

# QUEEN'S MATHEMATICAL COMMUNICATOR



SPRING 2008

9		6		7		4		3
			4			2		
	7			2	3		1	
5						1		
	4		2		8		6	
		3						5
	3		7				5	
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4		5		1		7		8

A Sudoku puzzle with exactly two solutions

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## QUEEN'S MATHEMATICAL COMMUNICATOR SPRING 2008

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# The Mathematics of Sudoku Squares

M. Ram Murty

## 1. Introduction

The Sudoku puzzle has become a very popular puzzle that many newspapers carry as a daily feature. Given its combinatorial flavour, it is natural to ask if there is any deep mathematical structure involved in the puzzle. Recently, Agnes Herzberg and I set ourselves the task of analyzing the Sudoku puzzle from a mathematical perspective. To be precise, we made explicit its connection to graph theory and probability theory. Our paper, “Sudoku squares and chromatic polynomials”, appeared in the Notices of the American Math. Society, Vol. 54 (2007), no. 6, pp. 708-717. [www.ams.org/notices/200706/tx070600708p.pdf](http://www.ams.org/notices/200706/tx070600708p.pdf). There, we showed that each Sudoku puzzle is in essence a graph colouring problem with some of the vertices already coloured. The challenge of each puzzle is to complete this colouring. From this perspective, it is unclear if any partial colouring can be completed uniquely to a complete colouring. So there really are serious mathematical questions to investigate.

The puzzle consists of a  $9 \times 9$  grid in which some of the entries of the grid have a number from 1 to 9. One is then required to complete the grid in such a way that every row, every column and every one of the nine  $3 \times 3$  sub-grids contain the digits from 1 to 9 exactly once. The sub-grids are shown in Figure 1.

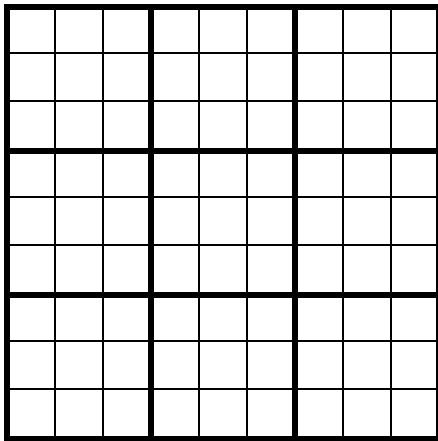


Fig. 1. A Sudoku grid

Recall that a Latin square of rank  $n$  is an  $n \times n$  array consisting of the numbers such that each row and column has all the numbers from 1 to  $n$ . In particular, every Sudoku square is a Latin square of rank 9, but not conversely because of the condition on the nine  $3 \times 3$  sub-grids. Figure 2 shows one such puzzle with seventeen entries given.

						1		
4								
	2							
				5		4		7
		8				3		
		1		9				
3			4			2		
	5		1					
			8		6			

Fig. 2. A Sudoku puzzle with 17 entries

For anyone trying to solve a Sudoku puzzle, several questions arise naturally. For a given puzzle, does a solution exist? If the solution exists, is it unique? If the solution is not unique, how many solutions are there? Moreover, is there a systematic way of determining all the solutions? How many puzzles are there with a unique solution? What is the minimum number of entries that can be specified in a single puzzle in order to ensure a unique solution? For instance, Figure 2 shows that the minimum is at most 17. (We leave it to the reader that the puzzle in Figure 2 has a unique solution.) It is unknown at present if a puzzle with 16 specified entries exists that yields a unique solution. Gordon Royle has collected 47,621 distinct Sudoku puzzles with 17 given entries (see <http://people.csse.uwa.edu.au/gordon/sudokumin.php>).

In our paper, we reformulate many of these questions in a mathematical context and attempt to answer them. More precisely, we reinterpret the Sudoku puzzle as a vertex colouring problem in graph theory. This enables us to generalize the questions and view them from a broader framework. In our paper, we discuss the relationship between Latin squares and Sudoku squares and show that the set of Sudoku squares is substantially smaller than the set of Latin squares. This involves quite a bit of combinatorics and delicate analytic estimates.

## 2. Counting Sudoku solutions

We address briefly the question of uniqueness of solution for a given Sudoku puzzle. It is not always clear at the outset if a given puzzle has a solution.

Figure 3, which can be found on the cover, gives an example of a Sudoku puzzle which affords precisely two solutions.

We leave it to the reader to show that the puzzle in Figure 3 leads to the configuration in Figure 4.

9	2	6	5	7	1	4	8	3
3	5	1	4	8	6	2	7	9
8	7	4	9	2	3	5	1	6
5	8	2	3	6	7	1	9	4
1	4	9	2	5	8	3	6	7
7	6	3	1			8	2	5
2	3	8	7			6	5	1
6	1	7	8	3	5	9	4	2
4	9	5	6	1	2	7		8

Fig. 4. The "solution" to the puzzle in Figure 3.

Clearly, one can insert either of the arrangements in Figure 5 to complete the grid. Thus, we have two solutions.

9	4
4	9

4	9
9	4

Fig. 5. Two ways of completing the puzzle in Figure 4.

