserved for outstanding senior instructors – while Professor Ali Sheikholeslami received the Early Career Teaching Award, both based on student and peer nominations.

Kschischang, whose classes often end in spontaneous applause, was elected by students as his department's "Professor of the Year" in 1992, 2001 and 2003. His classes have included visits from Nobel Laureates and successful entrepreneurs. Kschischang, the Canada Research Chair in Communications Algorithms, was recently elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). Professor Sheikholeslami's methods of encouraging creative thinking have been previously endorsed by ECE undergraduates who selected him as ECE "Professor of the Year" in 2000, 2002 and 2005. A senior member of the IEEE, Sheikholeslami returned to teaching this fall, after a year of research sabbatical with Fujitsu Ltd. in Japan and California.

The Engineering Faculty has been recognizing senior instructors with the Faculty Teaching Award since 1983, and teachers early in their careers since 1998.

Computer Animation Innovation Nets Oscar

"A milestone in computer graphics" led to an Oscar for Professor Demetri Terzopoulos. He is cross-appointed in ECE from the Department of Computer Science and is also a professor at the University of California, Los Angeles. Terzopoulos, along with Microsoft senior researcher John Platt, received a 2006 Academy Award for developing computer animation technology that makes simulated cloth look and move like actual fabric. "Our 1987 ACM SIGGRAPH paper is seminal to a very popular current trend in animation known as physics-based modeling," Terzopoulos said. Before the innovation, computer graphics models were based purely on geometry. Simulated cloth has appeared in movies such as the Harry Potter series, Monsters, Inc. and the Lord of the Rings films.

Eleftheriades and Gulak Named as Rogers' Chairs

Professors George Eleftheriades and Glenn Gulak, both of The Edward S. Rogers Sr. Department of Electrical and Computer Engineering, have been appointed to the Velma M. Rogers Graham Chair in Engineering and The Edward S. Rogers Sr. Chair in Engineering, respectively. Eleftheriades is one of the originators of the field of negative-refraction transmission-line metamaterials. His groundbreaking research holds potential for the development of enabling radio-frequency components and antennas for wireless telecommunications, among other applications. One goal of Gulak's research is the development of a CMOS Sequential Monte Carlo Receiver, illustrating the efficacy of the concept in real world, digital communication applications, leading to lower costs and more efficient wireless transceivers. Another research thrust involves the implementation of biosensors that detect and classify DNA, proteins, pathogens and chemical agents, enabling new applications in portable medical equipment.

Third International Victory for UofT Formula SAE Team

The UofT Formula SAE Racing Team streaked to a first place finish at this year's Formula Student World championship held in Bruntingthorpe, near Leicester, U.K., on July 5-8, 2006. This is the second year in a row the team has aced this international competition. Driving a car they designed and built, the SAE team bested 63 other groups from around the world in the grueling contest. To cap it off, the UofT team took home the Class 1 Dynamics award and placed second in the "Endurance" category. All 20 team members are engineering students. Those involved in the U.K. race were: Nadia Boin (team leader), Nilufar Damji, Antonio Gomes, Huang Iu, Vedran Juric, Jason Kao, Kevin Key, Stefan Kloppenborg, Maggie Lafreniere, Vince Libertucci, Neal Persaud, Andrew Wong and Daniel Zanini.

Photo: Andrew Wong

SAE Driver Vince Libertucci

The UofT SAE team has a stellar history of achievement. In 2003, the group became the first from Canada to capture the championship. The team also placed second in 2002 and 2004.

www.fsae.utoronto.ca

David McKay Wins Governor General's Silver Medal

David McKay, a 2006 Engineering Science graduate (physics option) was one of three students awarded the prestigious Governor General's Silver Medal for the highest academic ranking at UofT. He is the ninth Faculty of Applied Science and Engineering student to receive this award in the past decade.

Engineering Student Runs for Office

Environmental Engineering graduate student Bahar Aminvaziri (Chem. + PEY 0T4) defeated five other contenders in a June competition intended to jump start civic engagement. The winning prize was help in running for office in Toronto's municipal election, offered by "Who Runs This Town," the non-profit group that sponsored the competition. The 27-year-old political rookie was officially registered as a candidate, vying against 14 others to represent Don Valley West. During the campaign, Aminvaziri juggled part-time Masters degree studies with a full-time Ministry of the Environment job.

www.news.utoronto.ca/bin6/060621-2388.asp

Students Create New Bioengineering Labs

This September, students returned to a vastly improved bioengineering laboratory and a myriad of new and updated lab sessions that bring to life theoretical information, facts and formulas.

Fourth year students Eric Chung and Trevor Dell (both Eng. Sci. - biomedical option) worked this past summer under Lab Manager Bryan Keith to refine lab programs and create new state-of-the-art ones. Students now have 47 labs to choose from, up from 25 in 2005/06. This project was sponsored by the IBBME, the bioengineering program, The Edward S. Rogers Sr. Department of Electrical and Computer Engineering, and the Departments of Mechanical and Industrial Engineering and Chemical Engineering and Applied Chemistry.

cont'd

Renovations enlarged the facility's size by 60%, enabling two to four simultaneous labs and more than doubling the number of hours offered to students. New equipment includes devices to test gait and analyze brain waves and heartbeats.

For High School Students

High School Inventors Win Idea Competition

A design for an "intelligent" alarm clock brought first prize in the inaugural Idea Competition to ten Branksome Hall students last March. The winning group, one of 100 teams from across Ontario that sent in videotaped submissions, was awarded the top prize of $5,000 in scholarships and $1,000 cash for its concept of a clock that can monitor weather and traffic overnight, wake you earlier than usual and tell you which roads to avoid. The competition, run by Professor Parham Aarabi of The Edward S. Rogers Sr. Department of Electrical and Computer Engineering, encourages Ontario high school student teams to come up with novel technologies for solving global problems. Emily Debono, a member of the winning team, called the contest "empowering," while Aarabi said, "Everyone was impressed by the quality of the students' ideas." The next contest deadline is Dec. 1.

www.ideacompetition.com

New DEEP In-School Workshops

Toronto grade ten students learn about some of UofT Engineering's exciting research in the new DaVinci Engineering Enrichment Program (DEEP) in-school workshops. Visit ***www.ecf.utoronto.ca/apsc/html/deep/***

Ideas. Innovation. Impact.

UofT Engineers Reshaping Our World

**"You see things, and you say: 'Why?'
But I dream things that never were,
and I say 'Why not?' "**

GEORGE BERNARD SHAW

There is no limit to the innovation of UofT engineers. For more than 133 years, Skule™ has been the matrix for breakthrough ideas that have improved Canada's competitiveness and won international awards. Now, our alumni and researchers are accelerating discovery and making headlines around the world in emerging fields, including bio- and nano-technology, solar power and advanced materials. The impact of this 'enginuity' is gaining momentum in the health care system, in lower emissions on highways, in new-found sources of energy, on the sports field, in industry and elsewhere, creating knowledge, processes, products and devices to improve our health, prosperity, environment and quality of life.

From alumni, who have founded companies that are global leaders in their sector, to researchers advancing knowledge in the public domain, and blue ribbon students, this issue of *Skulematters* presents only a small and recent sampling of the exciting innovation that originates here.

