CMS NOTES de la SMC

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DANS CE NUMÉRO

Canadian Mathematical Society
Société mathématique du Canada

Vice-President's Notes / Notes du Vice-président

Robert van den Hoogen, *St. Francis Xavier University, Vice-President Atlantic*

Program prioritization and the value of service teaching

Many of our institutions have experienced, over the past couple of years, or will experience a program prioritization process. Probably the best known in the Canadian context, due to its national press coverage was the TransformUS initiative at the University of Saskatchewan. Other Program Prioritization Processes have taken place at University of Regina, Wilfred Laurier University and the University of Guelph to name a few. In most instances, the university will adapt a process based on the book *Prioritizing Academic Programs and Services: Reallocating Resources to Achieve Strategic Balance* by Robert C. Dickeson. Sometimes an external consultant is brought in to help facilitate the process, sometimes it is done in-house. Central to this prioritization process is a requirement that every department or program within the university be scrutinized and analyzed by a group of university faculty, staff and administrators charged with this task. These individuals have a responsibility to ascertain which programs should be enhanced, and which need to be revised to achieve a sustainable future, if possible. All recommendations and findings of these Program Prioritization Processes are based on multiple datasets, which may include number of students in program, cost of faculty and support salaries and research profile amongst other things. Each institution will construct their own individualized rubric to evaluate the programs and each institution will weigh the criteria to reflect their own local values. The end product is the result of a huge amount of institutional energy and usually concludes with

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La priorisation des programmes et la valeur de la contribution à l'ensemble de l'université

Depuis quelques années, bon nombre de nos établissements ont subi ou subiront un exercice de priorisation des programmes. L'exemple sans doute le plus connu en contexte canadien, en raison de la couverture médiatique à laquelle il a eu droit, est celui de l'initiative TransformUS de l'Université de la Saskatchewan. D'autres programmes du même genre ont été lancés à l'Université de Regina, à l'Université Wilfrid-Laurier et à l'Université de Guelph. Dans la plupart des cas, l'université adapte un exercice reposant sur le livre *Prioritizing Academic Programs and services: Reallocating Resources to Achieve Strategic Balance* de Robert C. Dickeson. Certains établissements font appel à un consultant pour les aider, d'autres s'organisent à l'interne. Ce type d'exercice de priorisation passe nécessairement par l'évaluation et l'analyse minutieuse de chaque département et programme de l'université par un groupe formé de membres du personnel enseignant, administratif et de direction. Ces personnes doivent déterminer quels programmes l'université devrait élargir et lesquels elle devrait revoir pour assurer sa viabilité, dans la mesure du possible. Les recommandations et résultats de l'exercice reposent sur de multiples ensembles de données, notamment le nombre d'étudiants par programme, le coût en salaire du corps professoral et du personnel de soutien et le profil de recherche. Chaque établissement construit sa propre grille d'évaluation des programmes et pondère les critères en fonction de ses propres valeurs. On obtient en fin de compte le résultat d'une énorme

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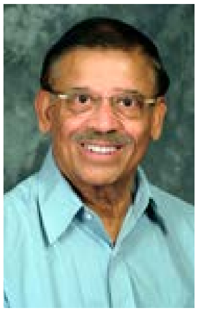
Homework Assignments



Srinivasa Swaminathan
Dalhousie University, Halifax N.S.

During lunch at the cafeteria on a Tuesday, I heard a student complaining bitterly about assignments: she had assignments in Biology, Physics and Mathematics all due on the following Friday.

Many students have to spend hours almost every evening doing homework. Most professors seem to believe that this will help them a lot in their academic career. Others feel that most such homework is useless; they may be routine.

It is claimed that there are several advantages to homework, if it is given in the correct amounts and at the right time. Students do need to gain some practice of any material done in the regular classes. They need to find out how well they understand the new information and ideas. Further such assignments help the professor to find out how much the students have or have not learned. Students may also get involved in group discussions; some students do prefer to work as a group.

However, there are negative aspects to homework assignments. Many students get too much homework, and often the quantity is not coordinated. Further they may find that they do not have free time to relax or play sports. Also assignments may raise the stress level of some students, resulting in actually lowering their productivity and performance. However, the main argument against homework seems to be that most of it is just boring practice. The students may get to learn nothing new. Some practice is good, but endless practice of the same material does not lead to improvement.

Thus the need to assign homework must be considered carefully. It can be helpful in certain circumstances. Those involved must understand the value and importance of homework. A good balance between free time and homework is necessary for the benefit of both the students and the professors.