This observation leads to the following remark. If in the solution to a Sudoku puzzle, we have a configuration of the type indicated in Figure 6 in the same vertical stack, then at least one of these entries must be included as a "given" in the initial puzzle, for otherwise, we would have two possible solutions to the initial puzzle simply by interchanging a and b in the configuration.

a	b
b	a

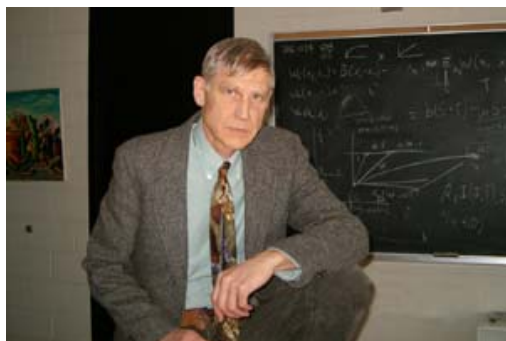
Fig. 6. A configuration leading to two solutions

This should give the reader a small idea of some of the mathematical structure in the Sudoku puzzle. In our paper, we generalize the puzzle to arbitrary size grids and state several unsolved problems in the theory.

All of this aside, it is clear that Sudoku puzzles are just fun to do and their neural stimulation on the brain has a beneficial effect. Perhaps one can even argue that it is good for mental health. So Sudoku away!

## Notes from the Head

Peter Taylor



Peter Taylor

I am on sabbatical leave this year with Ram Murty taking over as Acting Head. That's a significant break for me as the past three years have produced a number of administrative challenges which have given me too little time for either teaching or research. I am spending part of the Fall with the Program for Evolutionary Dynamics at Harvard and the Winter and Spring at Oxford and Edinburgh, both of which have fine programs in theoretical biology. My

colleague Troy Day will securely hold the biomath fort at Queen's. In addition I will be spending some time with various curriculum development programs, in particular writing resources materials for the new Ontario Grade 12 courses.

What I'll do here is muse in a rambling way on the interesting challenges in running a Math & Stats Department in a research-oriented (yes!) Canadian university. What are our major challenges and struggles? I would say they are of two kinds: workload and recruitment.

*Workload.* Everybody complains of having too much to do, and there's no point in adding my voice here. The usual breakdown for faculty workload is 40% teaching, 40% research and 20% administration (both within Queen's and with outside organizations such as the CMS, editorial work, etc). Expectations of faculty, in all three areas, are hugely different from my student days in the 60s.



*Research.* I won't say much here, except that Queen's, while continuing to value and support high quality undergraduate teaching, puts most of its de facto emphasis on research and graduate education. The big grant money, the big awards and the big reputation certainly seem to come, on many levels, mostly from research and while most of us enjoy our teaching and take care with it, the struggle for most of us is to carve out enough time and resources to do our research. And so a big question I have often encountered is how to give my colleagues this research time and still maintain (or recover?) Queen's reputation for top quality undergraduate teaching.

*Teaching.* On the teaching side, things are often not quite what they seem, and I believe that this is the case here. Certainly over the past 25 years the number of students has doubled and the number of faculty in the department has been cut by a third (from a high of 47 to the current 31). So classes are much bigger and many more of them are taught by sessional lecturers, post-docs and graduate students. Actually there a lot of richness in all that, and the advantages outweigh the disadvantages. I will make two closely related comments (along the lines of things not being quite what they seem), and these are about class size and expectations (student and faculty).

There's a lot of talk in the teaching world about student engagement (the importance of that for effective learning) and there's an idea that large class sizes are the enemy of engagement. I do not believe this. In my own life I have found myself engaged and absorbed in what was happening more often in a large crowded room than in a small more intimate setting. Engagement has to do with what is happening in the learner's mind and that is determined by the problems and challenges that are being posed, by the story (or narrative) that is unfolding. It is fashionable to promote engagement by breaking the class into small discussion groups, but that hardly ever works for me and I generally find that it disturbs rather than enhances my engagement with that unfolding story. Anyway, for my money, large lectures are great and I keep urging the university to build more of them. [Of course you need good lecturers and I believe that at the moment there are too few of them around. What we need are lectures that are fewer in number and of a higher quality.]

A closely related aspect of this concerns student-faculty ratio. The university-wide almost doubling of that has made it much less common for a student and professor to develop a close scholarly relationship. This, to my mind, is the main thing we have lost over my 40-year teaching career.

But that bring me to my point about student and faculty expectations. The increase in student numbers at Ontario universities is not due only to an increase in population; a much wider spectrum of the high school student body now go on to attend university and college. Many of these students have different objectives, different expectations, and a different kind of preparation, than was the norm 40 years ago. In my view, many of these students are not quite ready to learn, and indeed (worse), learning is not their principal objective, at least, not upon their arrival here. I'm not faulting them for coming here in the first place; they belong to a cultural system in which a university degree is almost essential for their intended career. But if learning is not their principal objective, getting good marks is, and along with that, getting the resources they need for success in assignments and exams, such as putting pressure on faculty to post their lecture notes on the web, and to spell out exactly what it is they need to know for the exam. Fair enough, but that puts a squeeze on us and is, I believe, partly responsible for my colleagues' quest for teaching release where possible. But here's the irony—the reason it's hard on us is that there is a lot of stuff we want to teach them (or more precisely feel that we need to teach them) when in fact most of them draw in their future life on almost none of the material that we try to make them learn. There are of course a few who really do need the material, but, and here's the second irony, they are the ones who are destined to be academics or researchers of different stripes and they will learn it almost no matter what we do.

What do I conclude? We need to teach less—much less. We need to change from an undergraduate model which is content oriented to one which puts a premium on more basic processes such as thinking clearly and logically, understanding the big picture, performing an incisive analysis and writing or talking about it clearly, perceptively and artistically. I have written some more extensive notes on this subject, and these can be found on my web-page at: [www.mast.queensu.ca/~peter/teaching.htm](http://www.mast.queensu.ca/~peter/teaching.htm)

Let me finish this section with a few comments that are particular to this department. One thing we do rather well is involve our undergraduates in creative ways in our teaching mission, and by this I mean more than marking and tutoring, though they certainly do a lot of that. For example, students in our large calculus service courses (MATHs 121, 122 and 126) are given the opportunity to enrol in an Investigations class which gives them an extra hour each week in a class of 10-15 with two undergraduate teachers tackling interesting problems. Last year we

ran 4 sections of this for a total of 50 students using 8 undergraduates. At the end of this experience, students talk glowingly about it, both the first-year students and the undergraduate teachers. It is a program we definitely want to keep going but funding for it will continue to be a challenge. If anyone wants to endow a named tutorship, let me know!