Innovation and Leadership
Dean Cristina Amon

By Ruth Weinstock

Knowledge may be key to a country's competitive advantage, but it is people who embody, create, develop and apply it. With the July 1, 2006 appointment of Professor Cristina Amon as the 13th Dean of the University of Toronto's Faculty of Applied Science and Engineering, Canada has just gained a major competitive edge.

As Director of the Institute for Complex Engineered Systems (ICES) at Carnegie Mellon University's College of Engineering from 1999 to 2006, Professor Amon conceived and led interdisciplinary research initiatives, seeded high-impact projects, fostered a culture of innovation and furthered strong interaction with industry. Her background demonstrates that she is a leader who understands the forces that will shape tomorrow and the transforming impact of new technologies – qualities essential to keeping our Faculty in the forefront of the ever-changing and fiercely competitive global engineering environment.

Professor Amon is a gifted institutional leader, researcher and educator. She served at the top level of dozens of committees at Carnegie Mellon University (CMU) and numerous professional associations. Recognized as an international expert in the field of computational fluid dynamics, our new Dean has been invited to deliver keynote lectures worldwide. She has written one textbook, 12 book chapters and more than 200 refereed articles. She has won awards for her initiatives in attracting youngsters to engineering, as well as for guiding her CMU students (see p.10). Professor Amon is the first female Dean in our Faculty's 133-year history.

When it comes to defining engineering innovation, Dean Amon cites Albert Einstein: "Scientists investigate that which already is; engineers create that which has never been."

Einstein's distinction holds personal meaning for Dean Amon. Like many young people who enjoy math and science, she had to decide between science and engineering when she began her undergraduate studies at Venezuela's renowned Universidad Simon Bolivar in 1976. Always curious about how things work, Amon chose the practical over the theoretical. She explained, "I was attracted to engineering because I wanted to create things that have an immediate impact on society and on people's lives. From airplanes to artificial lungs, tissue engineering to electronics – all that innovation comes from engineers."

Dr. Cristina Amon:
Selected Awards and Honours

2006 > Elected to the National Academy of Engineering
> Named one of America's most important Hispanics in technology and business

2004 > EPPD Thermal Management Award – Outstanding Contributions in Thermal Management Applications to the Field of Electronic and Photonic Packaging, American Society of Mechanical Engineers (ASME)

2002 > Ralph Coats Roe Award, American Society for Engineering Education (ASEE)

2000 > Gustus Larson Memorial Award for outstanding achievements, ASME

1999 > ASME Engineer of the Year
> Distinguished Engineering Educator, Society of Women Engineers

1998 > Benjamin Teare Award for Excellence in Engineering Education, CMU

1997 > George Westinghouse Award, ASEE

Fellow > American Association for the Advancement of Science, American Society for Engineering Education, American Society of Mechanical Engineers, Institute of Electrical and Electronic Engineers

After earning M.S. and Sc.D. degrees at the Massachusetts Institute of Technology in 1985 and 1988, respectively, Amon was the first woman hired in the Mechanical Engineering Faculty at Carnegie Mellon University (CMU), later becoming its first female full professor. Her selection in 2001 as the Raymond J. Lane Distinguished Professor of Mechanical and Biomedical Engineering made her CMU's first female distinguished chair. She was the first female department head in CMU's College of Engineering and is now one of only a few female engineering deans in North America.

"Innovation … is about the people you have, how you're led, and how much you get it."
Steve Jobs, CEO, Apple Computer

The raw material that Amon worked with as an academic administrator at CMU was the University's talented faculty and students – a material she feels is also in plentiful supply at UofT. "You start with the right people, people who are passionate about making an impact, and provide them with incentives and seed funding for innovative research. There can be a direct relationship between investing in high risk projects and high payoff," the new Dean observed.

"My first impression of UofT is that we have remarkable faculty members, deeply committed to both novel research and to their students," she stated. "Their innovative research fuels our programs and provides our students with a distinctive and nurturing educational environment. I believe there is a synergy between top-notch research and excellence in education."

As Director of the Institute for Complex Engineered Systems (ICES), Amon conceived multidisciplinary research initiatives, and created a laboratory-oriented structure and an industrial affiliate program. She initiated industry-sponsored multidisciplinary courses, integrating education, research and engineering practice. Amon secured over $21 million in state grants to seed high impact research and leverage industrial funding. This strengthened the link between Pennsylvania companies, agencies and students, and improved industry competitiveness through technology transfer, knowledge transfer and retention of graduates in the region.

She recalled, "I felt it was my responsibility to get involved in administration. It was an opportunity to contribute beyond my own research and my graduate students, and to build new areas of research for the College."

Two recent initiatives at ICES were the launch of the Center for Sensed Critical Infrastructure Research and the Center for Nano-Enabled Device and Energy Technologies. Both bring together multidisciplinary teams of experts from CMU and different College departments – a collaborative pattern that Amon feels can be fruitfully applied at UofT.

"As we go forward, I hope we're going to continue to use technology to make really big differences in how people live and work."
Sergey Brin, Co-founder, Google

Dr. Amon's own research is in fluid dynamics and heat transfer. She pioneered the development of Computational Fluid Dynamics for formulating and solving thermal design challenges, including micro- and nano-scale thermal transport and mass transport, subject to multidisciplinary competing constraints.

Throughout her career, Amon has engaged in collaborative research at the interface of traditional disciplines, focusing on the areas of thermal engineering of portable computers and high-heat flux electronics, algorithms for thermal-fluid phenomena, and hemodynamics and transport in biomedical systems, such as intravenous blood oxygenators (artificial lungs) and abdominal aortic aneurysms.

Motivated by the need for accurate heat and mass transport predictions for designing the next generation of electronics and artificial lungs, respectively, her research group created algorithms and computational tools for sub-continuum micro- and nano-scale transport. This includes Boltzmann Transport equations for coupled phonon and electron transport, and Molecular Dynamics and Lattice-Boltzmann approaches for atomistic simulation of heat and mass transport, with the goal of bridging the continuum and sub-continuum simulations for multiple length- and time-scale hierarchical modeling.

A theme underlying her research is the development of numerical algorithms for thermal-fluid applications and system integration for device realization. This includes blending fundamental investigation with multidisciplinary engineering applications, focusing on those areas that have the most potential for both engineering and societal impact and merging research into technology development.

Transport of heat in electronics is a critical consideration in developing high performance but miniature-sized computers, as is transport of mass in developing effective intravenous devices that oxygenate blood in patients whose lungs are failing, another key biomedical application of her research.

Clearly, Cristina Amon has fulfilled her own dream of applying her knowledge to making people's lives better.

Education from the Ground Up

"I take pride in my students' personal and academic development. I enjoy watching them grow," Dean Amon said, reflecting on her teaching activities.

The Dean's achievements in education cover the entire spectrum, from conceiving, developing and teaching undergraduate and graduate courses in Mechanical Engineering, thermo-fluid engineering, design and computational methods at Carnegie Mellon University (CMU) to organizing award-winning programs designed to inspire Pittsburgh youngsters to explore engineering.