Travaux pratiques

Srinivasa Swaminathan
Dalhousie University, Halifax N.É.

Pendant le dîner à la cafétéria un mardi, j'ai entendu une étudiante se plaindre amèrement des travaux pratiques : elle avait des travaux pratiques en biologie, en physique et en mathématiques. Tout était à remettre le vendredi suivant.

De nombreux étudiants doivent consacrer des heures pratiquement à tous les soirs à leurs travaux pratiques. La plupart des professeurs semblent croire que ces travaux aideront beaucoup les étudiants dans leur carrière universitaire. D'autres sont d'avis que de tels travaux sont une perte de temps; que ce ne sont des travaux routiniers.

On dit que les travaux pratiques présentent plusieurs avantages, à condition qu'ils soient donnés dans une mesure raisonnable et au bon moment. Les étudiants doivent pouvoir prendre de l'expérience du matériel qui est présenté dans les classes régulières. Ils doivent vérifier s'ils comprennent bien la nouvelle information et les nouvelles idées. De plus, de tels travaux permettent au professeur de savoir ce que les étudiants ont appris ou non. Les étudiants peuvent également lancer des discussions de groupe; certains préfèrent en fait travailler en groupe.

Les travaux pratiques présentent toutefois des désavantages. De nombreux étudiants se font imposer trop de travaux, et bien souvent la quantité de travaux n'est pas coordonnée. Aussi, les étudiants n'ont parfois plus le temps de se détendre ou de faire du sport. Les travaux pratiques peuvent également faire augmenter les niveaux de stress chez certains étudiants, ce qui entraîne une baisse de productivité et de rendement. L'argument principal contre les travaux pratiques toutefois est le suivant : l'exercice est tout simplement ennuyant. Les étudiants n'apprennent parfois rien de nouveau. S'exercer a des avantages, mais des exercices sans fin portant sur le même matériel ne mènent pas à des améliorations.

Par conséquent, il faut évaluer judicieusement l'utilité des travaux pratiques. Ces travaux sont utiles dans certaines circonstances. Les personnes concernées doivent comprendre la valeur et l'importance des travaux pratiques. Il faut bien concilier temps libre et travaux pratiques pour assurer le bien-être des étudiants et des professeurs.

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The Editors of the NOTES welcome letters in English or French on any subject of mathematical interest but reserve the right to condense them. Those accepted for publication will appear in the language of submission. Readers may reach us at the Executive Office or at **notes-letters@cms.math.ca**

Lettres aux Rédacteurs

Les rédacteurs des NOTES acceptent les lettres en français ou en anglais portant sur n'importe quel sujet d'intérêt mathématique, mais ils se réservent le droit de les comprimer. Les lettres acceptées paraîtront dans la langue soumise. Les lecteurs peuvent nous joindre au bureau administratif de la SMC ou à l'adresse suivante : **notes-lettres@smc.math.ca**.

NOTES DE LA SMC

Les Notes de la SMC sont publiés par la Société mathématique du Canada (SMC) six fois par année (février, mars/avril, juin, septembre, octobre/novembre et décembre).

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Note aux auteurs : indiquer la section choisie pour votre article et le faire parvenir au Notes de la SMC à l'adresse postale ou de courriel ci-dessous.

Les Notes de la SMC, les rédacteurs et la SMC ne peuvent être tenus responsables des opinions exprimées par les auteurs.

CMS NOTES

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Continued from cover

a number of broad recommendations, but commonly also contains a classification of programs into different ranked categories. University administrators through various university processes including the University Senate, Faculty Councils and Board of Governors will be using the results of these program prioritization processes to inform future allocations of resources. For many departments and programs within the university, this process identifies certain weaknesses and unsustainable practices that the university administration will attempt to rectify. What is clear in almost all cases is that the old way in which decisions on resource allocations were made, is being challenged on a university wide scale.

While I personally applaud and fully endorse a university-wide review of every program on a university campus, I also recommend that we as a mathematical community proceed cautiously. I am willing to wager that most university mathematics departments in the country do not have significant undergraduate majors and graduate students within their programs to warrant the faculty complement currently found within their departments. Naturally, if the number of undergraduate mathematics majors and graduate students are not sufficient to cover the operating costs and overhead for the department, then these programs would most likely be deemed unsustainable in their current form. What makes a mathematics department sustainable is not its major or graduate programming, but its service programming. Indeed, this weakness in methodology in some Program Prioritization Processes has been noted already, "For example, mathematics professors may teach thousands of business majors, but may not do well in program prioritization because math has few of its own majors."[1]

While our undergraduate major and graduate programs may not be sustainable, when taken together with the value of our immense service programing, the mathematics department becomes sustainable, and in some cases a valued contributor to the wider university.