Speaking of which, we do have a couple of these already, the Gill tutors and the Norman Miller Fellows. The latter were endowed by a gift from one of Norman Miller's former students, Oswald Hall, whom I used to visit whenever I was in Ottawa to keep him abreast of the program, but who, sadly, died earlier this year at the fine age of 99. [An article on Professor Miller was featured in a Communicator some years ago.]

Speaking of endowments, I mention teaching by post-doctoral students and that is one way the department has seen a major change over the past decade—in the number of post-doctoral fellows in residence (about a dozen each year). Our flagship program for this, the Coleman Fellows program, was started 6-7 years ago by Eddy Campbell and Bob Erdahl and we have obtained a few wonderfully generous gifts from former students of John Coleman to support this. [By the way we are half-way to our goal for this program so are still looking for contributions!]

*Service.* This component also has challenges that have arrived with changes over the past decades, mainly the increase in student/faculty ratio and along with that, what is a huge increase in the amount of work required to get resources (new positions, research chairs, strategic grants) and to justify our programs (various forms of accountability). There are good examples of that in all four of our key administrative officers, the Associate Head, the Chair of Undergraduate Studies, the Chair of Mathematics and Engineering, and the Graduate Chair.

The Associate Head is **Leslie Roberts** and he handles the appointment procedures (for hiring new faculty) and the tenure and promotion procedures. This is a much bigger job than it used to be, partly because of the collective agreement which mandates a comprehensive set of procedures for personnel decisions, and partly because of the huge number of applicants we typically get for mathematics positions. Over the past few years we have made a number of appointments, and this coming year we are attempting to fill two positions, one in Statistics and one in Statistics and Probability. We need to work hard to get good applicants as statisticians are everywhere in demand and can command high salaries. [If you have a son or daughter who is looking for an important area of

study with a great and flexible future, suggest statistics.]

The Chair of Undergraduate Studies is **Ole Nielsen** and his big challenges are in staffing all our courses and keeping tabs on the quality of our large instructional machine. Students follow a huge variety of paths and they are often seen in Ole's office needing special attention. **Alan Ableson** is a new adjunct faculty member who has been appointed Assistant Chair of Undergraduate Studies and relieves Ole of some of this workload. In addition, Alan teaches and coordinates some of our large service courses, and has become a crucial member of our teaching staff.

The Chair of our Mathematics and Engineering program is **Fady Alajaji**. This is an awesome program, virtually unique in Canada, and it equips students with a formidable array of skills and experience all the way from financial mathematics to information technology. It's an accredited professional program and that is what has required such enormous work in reporting and accountability over the past years. Thus we have created a position of Curriculum Chair in the program to take some of the load off of Fady and Navin Kashyap has stepped into that.

The Graduate Chair is **Andrew Lewis** and his job has been made much more interesting (Andrew might have chosen a different word) by the recent policy of the Ontario Government to put special funding into graduate expansion, particularly of domestic PhD students. This has created huge competition among Ontario universities for this limited pool of applicants and we have had to work hard, and will have to continue to do so, to recruit good students.

Finally, it is great for the department that **Ram Murty** has agreed to be Acting Head this year. Ram is a universal math prof, one of those who is star quality in all three aspects of his work. We have known this about his teaching and research for many years, but in working with him over the past months I have come to have an awesome respect for his wisdom in handling awkward administrative situations.

*Faculty Recruitment.* Over the past couple of years we have made two excellent additions to our Mathematics and Engineering program, **Abdol-Reza Mansouri** in Geometric Control and **Serdar Yüksel** in Communications and Control. Abdol-Reza comes from Harvard and MIT to join **Andrew Lewis** as a crucial colleague in our control theory group, following the retirement this year of **Ron Hirschorn**, and Serdar, who arrived this past fall from a post-doc at Yale, will form an effective bridge between our two main engineering areas—communications and control.

## News Items

Peter Taylor

### *Moving to the rhythm of the Sun*



Photo by David Tyner

Mathematics & Statistics Prof. David Thomson (second from right) with Queen's solar radio telescope and team members: Lindsay Smith (now at University of California), Robert Carkner (BSc Mechanical & Materials Eng) and Ben Gardiner (MSc Math & Eng)

**David Thomson's** statistical study of the radiation coming from the sun continues to receive active interest from the press. David's analysis of data from the Ulysses spacecraft mission has shown that sounds generated deep inside the Sun cause the Earth to shake and vibrate in sympathy. It appears that Earth's magnetic field, atmosphere and terrestrial systems, all take part in this cosmic sing-along.

David's co-authors include **Lindsay Smith**, a recent Math&Eng graduate. To demonstrate the effect, they use highly sophisticated statistical techniques. Their most dramatic and surprising finding has been to discover these resonances in the seismic data here on Earth. In short, earthquakes even respond to the sun.

Interestingly enough, although these tones are all around us, they are too low for the human ear, being some 12 octaves below the lowest audible note. David figures that the effect is caused by a type of resonance generated by the interaction between the magnetic fields of the two bodies.