At CMU, she created a nurturing environment for her own students, involving undergraduate students in her research, advising 69 undergraduate and 21 masters projects, and mentoring 31 doctoral students, ten of whom now hold faculty positions.

From 1993 to 2005, Amon joined female and minority high school students in a summer workshop called 'Engineering Your Future' that she co-developed for the Society of Women Engineers. For more than ten years, ICES has hosted 'Moving 4th Into Engineering'. Fourth-graders from four public schools spend a full day on campus, in activities from rocketry to "fun with polymers".

"In educating our students to take a global perspective," observed the much-travelled Dean, "we contribute to Canada's strategy of developing a skilled and innovative workforce that is one of the best in the world."

Kenneth Andreyo (Courtesy Carnegie Mellon University)

Enlightened Innovation: Professor **Ted Sargent**

By Zoe Cormier

Professor Ted Sargent holds up a vial containing the first infrared semiconductor laser. Created using colloidal quantum dots, Sargent's remarkable innovation can be painted on other materials.

Professor Edward (Ted) Sargent (Photonics PhD 1998) of The Edward S. Rogers Sr. Department of Electrical and Computer Engineering (ECE) has devoted the better part of the last decade to finding ways to harness light with nanotechnology. Only 32, he has already published almost a hundred scientific papers – many of which have made headlines around the world. Almost monthly, his lab unveils another new way to engineer particles, less than a billionth of a metre in size, that can do the most extraordinary things.

His groundbreaking work towards the creation of a light-based internet has practically made him a household name in computer science. His contributions to solar cell technology may be immeasurable. Sargent is a rare breed among scientists: he has gained the deep admiration of both technophiles and environmentalists.

Since he was a graduate student, Sargent has worked towards the development of an optical internet – one based on light instead of electricity. An internet that sends information via photons instead of electrons could be up to 100 times faster than today's internet (and would consume less energy to boot). Sargent and his team have toiled for years to create switches, lasers, semiconductor circuits and computer chips that will help us get there.

Last year, he made international news when his team revealed a new type of solar power cell that can capture light. He and his team "see a huge need to find alternative sources of energy [to fossil fuels]," he said – and they found one. Not in nuclear power, wind power, or even in bright rays of sunlight; they found it in heat.

Solar energy is clean, but inefficient and expensive. But this may change now that Sargent and his team have created solar cells that can capture infrared light (light that is invisible to us but that we feel as heat). Conventional solar cells can only capture visible light, and therefore only harness about 6% of the sun's energy. Sargent's technology may be able to capture up to 30%. Even better, his solar cells can be painted onto surfaces – walls, fabrics and plastics.

Theoretically, flexible sheets of solar cells could be cheaply and easily rolled onto our roofs, MP3 players could soak up enough energy to run themselves and people could even wear power-generating clothing.

So important is this innovation, that, in 2005, Sargent was named as one of *Scientific American's* 50 (a list of 50 individuals and organizations that brighten our future through science and technology) – the only Canadian selected.

Sargent's lab continues to dazzle. This past July, he and his team set a milestone in the prestigious journal *Nature* with a description of the world's first "paint-on" infrared detectors, proven to be more efficient than conventional ones by up to ten times.

But perhaps even more fascinating than the power of light is "the challenge of harnessing the tremendous creative powers of a diverse [research] team," said Sargent. "Each of the challenges we tackle … relies on innovations in materials chemistry, device fabrication, and experimental optics and electronics."

"The process is daunting, fascinating and – when it comes together – infinitely rewarding."

http://light.utoronto.ca/tsargent

Quick Biography

1998 > Received PhD (ECE - Photonics) from UofT. Hired as a professor at UofT.

2000 > Granted the title Canada Research Chair in Emerging Technologies.

2002 > Named one of Canada's top 20 researchers under the age of 40 by the Canadian Institute for Advanced Research.

2003 > Listed as one of the world's top 100 young innovators by the Massachusetts Institute of Technology's (MIT) *Technology Review* magazine.

2004 > Ranked in the "Top 40 Under 40" by *The Globe and Mail's Report on Business* magazine. Spent the year as a Visiting Professor at MIT.

2005 > Named as one of *Scientific American*'s 50. Published *The Dance of Molecules: How Nanotechnology is Changing Our Lives*.

Taking Solar Mainstream: Professors Kherani and Zukotynski

By Ruth Weinstock and Kelly Robertson

An innovative process that makes silicon photovoltaic (PV) cells cheaper to manufacture and install has been developed by Professor Nazir Kherani and Professor Emeritus Stefan Zukotynski, of The Edward S. Rogers Sr. Department of Electrical and Computer Engineering. Kherani is also cross-appointed to the Department of Materials Science and Engineering.

ARISE Technologies Corporation, an Ontario-based solar energy technology company, has acquired patent rights to the new process. It has teamed up with Komag Inc., a major California manufacturer of thin-film disks, with the goal of bringing to market an 18% efficient cell in 2007, as compared to 14% for conventional cells. The continual drop in the cost of solar electricity is making its adoption more economically attractive. In fact, many predict that solar will become the lowest cost source of electrical power, according to Kherani.

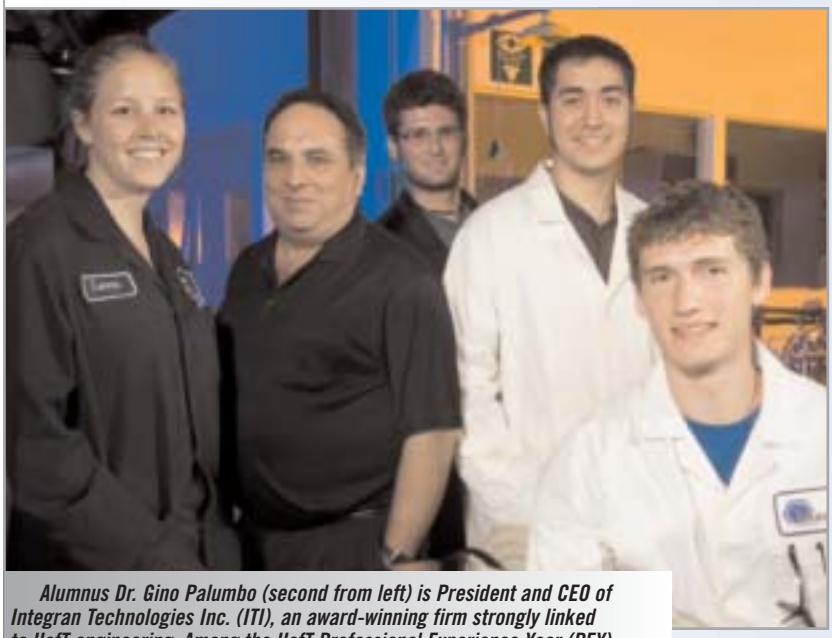
The process, called the dc saddle-field glow discharge deposition, uses silane precursor gas to deposit nano-metre thin films of amorphous silicon onto a crystalline silicon substrate. "This technology provides the lowest cost per watt [on the market]," said Professor Zukotynski, who counted versatility, scalability and uniform distribution as other virtues of the process.