I hesitate to say it, but we must come to the realization that in almost every university in the country, the department of mathematics is a service department. We are all aware that the mathematics department offers a smorgasbord of service courses to physics, engineering, chemistry, economics, business and a whole host of other disciplines. These departments appreciate the value that we add to their respective programs when subject matter experts, i.e. mathematicians, teach the required subject matter, i.e., mathematics courses. That is, having subject matter experts increases the quality of the program, sometimes an undervalued attribute in these Program Prioritization Processes. Having a cadre of highly qualified mathematics faculty lends creditability to the program, department and the university.

One of the items to be noted, is that mathematics as a subject area is absolutely essential to so many programs, that with its entire host of programming (service teaching, majors teaching, research, and service) the mathematics department is a little bit more immune to the yearly fluctuations found in student program choices. In essence, our teaching portfolio is diversified, and therefore we are not as sensitive to small changes in student programming decisions over the decades. What and who we teach may be a little different, but on the whole, we should not be seeing huge declines in the overall student numbers taking mathematics courses.

So if we are a service department, then we should be striving to become the best service department within each of our respective faculties and institutions. How can this be done? Put our best instructors in front of these classes and give them the support necessary to help them succeed. This is also important in that it is our way of ensuring that each student receives a solid foundation in the fundamentals of whatever mathematical concept we are teaching. We would be reaching a wide audience, and impressing upon them the value and beauty of mathematics; hopefully bringing a better understanding of the discipline to the wider public.

Do not underestimate the value of providing excellent service to the wider university. It provides evidence that the mathematics department is an excellent university citizen and contributor to the greater good of the institution. Providing students with excellent learning opportunities promotes a healthy appreciation for mathematics as reflected in student comments such as "While math was not my favorite subject, I was impressed with the level of engagement my mathematics professor gave me even though I am not a math major." These sorts of comments resonate with university administrators. Obtaining more resources to provide excellent learning opportunities for students in service courses has spin off effects that will support the majors and graduate programs. The most obvious one of course is additional faculty.

I am not advocating for eliminating the majors and/or graduate programming in mathematics in our respective institutions, quite the contrary. Having a robust majors and graduate program is absolutely essential to keep the faculty engaged and to support the greater demands on research and scholarly work that we all are expected to do. Without a robust major and/or graduate program, the research expectations of the faculty would need to change. The university would have extreme difficulty in retaining excellent faculty to teach in the service programming, if there were no majors and/or graduate programming. However, we must recognize that it is the high quality service teaching that makes the department a valued contributor to the university and it is this service teaching that allows us to do what we love to do, mathematics.

As you read this, and prepare for your teaching assignment for next year, give some thought to talking to your Chair or Head, and asking them how you can better contribute to the sustainability of the department.

1 http://www.macleans.ca/education/university/saskatchewan-isnt-only-school-doing-program-prioritization/

Calendar Notes brings current and upcoming domestic and select international mathematical sciences and education events to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

Johan Rudnick, *Canadian Mathematical Society, (director@cms.math.ca)*

Le calendrier des activities annonce aux lecteurs de la SMC les activités en cours et à venir, sur la scène pancanadienne et internationale, dans les domaines des mathématiques et de l'enseignement des mathématiques. Vos commentaires, suggestions et propositions sont le bienvenue.

Johan Rudnick, *Société mathématique du Canada (directeur@smc.math.ca)*

MARCH 2015

9-14 CRM **Workshop: p-adic methods in the theory of classical automorphic forms**, Montreal, Que.

13 PIMS/UBC PIMS/UBC **Distinguished Colloquium: Jill Pipher**, University of British Columbia, B.C.

23-27 FIELDS/CANSSI **Workshop on Big Data in Health Policy**, Toronto, Ont.

29-A2 FIELDS **Forcing & Applications**, Fields Institute, Toronto, Ont.

APRIL 2015

6-10 CRM **Workshop: The Kudla programme**, Montreal, Que.

13-17 FIELDS/CANSSI **Workshop on Big Data for Social Policy**, Toronto, Ont.

15- 18 NCTM **2015 Annual Meeting and Exposition**, Boston, MA

30-M2 SIAM **International Conference on Data Mining**, Vancouver, B.C.