### *Sudoku and chromatic polynomials*

**Agnes Herzberg** and **M. Ram Murty** are in the news because of their article "[Sudoku Squares and Chromatic Polynomials](#)", (see cover and lead article of this issue) which appeared in the June/July 2007 issue of the *Notices of the AMS*. In the article they pose some mathematical questions about Sudoku and then use graph theory, in particular chromatic polynomials, to try to answer the questions. Some of the media coverage convey a tone of surprise at the notion that fun stuff like Sudoku could be connected to something serious like mathematics, but of course

*Communicator* readers won't be surprised at all. Murty, described in the *Milwaukee Journal-Sentinel* as a "number theorist by day", is quoted in the paper as saying, "I did this just for kicks."

### *Sisters killing brothers*

**Peter Taylor** is a co-author of a paper which has received recent coverage in the New York Times. Written by **Andy Gardner**, one of our Coleman post-doctoral fellows now at the University of Edinburgh, it discusses a phenomenon of offspring killing their siblings. Such pathologies are always newsworthy, but in this case the organism is a wasp that lays its eggs inside the eggs of a caterpillar. Most of these eggs develop into reproductive offspring that feed on the developing caterpillar, but up to a quarter of the female offspring instead develop "slender snake-like bodies and rasping jaws" and instead of feeding on the blood of the caterpillar they attack and eat their siblings, mainly their brothers. This behaviour comes at great personal sacrifice, as when the caterpillar is eaten up, the soldier dies whereas the others who survive go on to reproduce.

The soldiers also kill offspring from other wasps, and the conventional wisdom has been that their altruistic role has been to reduce competition for their sibs. But Andy's theory is that it is more likely the case that their primary role is to adjust the sex ratio, giving their sisters a greater chance of surviving. The gender asymmetry here comes from the unusual haplodiploid genetic system of the wasp in which sisters are more closely related to one another than they are to their brothers.

### *Pi day March 14, 2007*

This year the day began with provincial coverage! Our DSC co-chair **Vanessa Kehoe** was interviewed on CBC Ontario Morning talking about mathematics and *pi* and what we were planning at Queen's.



Events in Jeffery Hall got underway shortly after noon, with free pie and Math Jeopardy in the 3<sup>rd</sup> floor lounge.

Pie eating on Pi Day!

*Pi* Day events culminated at 1:59 (that's at 03 14 159 to be precise) with the annual *pi*-recital contest. The winner was **Jenica Baulk-Smith** with a flawless execution of 101 digits. In talking to her afterwards she confessed that her trade secret was to use songs.



Jenica reciting Pi

## Significant Events in the Department of Mathematics and Statistics

M. Ram Murty

### PROMOTION AND TENURE

*Spring 2006:* **Fady Alajaji** and **Tamás Linder** promoted to Full Professor.

*Spring 2007:* **Mike Roth** and **Greg Smith** promoted to Associate Professor.

### APPOINTMENTS

**Serdar Yüksel** (July 1, 2007) received his PhD in 2006 from the University of Illinois, Urbana-Champaign, with a thesis on information transmission in control systems. Following this, he worked as a post-doctoral associate at Yale University (New Haven, CT), working mostly on information theory. Serdar also has some industrial research experience, having worked as a summer research intern in 2004 at Xerox-PARC (Palo Alto, CA), applying some of his research concepts to large-scale printer design. He currently works primarily on understanding the value of information in multiple-agent control and communication systems. Serdar adds strength to both our control theory and communications theory groups.

It is a pleasure to announce the appointments of two new members of the department. **Drs. Wenyu Jiang** and **Chunfang (Devon) Lin** will join our department starting July 1, 2008.

**Wenyu Jiang** obtained her PhD in Biostatistics from the University of Waterloo in 2004. Her current research interests include computational methods for high dimensional gene expression data; improvement on the design and analysis of randomized clinical trials with biomarker covariate information; development of resampling methods and applications to biostatistics. She has worked as a post-doctoral fellow at the National Cancer Institute of the United States and most recently as an Assistant Professor at Concordia University (Montreal, QC).

**Chunfang (Devon) Lin** received her PhD in Statistics from Simon Fraser University (Burnaby, BC)

in 2008. Her research interests include analysis of complex survey data, design and analysis of experiments and computer experiments, and industrial statistics. Her thesis research develops a flexible method for constructing designs for computer experiments, which have been used by scientists in diverse areas such as weather modeling, cosmology, aircraft design and engineering. Devon has been involved in research on analysis of complex survey in collaboration with Westat (Rockville, MD). She has also worked with the Canadian National Institute on Complex Data Structures (NICDS) Program for the Design and Analysis of Computer Experiments for Complex Systems.

### RETIREMENTS

**Ron Hirschorn**, Professor, June 30, 2007

Immediately following his Harvard PhD in 1973, Ron Hirschorn was appointed as an Assistant Professor in the Department of Mathematics and Statistics. He was promoted to Associate Professor in 1979 and to Full Professor in 1992. He held the position of Chair of Mathematics and Engineering from 1991 until 2003, a crucial period which shepherded the program into the modern highly competitive and research oriented era. He is a member of IEEE and SIAM and Associate Editor of the SIAM Journal on Control and Optimization.

### RESIGNATIONS

**David Steinsaltz**, as of Oct. 1 2007, to take a position at Oxford University.

**Julia Brettschneider**, as of Sept 1, 2007, to take a position at the University of Warwick.

**Maria Saprykina**, as of January 1, 2008, to take a position at KTH, Royal Institute of Technology, Stockholm, Sweden.



## AWARDS AND RECOGNITION

### FACULTY AWARDS 2005

**Andrew Lewis** was one of two Queen's winners in the Round 1 competition of a new Ontario research support program, the **ERA (Early Researchers Award)**. Andrew works in what might be called geometric control, using sophisticated geometric concepts to tackle questions of controllability. In the words of one researcher, Andrew's work shows us what controllability really is. His definitive book, with Francesco Bullo, *Geometric Control of Mechanical Systems: Modeling, Analysis and Design*, was published in the influential *Texts in Applied Mathematics* series of Springer-Verlag, to enthusiastic reviews.