In addition, the dc saddle-field technology will be used to develop advanced photovoltaic devices. "Our recently proposed novel solar cell topology indicates 20% plus efficiency," said Professor Kherani. Research support to develop the ultra-high efficient solar cells is being provided by the Ontario Centres of Excellence and ARISE.

www.ecf.utoronto.ca/~kherani

Alumnus a Global Leader in Nano-structured Materials

By Ruth Weinstock



Alumnus Dr. Gino Palumbo (second from left) is President and CEO of Integran Technologies Inc. (ITI), an award-winning firm strongly linked to UofT engineering. Among the UofT Professional Experience Year (PEY) students working at ITI's Toronto headquarters are: (l.-r.) Leona Smith, Thomas Arato, Marc Suralvo and Ian Winfield.

Dr. Gino Palumbo has a tiger by the tail.

As CEO, President and Co-founder of Integran Technologies Inc. (ITI), a supplier of nano-structured material technologies, Palumbo and his associates have parlayed innovative research on improving the properties of materials into more than 100 patents, a dizzying array of applications, an international customer base, several spin-off companies and multiple awards.

And it looks like there is more to come.

"A lot of the fundamental research on which our company is based originated at UofT," explained Palumbo, a triple grad (M.S.E. (formerly M.M.S.) 8T3; MASc 1985; PhD 1989). "We took this technology from pie-in-the-sky-science to commercialization. We are one of few companies that can put nano-metal products in your hand."

The company holds one of the first U.S. patents issued in nano-technology (the precise manipulation of individual atoms and molecules) dating to 1993. It is also one of the first in the world to execute bulk nano-structured materials for specific structural applications, including the award-winning Electrosleeve ™ process for steam generator repair. In collaboration with Professor Uwe Erb of the Department of Materials Science and Engineering (M.S.E.), ITI also developed the first major commercial applications for electro-magnetic nano-materials.

Lower cost, higher performance materials are ITI's signature. By altering the grain boundaries of materials, attributes - such as resistance to corrosion and wear, strength, hardness and energy absorption - can be improved. The result? Longwearing hip and knee implants, lightweight, rugged golf clubs and car parts, stronger watch gears, anti-microbial medical instruments, and even sunscreen with enhanced UV protection.

ITI's global client network includes Waterpik, the U.S. Department of Defense and Vascotube, a German medical tubing manufacturer. Operations include R&D for process and product design solutions, contract manufacturing, material sales and technology licensing for automotive, biomedical, aerospace, defense, nuclear, cosmetics and sporting goods applications.

Two proprietary methods for nano-material production give ITI its 'edge'. The Grain Boundary Engineering™ process alters the internal structure of materials on the nano-metre scale to dramatically improve features, including durability. The award-winning NanoPLATE ™ process adds nano-structured layers to surfaces. When used to replace electroplating, it eliminates environmental problems.

Although their work is the stuff of tomorrow, ITI and its predecessors have been in the forefront of metallurgical nano-technology for more than 20 years. The company's roots date to the internationally recognized research of Professor Emeritus Karl Aust (PhD 1950), an MSE faculty member at UofT from 1967 to 1991. Aust is still active at ITI and UofT.

Palumbo's imagination was captured by working with Aust at UofT, first as an undergraduate and later as a grad. In Aust's lab, Palumbo also met Uwe Erb, then a post-doc, and later a key figure at Integran. In 1985, Erb became the first to synthesize fully dense nano-structured materials. He has received multiple awards, particularly for his work in nanocrystalline metals. He held the Ontario Hydro Technologies NSERC Industrial Research Chair in Micro-Engineered Materials.

In the early 1990s, when Erb and Palumbo were both working at Ontario Hydro, their team developed technology for repairing nuclear reactors still used today. Their team also developed a technique for prolonging the life of lead acid car batteries, motivating Hydro to spin off a separate company. Integran was formally launched in 1999 by Palumbo and four Hydro colleagues.

Two and half years ago, after a management-employee buyout, ITI began a growth spurt, launching three spin-off companies. Power Metal Technologies Inc., a California-based sporting and consumer goods affiliate, supplies game-changing components for golf, baseball, cycling and hockey, as well as tennis racquets manufactured by Head.

A second company, Morph Technologies, commercializes ITI's nanocrystalline electrodeposition technology for automotive applications. The third spin-off, Pittsburgh-based Integran Defense Systems, recently signed an agreement with Science Applications International Corporation (SAIC) to pursue opportunities in aerospace and defense. SAIC operates in 150 cities worldwide and, in January 2006, reported annual revenues of $7.8 billion. ITI also plans future biotech and electronic materials spin-offs.

ITI has strong links to the Faculty. Of 35 employees in its Toronto headquarters, about 20 are UofT alumni. The firm works extensively with MSE Chair Professor Douglas Perovic, as well as Professors Aust, Erb, Glen Hibbard (a former ITI employee) and Robert Pilliar, of the Institute of Biomaterials and Biomedical Engineering and the Faculty of Dentistry.

In addition to PhDs from UofT active in research at ITI, eight UofT undergraduates are currently doing a 16-month Professional Experience Year (PEY) there.

"The light bulb goes on in their heads when they arrive here," Palumbo remarked. "I hope to do for these students what Karl Aust did for me – make engineering a creative endeavour."

Alumna Propels Golf to New Heights

By Ruth Weinstock

Nataliya Hearn (Civ 8T8) co-founded Element 21 Golf, a company based on the special properties of scandium.

Natalyia Hearn (Civ. 8T8) has some out of this world plans for her company.

Hearn is CEO and President of Element 21 Golf Company (E21), which markets golf clubs made with scandium – a super light and strong space-age alloy. To highlight her firm's claim that its clubs can significantly improve players' distance and accuracy, Hearn plans to have Russian cosmonaut Mikhail Tyurin use an E21 6-iron to propel a golf ball into orbit from the International Space Station this fall.

The imaginative stunt has been covered in the past half year by more than 100 news outlets worldwide. At one point, a Google search on the topic brought 44 million hits. See **www.e21golf.com.**

Scandium, originally developed in the seventies for the Russian space program, was kept a secret until the collapse of the Soviet Union. When the Ukrainian-born Hearn, and E21 Co-founder David Sindall, learned about scandium's special properties through their academic, business and government ties to Russia, they applied for U.S. patents. Their firm's name derives from the fact that scandium is the 21st element on the periodic table.

The company says its scandium clubs have a 25% strength-to-weight advantage over titanium and a 40% advantage over graphite clubs. An innovative design for the shaft – seamless extruded tubes, not the standard rolled and welded metal – gives E21 shafts "the lowest torque of any shaft in the industry," Hearn stated. "The energy redirected to the ball face creates an extra kick, while sparing the player's hands from the damaging shock, particularly on miss-hits."

E21 first licensed scandium to Easton Sports for its Red Line™ baseball bats; the alloy holds great potential for other types of sports equipment. Hearn foresees further applications of scandium's special attributes. Its reduced weight could mean fuel savings in aerospace and ground transportation. Ocean vessels could benefit from its corrosion resistance and superior fatigue and welding characteristics.

After earning her undergraduate degree at Skule™, the alumna became the first woman to receive a PhD in civil engineering at Cambridge University in 1993. She taught civil engineering at UofT from 1994 to 1999. Since 2000, Professor Hearn has taught in the University of Windsor's Department of Civil and Environmental Engineering.

"The amount of technological information squeezed into you at UofT was phenomenal," Hearn recalled. "What I'm doing now in business is parallel to what I learned to do as a student: take an idea and propel it to the next level."

Cosmonaut Mikhail Tyurin will propel a golf ball into orbit from the International Space Station using an Element 21 scandium golf club.

Photos: Courtesy Element 21 Golf Co.

Novel Material Accelerates Microelectronics Advances

By Megan Easton

A new class of nano-scale materials, jointly created by researchers in the Department of Materials Science Engineering and the Department of Chemistry (Faculty of Arts and Science), is generating excitement in the high-tech industry by promising to help make computers not just smaller, but faster and more powerful.

The material, known as three-ring periodic mesoporous organosilica or PMO, has a honeycomb-like structure with pores that are approximately two-billionths of a metre in diameter. The proportion of organic to inorganic material is higher than in all previous composites of this type, giving the new material unique properties that are ideal for insulating the tiny components used in today's ever-shrinking computer chips. Tests have shown the three-ring PMO to have a very low capacitance, which becomes an important factor to the flow of information as the space between interconnect wires in chips gets smaller.

"This is an example of how materials chemistry can provide innovative solutions to the design of novel materials."
- Alumnus Dr. Benjamin Hatton

"Industry is always looking for a better insulator. This is an example of how materials chemistry can provide innovative solutions to the design of novel materials," said Dr. Benjamin Hatton (M.S.E. PhD 2005), who led this research while he was a PhD student working with co-supervisors Professors Doug Perovic, Chair of Materials Science and Engineering, and Geoffrey Ozin, of the Department of Chemistry. Co-author Kai Landskron first synthesized the three-ring PMO as a post-doctoral fellow in Ozin's group.

In addition to its superior insulating abilities, the material is resistant to water adsorption and has a much higher stiffness than conventional porous materials. "We seem to have the right combination of attributes in this material to make it well-suited to the complex chip manufacturing process," said Perovic.

The discovery appeared on the March 2006 cover of *Materials Today*, although the original research took place several years ago and has been in development since then. Hatton, now a post-doctoral researcher at Bell Labs in New Jersey, remains involved in the UofT team's current plans to take the innovation from the lab to industrial application.

www.materialstoday.com/recentissues.htm

Sparking a Nano-tech Revolution

By Megan Easton

A nano-material enabling technology, developed by Professor Zhenghong Lu, of the Department of Materials Science and Engineering, is poised to revolutionize the multi-billion dollar flat panel display market and in the future may even revamp the everyday light bulb.

Lu is a recognized pioneer in the field of organic light emitting diodes (OLEDs), which are light-generating devices made on thin films of transparent plastic or metal foil. They are created by sandwiching layers of molecules between metallic electrodes, then applying voltage to convert electrical energy into visible light. OLEDs have many advantages over conventional liquid crystal displays (LCDs), which are currently used in high-resolution, portable technologies such as cell phones and laptop computers. OLEDs are thinner, lighter and less expensive to produce. Lu's research team was the first in Canada to construct flexible OLEDs on a variety of lightweight materials, paving the way for bendable television, computer and cell phone screens in the future.

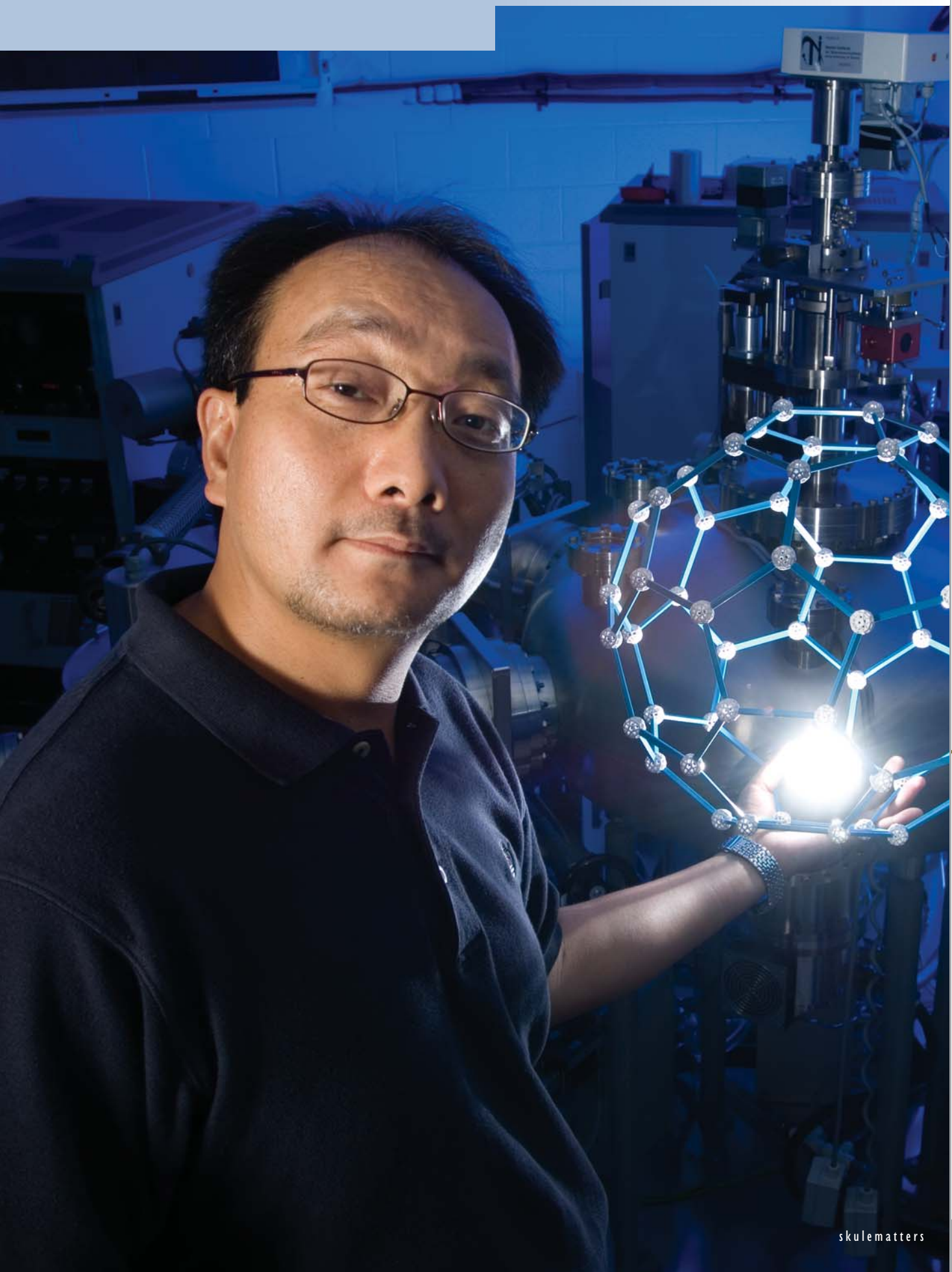
OLEDs have not yet replaced LCDs, but a recent nano-technology innovation by Lu will speed up this process by dramatically improving OLED performance. Lu was the first to use nano-structured fullerene – a form of carbon that acts as a super charge carrier – in OLEDs to deliver 50% to 100% more power efficiency, lower power consumption, improved lifetime and stability, and better colour. In 2005, the forerunner of Innovations at UofT patented Lu's breakthrough technology; the commercialization process is well underway. The technology licensee Norel Optronics Inc., co-founded by Lu in 2003, is negotiating with several Japanese flat panel makers to form a consortium for product development.