The **2005 Steacie Prize** was awarded to **Troy Day**. This prize is presented once a year to a scientist or engineer of 40 years of age or less for outstanding scientific research carried out in Canada. In the 40-year history of the prize there has been only one other Queen's winner and that was John Smol, Canada Research Chair in Environmental Change, in 1992. Prize recipients deliver a lecture about their research work at the Steacie Institute for Molecular Sciences in Ottawa.

### FACULTY AWARDS 2006

Morris Orzech was the winner of the 2006 Clarence F. Stephens Award for Distinguished Teaching from the Seaway Section of the MAA.

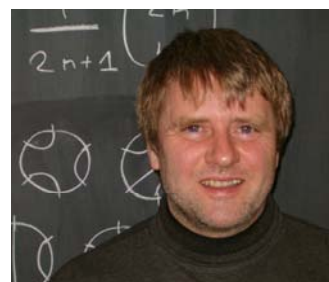


**Noriko Yui** was inducted as a **Fields Institute Fellows (FIF)** at its Annual General Meeting on June 15, 2006. This lifetime appointment is conferred on certain individuals who have made outstanding contributions to the Fields Institute, its programs, and to the Canadian mathematical community. Noriko is a frequent visitor to Fields,

where she organizes an ongoing and successful series of Fields weekend workshops on algebraic varieties and Calabi-Yau manifolds. She serves on the Fields Institute editorial board, where she has been highly active in soliciting and reviewing manuscripts.

The **2006 Adrien Pouliot Award** was awarded to **Peter D. Taylor** for his outstanding contributions to the teaching and learning of mathematics in Canada. Peter's work is grounded in an innovative and evolving curriculum philosophy and an approach to mathematics which is fundamentally aesthetic. Peter is cross-appointed to the Department of Biology and the Faculty of Education. During his career Peter has taught and published in all three areas including two semesters in high school to prepare for the extensive curriculum writing work he continues to do with the Ontario Ministry of Education.

**Roland Speicher** was named a **Killam Research Fellow** for 2006. One of Canada's most prestigious research awards (10 are awarded annually), Killam Fellowships are administered by the Canada



Council for the Arts. Roland's research focuses on relations between free probability theory and the quite different fields of mathematics and physics. In particular he is studying the combinatorial and probabilistic aspects of free probability, as well as its application to problems in quantum statistical physics.

### FACULTY AWARDS 2007

**Gregory G. Smith** was awarded the **2006-07 Andre Aisenstadt Mathematics Prize** by the Centre de recherches mathématiques (CRM). This award recognizes outstanding research achievement by a young Canadian mathematician in pure or applied mathematics. Queen's has never won this award before so this is indeed a notable event. Greg shared this prize with Alexander Holroyd (UBC). The recipients of this award are chosen by CRM's scientific advisory committee, and are invited to deliver a lecture at CRM.



**M. Ram Murty**, was elected fellow of the National Academy of Sciences of India. Apart from being a distinguished scientist, a nominee must be associated with the development of Science in India and asso-

ciated with Indian scientists as evidenced by collaborative programmes with the Indian scientists, training



of Indian scientists by the nominee, participation in Indian scientific programmes, visits to India for participation in conferences, consultancy, programmes, etc. Founded in the year 1930, the National

Academy of Sciences, India is the oldest Science Academy of the country. The main objective of the Academy is to provide a national forum for the publication of research work carried out by Indian scientists and to provide opportunities for exchange of views among them.

#### FACULTY AWARDS 2008

An expert in modeling the transmission and evolution of infectious diseases such as SARS and avian flu, **Troy Day** is one of six outstanding Canadian university researchers to receive a 2008 **E.W.R. Steacie Memorial Fellowship** from the Natural Sciences and Engineering Research Council (NSERC). Troy studies the evolution and causes of infectious diseases through the use of mathematical models. His research examines how and why diseases appear when they do, as well as the reasons some diseases become deadly while others remain relatively benign. Dr. Day will receive funding enabling him to pursue his research full-time. The universities receive a salary contribution to fund a replacement for the Fellows' teaching and administrative duties for two years.



Hwashin Shin (Health Canada), Glen Takahara and Duncan Murdoch  
(University of Western Ontario)

**Glen Takahara**, his former student **Hwashin Shin** and our former member of department, **Duncan Murdoch** have been awarded the Canadian Journal of Statistics Award for their paper "Optimal designs for calibration of orientations" published in that journal in Volume 35, pp. 365-380. Orientations describe rotations of three-dimensional objects. These are used in virtual reality systems in connection with 3D animation, and in motion-tracking devices studying human motion. In order to calibrate these tools, a statistical model must be used. The winning article discusses efficient ways of conducting experiments to estimate the parameters in such models. This work

was motivated by a study of how to reduce back pain in industrial workers.

#### TEACHING DISTINCTIONS

**Patrick Reynolds** (PhD student of Oleg Bogoyavlenskij) was nominated for the Frank Knox Award, the AMS teaching excellence award, for MATH 126. Patrick was up against a formidable array of 6-8 experienced faculty (including Bill Newstead and Ron Anderson) and was the only teaching fellow in the group. A formidable accomplishment in itself. Recent Math & Stats winners of this award have been **Ole Nielsen** in 2002 and **Mike Roth** in 2005.