"This latest innovation has huge potential to replace the common light bulb."
- Professor Zhenghong Lu

Lu is also exploring the possibility of using his 'nanOLED' technology in general lighting applications. "This latest innovation has huge potential to replace the common light bulb," he said. Not only does it offer superior performance and energy efficiency, but it is also more environmentally friendly than compact fluorescent light bulbs because it does not use toxic mercury.

www.ecf.utoronto.ca/~luzheng/

Discoveries by Professor Zhenghong Lu, a pioneer in the field of organic light emitting diodes (OLEDs), have the potential to revolutionize the flat panel display and lighting industries.



Leading the Drive to Green Products

By Ruth Weinstock and Kelly Robertson

Professor Mohini Sain holds a car seat made from a new biocomposite material. It is one of dozens of recyclable products, from medical devices to parts for airplanes and autos, that could result from his innovative research.

Soybean car seats. Consoles crafted from corn. Natural fibre reinforced door modules.

Professor Mohini Sain and colleagues are spearheading a green revolution – and making headlines – with a process that results in strong, but completely biodegradable, interior and exterior components for cars and a wide range of other applications.

To create these light, recyclable biocomposite materials, strands of agricultural or wood fibres are extracted and treated with chemicals to break down the 'glue' that holds fibrous clumps together. Fibres are then combined with synthetic- or bio-plastic. Applying heat and pressure, they are compressed into various shapes. The process, which also works with flax, forest floor debris and wheat, minimizes structural defects, making a material tough enough to withstand roughly 15 years of use. Though creating biomaterials using natural products is not new technology, Sain's approach greatly improves strength and durability.

"By training PhDs and post-docs in this cutting-edge technology, we make Canada a leader in a rapidly growing, global field."
- Professor Mohini Sain

Professor Sain's resolve to focus on sustainable, clean technology started when he was growing up in India. The pollution was so bad, he felt he was "bathed in it". Cross-appointed to the Department of Chemical Engineering and Applied Chemistry (Chem.) and the Faculty of Forestry since 2001, he has published more than 300 papers. Sain directs UofT's Centre for Biocomposites and Biomaterials Processing, which collaborates with eight universities and more than 40 researchers across Canada, as well as more than two dozen private and public sector companies. Colleagues in the centre include Professors Chul Park and Jan Spelt (PhD 1985) of the Department of Mechanical and Industrial Engineering, Mark Kortschot (Eng. Sci. 8T4, MASc 1985) of Chem., and Ming Yang (PhD 1997) of Chem. and Forestry.

"The centre is active in nanotechnology research," Sain said. "We are attempting to incorporate micro- and/or nano-sized natural fibres and capitalize on the characteristics of certain plants to fit particular applications." For example, hemp is tough and has a high energy absorption capacity, making it appropriate for automotive applications.

Sain created a prototype of a natural fibre-based door module in 2003, and is working intensively with Magna International Inc. and Auto-21 to commercialize it and other natural fibre car parts. Sain said he would not be surprised to see biocomposites comprising 20% to 25% of cars in five years. Agriculture or wood fibre based biocomposites have already been commercialized for use in decks, shingles, siding and patio furniture. Additional applications potentially include electronic devices, furniture, sports equipment, paper, construction materials, and medical devices, such as cardiac devices and intravenous blood bags. The centre is also exploring "nano-biocomposite" technology that could someday be used

in tissue engineering. And, it is working with the Ontario Ministry of Agriculture and Food to use wheat straw, soybean oil and cornstarch for nanocomposite applications, such as using soybean oil to create airplane wings. Vehicles made using plant fibre composites offer many benefits. When compared to the materials the biocomposites replace, production can consume less energy, cost less and result in reduced greenhouse gas emissions. Plants are also a renewable, non-depletable resource. Some composites can offer product design flexibility, noise absorption and insulation. Weight reduction translates into better gas mileage.

Sain adds another advantage: "By training PhDs and post-docs in this cutting-edge technology, we make Canada a leader in a rapidly growing, global field."

Alumni Build a Hydrogen Powerhouse

By Zoe Cormier

On August 10, 2006, Hydrogenics Corp. hit the big one. The pioneering firm, co-founded by alumni Pierre Rivard (MEng 1994) and Joseph Cargnelli (Mech. 9T2, MASc 1995) received an order for 500 hydrogen fuel cells from American Power Conversion (APC) – the largest order ever for the global hydrogen fuel cell industry. "This is an important milestone – this is truly industry defining," said President and CEO Rivard.

In 1995, Hydrogenics was launched with just three employees and a dream: to be at the forefront of a global economy based on hydrogen. Hydrogen eliminates concerns over greenhouse gases and pollutants, it can be produced anywhere in the world (so it isn't subject to price fluctuations or wars) and we will never run out of it.

Although its ultimate dream has yet to be realized, Hydrogenics is on its way. The Mississauga-based company now has 300 employees and operations in more than 100 countries. In 2005 it had net sales of $37.6 million. In 2004, the World Economic Forum called it a 'Technology Pioneer' and, in 2003, *Profit* magazine cited it as Canada's fastest growing company.

Hydrogenics creates products for all levels of the hydrogen economy – generators that create the pure hydrogen gas, fuel cells that produce electricity using hydrogen, and test systems to assist in the development of fuel cells.

The automobile sector promises the most exciting future, including the potential for hydrogen-powered vehicles to generate electricity. To date, Hydrogenics has provided fuel cells for buses from Hawaii to Europe. It is also involved in projects with major OEMs and in the construction of fueling stations for California's eagerly awaited 'Hydrogen Highway'.

Rivard predicted it will be at least three years before consumers can buy hydrogen cars, if not more. In the meantime, Hydrogenics already has other fuel cell products in the marketplace – batteries for forklifts (which operate indoors and are therefore subject to emissions regulations), back-up AC systems for data server rooms (like those that APC purchased), and back-up DC systems, such as telecommunications relay towers for cellular phone companies.

"We're evolving from a project-based business model to a product-based one," said Rivard. "We've invested in hiring people with the right skill sets to develop products and in securing agreements with key partners to distribute the products into well-targeted markets."

At least 30 Hydrogenics employees are UofT engineering graduates – including Chief Technical Officer Joseph Cargnelli and Norman M. Seagram (Eng. Bus. 5T8), Chair of its Board of Directors. "We have a strong history with, alignment and allegiance to UofT. This is a key source of pride for us," said Rivard.

Cool Innovation in Thermal Storage

By Marlena McCarthy

Professor Masahiro Kawaji (Eng. Sci. 7T8), leader of the Sustainable Energy Research Cluster in the Department of Chemical Engineering and Applied Chemistry, has created a simple, small and portable device that can keep the interior of a stopped car or truck cool without having to keep the engine and air conditioner on.

Kawaji and two Japanese researchers created a device that plugs into a cigarette lighter. In two hours, it creates ice and then supplies a stream of cool air for up to 30 minutes. Particularly beneficial for professional drivers, this unit will save gas and the environment by cutting down on engine idling. Kawaji was granted a U.S. patent in June 2006.

New Plant Produces Diesel Fuel from Waste

By Ruth Weinstock

This summer, BIOX Corp. completed the construction of one of the world's largest continuous flow facilities for biodiesel production. The Hamilton plant increases BIOX's output from one to 60 million litres per annum. BIOX was founded in 2000 to commercialize the groundbreaking technology for producing biodiesel developed by Professor David Boocock, of the Department of Chemical Engineering and Applied Chemistry. Boocock's process makes churning out the green fuel faster and cheaper than previous technologies. It transforms recycled cooking oils, yellow grease, animal fats or any seed oil into a renewable, biodegradable and sulphur-free replacement for diesel. A BIOX spokesperson said the company is now investigating sites around the world for additional plants.

Helping Paralyzed Patients Regain Motion

By Ruth Weinstock

"I encourage my students not to be confined by the literature," declared Professor Milos Popovic (Mech. PhD 1996) of the Toronto Rehabilitation Institute and the Institute of Biomaterials and Biomedical Engineering. "I tell them if your guts suggest something different, try it."

(l to r.) Dr. Adam Thrasher, patient Raymond Daniel and PhD student Albert Vette in the Rehabilitation Engineering Laboratory founded by Dr. Milos Popovic. Dr. Popovic's new functional electrical stimulation device helps spinal cord and stroke-injured patients move again.

Photo: Zoe Cormier

That openness to exploration has led Popovic to some "fantastic" results in his quest to help spinal cord and stroke patients who were not expected to recover or improve their ability to reach, grasp, stand, walk or sit.

Some of Popovic's patients whose hands were paralyzed are now able to answer the phone, turn the pages of a book, put on a jacket, write, or feed themselves. Patients confined to wheelchairs have been able to stand and take a few steps, aided by a walker. With time and persistence, some have improved step frequency, speed and stride length. Thank you letters from Popovic's grateful patients demonstrate what a dramatic difference these gains can make to human independence.

Prior to 1997, Popovic worked in the Canadian aerospace industry and "knew nothing" about physiology. A new position in rehabilitation at ETH Zurich changed his life. "I could see the potential to help people if one succeeded," Popovic said. He came to UofT from Switzerland in 2001 and founded the Rehabilitation Engineering Laboratory.

Popovic's "open door policy" in his lab brings in experts, including neurosurgeons, neurologists and anesthesiologists, to add new perspective to his team of over 30. He collaborates with hospitals and universities in Japan, Mexico and Switzerland, as well as Canadian institutions, "to support each other and surmount barriers."

Hypothesizing that even a damaged central nervous system has untapped reserves that might produce movement, Popovic experimented with functional electrical stimulation (FES). Although the technology is several decades old, its application as a therapy, rather than as a prosthetic system, makes it revolutionary. With an estimated 300,000 stroke patients in Canada today and 550,000 new strokes occurring annually in North America alone, it is not surprising that Popovic's successful trials have made headlines around the globe. Spinal cord injuries, stroke and injuries from falls cost an estimated $5.7 billion a year in Canada alone.

The FES process acts as a catalyst to shock paralyzed muscles into movement. Electrodes send controlled bursts of electricity into patients' muscles, stimulating nerves with electrical impulses. By repeating movements with the arm, hand or leg, therapists "retrain" the brain. Therapy lasts between eight and 16 weeks and is rigorous and repetitive. As control returns, electrodes are placed on different muscles. With practice, the body seems to take over.

"Each time, patients do more and more themselves," Popovic explained. "What is unique about our therapy is that patients have to plan the movement and be committed to do it. People who are not motivated do less well."

More than two years after a stroke study was completed, the patients studied have been able to maintain the gains they achieved - 40% improved function on average, as compared to the control group's 10%. A recent study of spinal cord patients, whose injuries had taken place two to 24 years earlier, showed considerable improvement in walking. But ten weeks after treatment finished, walking skills, though better than before, had somewhat diminished. Another four years of spinal cord trials are planned.

"What a dramatic difference it makes if patients can use the washroom in dignity."
- Professor Milos Popovic

The encouraging aspects of Popovic's work balance the roadblocks and disappointments. Some patients, though motivated, fail to improve, for reasons that remain a mystery. Funding the research, at approximately $10,000 per patient, remains an ongoing problem. No company has yet stepped forward to manufacture Popovic's functional electrical therapy device. Each new headline results in a level of patient demand that the clinic can't possibly meet. "We are trying to fight on all fronts," Popovic said. "There is such a need for this type of intervention."

"I consider the therapy a success if a patient can take several steps to the washroom, close the door in privacy and dignity and return to their wheelchair on their own," Popovic said. "What a dramatic difference that makes to reducing costs for nurses and also to human lives."

Professor Popovic is co-hosting a June 16 - 19, 2007 international event, bringing together five key conferences on care-giving, disability, aging and technology. www.ficdat.ca

New Umbilical Cord Stem Cell Technologies

By Megan Easton

There are now even more compelling reasons for parents to consider storing disease-fighting cells from their infant's umbilical cords, thanks to two new processes developed by Dr. Gerard J. Madlambayan, a PhD graduate of the Institute of Biomaterials and Biomedical Engineering (IBBME) and now the senior scientist at Insception Biosciences Inc., a Canadian cord blood bank founded in 1996, and Professor John E. Davies of the IBBME. Their research expands the possibilities for obtaining or using cord stem cells to treat life-threatening illnesses.

Stem cells are immature cells that have the unique ability to heal or rebuild human tissue by dividing and differentiating into more advanced cell types. Umbilical cord blood is a rich source of blood-forming stem cells, currently used in transplantation-based therapies to regenerate blood systems damaged by conditions such as cancer, bone marrow failure and immunodeficiency diseases.

As a student in Professor Peter Zandstra's Stem Cell Bioengineering Laboratory at the IBBME from 1999 to 2004, Madlambayan developed a culture methodology to increase the number of stem cells collected from cord blood, thus enhancing the opportunities for therapeutic applications – a goal scientists worldwide have been trying to achieve for decades.

By removing certain mature blood cells that were found to inhibit the growth of cord blood stem cells outside the body, he was able to achieve an approximate five-fold increase. Madlambayan then built on this initial finding by creating a special closed system – a 'bioreactor' – that controls environmental conditions which can disrupt the growth of cord blood stem cells in culture. "Because cell dose per kilogram is an important factor for successful engraftment, this technology could help translate the use of these stem cells from mainly paediatric patients to adults or even multiple patients," Madlambayan explained. Clinical trials are now being planned for as early as 2007.