#### UNDERGRADUATE AWARDS

An **NSERC-CMS Math in Moscow scholarship** to attend the Winter 2006 semester at the Independent Moscow University was awarded to **Nithum Thain** (Hons. Math, 2006). **Tim Kusalik** (Hons. Math, 2006) had previously won the scholarship and attended the Fall 2004 session.

**The Prince of Wales Prizes**, established in the 1860s, are the most prestigious awards for Arts and Science undergraduates. Four prizes are awarded University-wide for academic excellence—the Science Prize and Runner-Up, and the Humanities Prize and Runner-Up.

2006: **Nithum Thain** (Hons. Math.): the Science Prize;  
**Tim Kusalik** (Hons. Math.): Honourable Mention.

2007: **Aaron Mathew Smith** (Hons. Math.): the Science Prize.

**Governor General's Silver Medal** (Created in 1873 to encourage academic excellence across the nation, this medal is presented to the student graduating at each University with the highest academic standing.)

2006: **Nithum Thain** (Hons. Math.)

2007: **Carlos Antonio Sánchez** (Math. & Eng.)

**J.B. Stirling Gold Medal in Applied Science** (Awarded to the student who has made the highest standing throughout the four-year program.)

2006: **Thomas Maxwell Norman** (Math. & Eng.)

2007: **Carlos Antonio Sánchez** (Math. & Eng.)

**H.G. Conn Award** (Awarded to graduating students who have rendered valuable and distinguished service to the Engineering Society and the University in non-athletic, extra-curricular activities.)

2007: **Wei-Hsiang Tseng** (Math. & Eng.)

**Ontario Professional Engineers Foundation of Education Medal for Academic Achievement** (Awarded to the engineering graduate in each university with the highest academic standing in final year.)

2006: **Thomas Maxwell Norman** (Math. & Eng.)

**Annie Bentley Lillie Prize in Mathematics**  
(Awarded to the graduating student in Mathematics and Engineering who has highest average on courses in Mathematics in final year.)

2006: **Thomas Maxwell Norman** (Math. & Eng.)

2007: **Duncan Allan Findlay** (Math. & Eng.)

**University Medals** (Awarded to a student who has the highest average in all courses of third and fourth years, provided average is 80% or higher.)

*Spring 2006 Convocation*

**Nithum Thain:** Medal in Mathematics & Statistics

**Megan Macdonald:** Medal in Mathematics & French Studies

**Thomas Maxwell Norman:** Medal in Mathematics & Engineering

*Spring 2007 Convocation*

**Jenna Beth Rajchgot:** Medal in Mathematics & Statistics

**Aaron Mathew Smith:** Medal in Mathematics & Statistics

**Carlos Antonio Sánchez:** Medal in Mathematics & Engineering

## News from Alumni

**Peter Taylor**

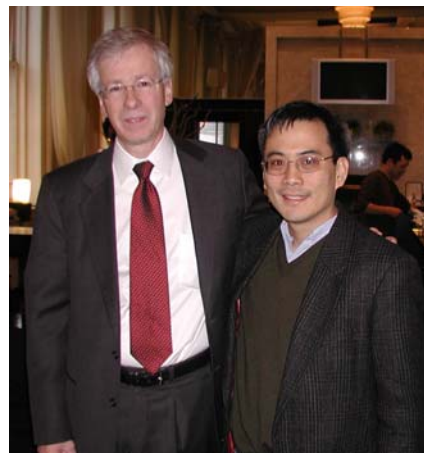
Please send us an email telling us all what you're up to. We'll print all the "capsules" that we get!

**Nithum Thain** (ArtSci 06—now at McGill) writes: Perhaps you'd be interested to know that **Greg Costain** (ArtSci 07—also at McGill) and I have started a Math club for Grade 4s and 5s at a local school. It was mostly Greg's idea, but it was a great one. The kids are surprisingly clever and I'm amazed at the things we can teach them. I taught them something about graphs 2 weeks ago and Greg taught them primes this week! They're such fast learners! Primes when they have barely learned their times tables!! But, perhaps it has something to do with unquestioning acceptance or something.

**Ted Hsu** (ArtSci '84): Wow! A quarter century has passed since I was an undergrad, and here I am living in Kingston again, trying to learn new things. After spending 20 years working in theoretical physics and quantitative finance, I'm now learning about greenhouse gases, public policy, and party politics. It started a couple of years ago when my wife introduced me to Terrapass, a greenhouse gas (GHG) offset company. My research into how exactly the money one pays for a GHG offset leads to a reduction in GHG emissions led me to join those thinking about how to effect changes in society to reduce GHG emissions.

I'm a co-chair of a City of Kingston committee called, "Kingston Environmental Advisory Forum". I'm helping to create a Community Action Plan to achieve a GHG emissions reduction target set by City Council. There seem to be hundreds of components to any realistic plan of action. Perhaps the most one

can do is concentrate on one piece of the puzzle and hope that everything else falls into place elsewhere.



Ted Hsu with Stéphane Dion

I felt much the same when I decided to participate in party politics for the first time by choosing, near the beginning, a candidate (Stéphane Dion) to support for the Liberal Party leadership race in 2006. During the campaign and convention I was dazzled by the many, many interests, groupings, and loyalties interacting with each other that make up the Liberal Party. I gave Mr. Dion a gift of carbon offsets during the leadership campaign to offset his travel. After the campaign, I was able to continue my involvement by helping to edit a white paper on the Liberal Party plan to reduce GHG emissions from large industrial emitters.

I'm still new at all of this, so if any of you have any good advice to offer or would like to say hello, please send me an email at [tedhsu75@gmail.com](mailto:tedhsu75@gmail.com).