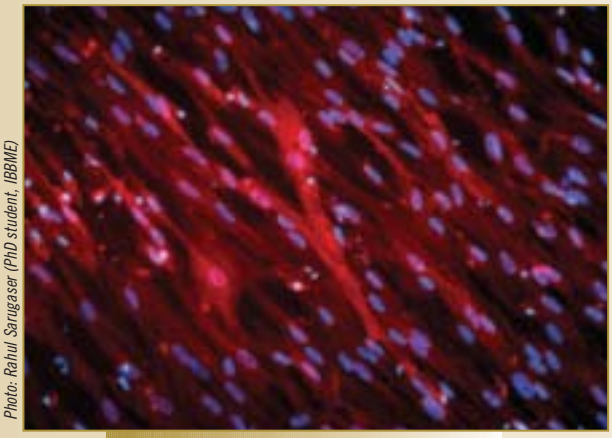


Photo: Rahul Sarugaser (PhD student, IBBME)

Human Umbilical Cord Perivascular stem cells in culture, stained with a fluorescent dye.

www.insception.com/

In a separate advancement, Davies and his IBBME team discovered a method to extract an abundant source of rapidly proliferating mesenchymal stem cells from the tissue around the cord's blood vessels. These stem cells can regenerate the musculoskeletal tissues of the body and can also be effective in treating a wide range of immune and inflammatory diseases.

"The blood and mesenchymal stem cell types complement each other," said Davies. Until now, bone marrow was the only reliable source of mesenchymal stem cells.

These stem cells have a different repertoire of biological responses than cord blood stem cells. Davies' research, independently confirmed in the U.S. and Europe, showed that the stem cells obtained from cord tissue are equivalent to those obtained from bone marrow, but are available in much larger numbers.

In June 2006, Davies' firm, Tissue Regeneration Therapeutics, licensed the technology to CReATe Cord Blood Bank in Toronto, which can now offer to bank both blood and mesenchymal stem cells for expecting parents. Professor Davies said, "Why save only one type of stem cell when you can save both?"

www.news.utoronto.ca /bin6/060629-2403.asp

Biomedical Enginuity cont'd on p. 22

Biomedical Enginuity
cont'd from p. 21

Stem Cell Research Nets Moody Award for Ryan Davey

By Kate Brand

Maintaining control over stem cell behaviour to develop new treatments for heart disease, Parkinson's, diabetes, spinal cord injuries and other conditions is the key goal of Ryan Davey's research.

Davey, a PhD candidate in his final year, who works in the lab of Professor Peter Zandstra, is the recipient of the 2005/6 Norman F. Moody Award. The annual prize was established in 1974 to recognize excellence in a graduate student in the Institute of Biomaterials and Biomedical Engineering (IBBME) and also honour Moody, the IBBME's founder and first Director.

"It was nice to receive this award because it lets me know that all my hard work is appreciated," said Davey.

Davey chose IBBME largely because of Professor Peter Zandstra's stem cell work. A graduate of the University of Guelph's molecular biology and genetics program, Davey's research focuses on communication among embryonic stem cells and between the cells and the environments they reside in.

In the past five years at UofT, Davey has created math models of stem cell behaviour and has worked on other new tools and approaches for controlling stem cells. He has published papers, received awards at poster presentations, and twice received prestigious Natural Sciences and Engineering Research Council of Canada scholarships.

"[IBBME] understands that the greatest innovation comes from the intersection of disparate fields and has made this a high priority," Davey said.

Congratulations to the 2006 Engineering Honours and Awards Winners

The Faculty of Applied Science & Engineering is proud of our association with:

John Cowan, Ind. 6T1
Former CEO and President,
Everest & Jennings Canadian Limited
Malcolm F. McGrath Alumni Achievement Award

Anton Davies, Mech. 7T2
Founder and Board Chair,
RWDI Group Inc.,
Hall of Distinction

David Harquail, Geo. 7T9
Managing Director, Newmont Capital
Hall of Distinction

Pierre Lassonde,
President, Newmont Mining Corporation and
Chair, World Gold Council
Honourary Member, Engineering Alumni Association

George Myhal, Ind. 7T8
Chief Operating Officer and Managing Partner,
Brookfield Asset Management
Hall of Distinction

Jane Phillips, Chem. 5T3
Formerly: Associate Chair, Department of
Chemical Engineering and Applied Chemistry
and Associate Dean, UofT School of Graduate Studies
Hall of Distinction

David Poirier, Ind. 8T1
CEO and Executive Director, Noske Kaeser Group
2T5 Mid-Career Award

Marc Rosen, Eng. Sci. 8T1
First Dean, Faculty of Engineering & Applied Science,
University of Ontario Institute of Technology
2T5 Mid-Career Award

Mark Stirpe, M.S.E. 9T6
Product Manager, Husky Injection Molding Systems
7T6 Early Career Award

Bert Wasmund, Chem. PhD 1966
Executive Director, Hatch Ltd.
Hall of Distinction

Luke Wesley, Mech. 0T5 + PEY
Former Lady Godiva Memorial Bnad Leedur
and Member, Skule™ Stage Band
L. E. (Ted) Jones Award of Distinction

Morden Yolles, Civ. 4T8
Founder and CEO, M.S. Yolles & Associates
(now: Halcrow Yolles)
Engineering Alumni Medal

Mark These Events on Your Calendar Now

Skule™ Nite: March 14, 2007
For tickets contact: Mary Butera
416-978-4941 or **butera@ecf.utoronto.ca**

Spring Reunion 2007

5th Annual Skule™ Alumni Golf Classic: Thursday May 31, 2007
Sleepy Hollow Golf & Country Club, Stouffville
Contact: Jim Webster: **416-978-3177** or **webster@ecf.utoronto.ca**

Dinner Dance: Friday June 1, 2007
Reserve your tickets and class hospitality rooms soon.
Contact: Mary Butera **416-978-4941** or **butera@ecf.utoronto.ca**

Hall of Distinction Unveiling: Saturday June 2, 2007

Help shape the future of UofT:

Call for Nominations

Alumni Representatives
for the University of Toronto's

Governing Council

contact: College of Electors
416-978-8794 or **www.utoronto.ca/govcncl**
Nomination Deadline: February 24, 2007

www.skulealumni.ca

Faculty of Applied Science & Engineering
University of Toronto

Website: www.engineering.utoronto.ca

35 St. George Street, Toronto, Ontario M5S 1A4

Publications mail agreement no. 40062475

Dean:	Tel. 416-978-3131	Fax 416-978-4859	e-mail: dean@ecf.utoronto.ca
Vice-Dean, Undergraduate:	Tel. 416-978-1904	Fax 416-946-0371	e-mail: vicedean@ecf.utoronto.ca
Vice-Dean, Research:	Tel. 416-946-8802	Fax 416-946-8252	e-mail: office-vdrgs@ecf.utoronto.ca
Vice-Dean, Graduate Studies:	Tel. 416-946-3505	Fax 416-978-5054	e-mail: brenda.mccabe@utoronto.ca
Alumni Relations:	Tel. 416-978-4941 or 416-978-3177	Fax 416-946-3450	e-mail: info@skulealumni.ca
Professional Experience Year (PEY):	Tel. 416-978-6649	Fax 416-971-2351	e-mail: pey@ecf.utoronto.ca
Advancement Office:	Tel. 416-978-0380	Fax 416-946-3450	e-mail: campaign@ecf.utoronto.ca
Professional Development Centre:	Tel. 416-978-3119	Fax 416-971-2141	e-mail: pdc@ecf.utoronto.ca