**Sumit Oberai** (Apple Math 95) writes: I'm the Vice President of Customer Solutions at Indigo Books & Music, where I manage the team that delivers all of the front office technology for Indigo, including the Online eCommerce Site, the POS (cash registers), Loyalty program (iRewards), and in-store technologies. I enjoy my job because of the variety driven by the difference in managing for both an online environment and a physical store, as well the mix of day-to-day operational challenges, projects to address business challenges, and work on the technology direction for future stores. It is also interesting to be part of a well-known consumer brand in Canada as it explores growth options for the future. And as a shameless plug, I am most excited about the recently launched Canadian Booklovers Community at <http://community.indigo.ca>.

**Erica Blom** (ArtSci 06) writes: When I completed my studies at Queen's in December 2005, I had no idea what the future would hold for me. I had studied both political science and mathematics—surely a more unlikely pairing would be difficult to find!



Erica Blom

In any event, I found myself in Brussels for half a year, working as an intern for the European Commission in Directorate-General Budget. Watching delegates squabble in the Parliament and the Council, and

bills get tossed back-and-forth from one arm of the Budgetary Authority to the other in an intricate juggling routine, I gained real insight into political decision-making in practice, rather than merely in theory. Fascinating and enlightening, yet frustrating!

At the same time, I took the opportunity to see some of Europe and even visited Dr. Geramita in Genoa, whose hospitality is unparalleled. (He even offered some math problems to offset all the politics!)

I then completed a Master's in Economics at the University of Western Ontario—a subject that manages to combine mathematics and political science—before embarking on a PhD (also in Economics) at Yale University.

**Rob McCann** (ArtSci 89), now a Math Prof at University of Toronto, has been “recreating” a version of our Math & Poetry course (IDIS 303) at U of T this past fall with Malcolm Woodlands (of the Dept. of English). He used many of the same math problems that we use here, and found himself wondering how to provide them to the students. He writes:

I suppose I could have students buy the notes directly from Queen's if that is your preferred route. But I might rather prefer to do as you did at the time when I took the course, which is to provide the notes to the students only after the class in which the material has been covered. I am not sure how you handle this conundrum with your own course, and would be glad for your advice.

In fact Rob has touched upon an important issue. Can you have a genuine “investigative” class if the investigation is written up already in a text book which the students already have? This question makes it difficult to write text-books for an investigative curriculum. For me, the online culture is the easiest way to solve the problem: I post the notes at the end of the class, and by the year's end, the students have the complete text-book. That's what Rob will be doing.

## Math 494 – Mathematics and Engineering Seminar

The Fall term Math & Engineering Seminar (Math 494) gives students in the Math&Eng program exposure to and insight into various aspects of the profession and practice of engineering. There are speakers on professional engineers' organizations and the role and responsibility of the professional engineer, health

and safety considerations in the engineering workplace, as well as technical topics relating to various careers in engineering (by Math&Eng alumni) and ongoing research activities (by Math&Eng faculty and faculty from other departments at Queen's).



Students also develop communications (written and oral) skills by receiving instruction on effective technical writing and reporting from a Queen's Writing Centre instructor at the beginning of the term, producing typed essays on four seminars, and presenting a 15-minute talk on an engineering topic.

**If you are a Math&Eng alumnus with an interesting career story to share**, and you are interested in participating in this Fall's seminar, contact Johana Ng <[johana@mast.queensu.ca](mailto:johana@mast.queensu.ca)> or 613-533-6000 x74469.

Thanks to our **Alumni** who participated in the Fall 2007 Seminar:

**Mr. Timothy Evans**, Gennum Corporation, Burlington, Ont. (B.Sc. Math&Eng '05, M9 option): *Video Processing Systems*

**Dr. Ron Kerr**, Communications Research Centre, Ottawa (B.Sc. Math&Eng '87, M7 option; M.Sc.,

E.E., Queen's; Ph.D., Univ. of Victoria): *Research at Communication Research Centre*

**Prof. Kevin Deluzio**, Mech. and Materials Eng., Queen's (B.Sc. Math&Eng '88, M6 option; M.Sc., Ph.D., Mech. Eng., Queen's): *What Can Eigenvectors Tell You About Knee Arthritis?*

**Ms. Cynthia Thomas**, Alcatel-Lucent, Ottawa (B.Sc. Math&Eng '02, M9 option; M.Sc., Math & Eng '05): *IPTV: Coming to A Phone Near You*

**Mr. Nicholas Whalen**, Stikeman Elliott LLP, Toronto (B.Sc. Math&Eng '96 M7 option; M.Sc. Math&Eng '98; LL.B.'01, McGill): *Law After Engineering: Applications of Your Skills in Intellectual Property & Corporate Law*

**Ms. Meghan Patterson**, Cobalt Engineering, Toronto (B.Sc., Math&Eng '04 M6 option): *A Green Apple: Designing Sustainable Buildings*

## Celebrating Marge Lambert

Peter Taylor

This year, **Marge Lambert** became a member of that awesome 40-year club at Queen's University, and was celebrated as such by the Principal. The great mystery for us is how, at her current age of 52, she has managed to do that. But then mathematicians are well known for their inability to add or subtract.



A number of us date back to the time of the formidable Eileen Wight, Marge's predecessor as Administrative Assistant. That's a crazy job because you interact all the time with naïve idealistic creatures (Profs) who have only a hazy notion of the realities of administrative life. Eileen had a pointed way of showing her displeasure with any off-the-

wall request. Marge's administrative style was quite different. She smiles and says, "Well now let me see," and when you leave her office you have a feeling that there's a better way, and furthermore, that you thought of it yourself.

For my own part, having just spent 3 years as Head, with Marge acting as my assistant, her most striking contribution to our work has been her wisdom. Conflicts arise all the time, decisions need to be made, do we support this or that, do we go this way or that way? Often I went to her office with my mind mostly made up, looking for confirmation. What Marge would do is open up the landscape so I could see things from a larger point of view. And then she'd focus a moment not on the issues but on the people.

Marge started out as a stenographer ("back when we did carbon copies and the blue ditto"), and over the years had many jobs, including Graduate Secretary and Senior Secretary. She recalls the time before the Department moved into Jeffery Hall in September 1969, when members of the department were housed in Carruthers, Watson, the "Grey House", and Summerhill.

The best part of the job? Marge says it's "...sitting here and having the world pass through. It's great meeting different people from different backgrounds and different cultures.

## Gifts to the Department of Math & Stats

Peter Taylor

You might consider directing your alumni giving to the Department. We have two fine programs that would profit greatly from your support.

### The Coleman Fellows Program

Our drive to build this program started 5 years ago at the initiative of the Head, Bob Erdahl. The fund celebrates the pioneering work of John Coleman, who shaped the Department during his 20 years as Head (1960 to 1980), and who in fact celebrated his 90<sup>th</sup> birthday this May at a departmental conference held in his honour at which he delivered a 1-hour talk comparing Whitehead's and Einstein's General Theory of Relativity. When we decided we wanted a permanent memorial to recognize John's passion for teaching, his ardent pursuit of research at the borders of Algebra and of Quantum Theory, and his conviction that Canadians have a duty to bring intelligence and good will to bear on international affairs, he was clear that he wanted it to support young mathematicians who could come and add vitality to the research and teaching life of the Department. And that is exactly what has happened. Our overall goal is to establish eight Coleman Fellowships, requiring a total endowment of 2.4 million dollars and thanks to the extraordinary generosity of a number of John's former students, we are halfway there (and as a consequence are now supporting four Fellows). The second half is always harder than the first, but this is a great

program, great for us and great for the wonderful young men and women who come.

### The Trust Fund

Built up largely from royalties and alumni donations, it is an essential component of the work of the Department. Just to give you an inside peek at departmental resource allocation (this will surprise most of you as it did me), the Trust Fund finances:

- Orientation evenings for both Arts & Science and Math & Engineering;
- Convocation receptions;
- Homecoming reception (that's you!);
- Refreshments for Math Club and High School Enrichment sessions;
- Travel grants to Undergraduates (e.g., Undergrad Math Conference);
- The Departmental December Holiday Party;
- Special celebrations during the year (e.g. John Coleman's 90<sup>th</sup> conference).

Over the past few years the demands on the Fund have increased (more activities and Faculty cut-backs) and the income has decreased (a possible reason is the stronger push from the university as a whole for alumni funds). So this is an excellent place to target your gifts. The "gift ticket" on the next page can be sent to Alumni Affairs with your donation.

## A Curiosity

*Submitted by Tom Stroud, Professor Emeritus*

It is easy to obtain the decimal equivalent of  $1/19 = 5/95$  using  $1/95 = 0.01(1-0.05)^{-1}$ , which results in  $1/19 = 0.05 + 0.0025 + 0.000125 + \dots = 0.052631578947368421$  repeat, but how many people are aware that the digits can also be obtained from  $0.05 + 0.0026 + 0.000031 + 0.00000057 + 0.0000000088 + 0.00000000145 + \dots$ , where, once the 05 and 26 have been specified, the rest of numbers are obtained in Fibonacci-like manner as  $5 + 26 = 31$ ,  $26 + 31 = 57$ ,  $31 + 57 = 88$ , etc.?

Can anyone explain why? (Send explanations to [mathstat@mast.queensu.ca](mailto:mathstat@mast.queensu.ca))

Name: \_\_\_\_\_ DG07D  
Address: \_\_\_\_\_  
\_\_\_\_\_  
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*In support of Queen's University, I am pleased to make a gift of: \$ \_\_\_\_\_*

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**Please direct donations or related inquiries to:**

Laura Costello, Queen's University, Faculty of Arts & Science, 140 Stuart St, Kingston ON K7L 3N6  
Tel: 1-800-267-7837 (North America) or 1-613-533-6000 (local) ext. 75501 Email: costelll@queensu.ca

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# QUEEN'S MATHEMATICAL COMMUNICATOR

## SPRING 2008

### New Problem

Peter Taylor

#### The airplane seats.

There are 100 seats on the airplane and 100 passengers are waiting to get aboard. First in line is a senior executive called Adam, then come 98 little old ladies, and finally a math student called Zak. Adam has misplaced his boarding card and so simply takes a random seat. The little old ladies, all of whom have their boarding cards, are very polite and behave as follows. As each gets on, if her seat is free she takes it, and if it is occupied, she simply sits quietly in a random empty seat. The question is, what is the probability that Zak will sit in his assigned seat?

I was given this problem by a friend who told me that there was a simple solution. After some time with it I found a solution but it was certainly not simple. But I worked away at it, always trying to find a simpler way to look at things, and ultimately it got fairly nice. Have I made my solution as simple as it can be?—I'm not sure. But I do know that playing with your solution after you've solved it can reap great benefits in simplicity and elegance. Send me anything you get that's simple and elegant!

**Send your solutions, or new problem suggestions, to:** [peter.taylor@queensu.ca](mailto:peter.taylor@queensu.ca)

Look for this issue of "The Communicator" on the Department's website: <http://www.mast.queensu.ca/>.

QUEEN'S MATHEMATICAL COMMUNICATOR  
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