MAY 2015

2 SIAM **Great Lakes Section 2015 Annual Conference**, Grand Rapids, Michigan

4-8 FIELDS Short Thematic Program: **Differential equations with variable delay**, Toronto, Ont.

6-8 FIELDS **Algorithms and Complexity in Mathematics, Epistemology and Science** (ACMES), Western University, Ont.

7-10 FIELDS **Representation Theory and Analysis on Lie Groups over Local Fields**, University of Ottawa, Ont.

11-15 FIELDS Short Thematic Program: **Delay-Differential equations in physical sciences and engineering**, Toronto, Ont.

11-22 IAS **Aspects of Algebraic Geometry**, Princeton, NJ

15-17 CRM **XVIII^{e} colloque panquébécois des étudiants de l'Institut des Sciences Mathématiques** (ISM), Montreal, Que.

19-22 FIELDS Short Thematic Program: **Structured delay systems**, Toronto, Ont.

25-29 FIELDS Short Thematic Program: **Delay differential equations in life sciences and medicine**, Toronto, Ont.

JUNE 2015

1-4 CanaDam **5th biennial Canadian Discrete and Algorithmic Mathematics Conference**, University of Saskatchewan, Sask.

5-8 **CMS Summer Meeting**, University of Prince Edward Island, Charlottetown, P.E.I

5-9 CMESG **2015 Meeting**, University of Moncton, Moncton, N.B.

7-12 AMMCS- CAIMS **2015 AMMCS-CAIMS Congress**, Waterloo, Ont.

10-13 **2015 Joint International Meeting** with the AMS, the European Mathematical Society (EMS) and the Sociedade Portuguesa de Matemática (SPM) University of Porto, Porto, Portugal

12-14 FIELDS **Math and Coding Symposium**, Faculty of Education, Western University, Ont.

13-14 FIELDS/CANSSI Thematic Program on Statistical Inference, Learning and Models for Big Data, **Closing Conference**, Toronto, Ont.

14-17 SSC **2015 43rd Annual Meeting**, Dalhousie University, Halifax, N.S.

15-16 FIELDS/CRM **Séminaire de Mathématiques Supérieures - Geometric and Computational Spectral Theory**, Montreal, Que.

17-21 **Canadian Undergraduate Mathematics Conference**, University of Alberta, Alta.

29-J7 PIMS **Symposium on the Geometry and Topology of Manifolds**, University of British Columbia, B.C.

JULY 2015

6-8 AARMS **International Symposium in Statistics** 2015, Memorial University, St. John's, N.L.

6-10 IWOTA 2015 **Workshop on Operator Theory & Applications**, Tbilisi, Georgia

AUGUST 2015

4-8 AARMS "Domain Decomposition Methods for PDEs" Short Course + Collaborative Workshop, Halifax, N.S.

17-21 AARMS **AHA 2015**, Dalhousie University, Halifax, N.S.

DECEMBER 2015

7-10 SIAM **Conference on Analysis of Partial Differential Equations**, Scottsville, Arizona

Book Review Notes brings interesting mathematical sciences and education publications drawn from across the entire spectrum of mathematics to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

Karl Dilcher, *Dalhousie University (notes-reviews@cms.math.ca)*

Les critiques litéraires présent aux lecteurs de la SMC des ouvrages intéressants sur les mathématiques et l'enseignement des mathématiques dans un large éventail de domaines et sous-domaines. Vos commentaires, suggestions et propositions sont le bienvenue.

Karl Dilcher, *Dalhousie University (notes-critiques@smc.math.ca)*

Classical and Multilinear Harmonic Analysis, 2 Volumes

by Camil Muscalu and Wilhelm Schlag

Cambridge University Press, 2013

ISBN: 978-0-521-88245-3, 978-1-107-03182-1

Reviewed by ***Hartmut Führ****, Lehrstuhl A für Mathematik, RWTH Aachen, Germany.*

It is probably safe to say that suitable alternative titles for Volumes I and II would have been "Classical Harmonic Analysis" and "Multilinear Harmonic Analysis", respectively. Thus, Volume I is intended to appeal to a broader audience, providing a general introduction to Fourier analysis, with emphasis on techniques that are needed in the more specialized Volume II. The latter functions as a focussed introduction into a very active, current field of mathematical research at the intersection between Fourier analysis and the theory of partial differential equations. The first author was very much involved in the progress that this field has seen in the last 15 to 20 years, whereas the second author has published eminently on a large variety of topics relating Fourier analysis and PDE.

1. Classical Harmonic Analysis

An introduction to Fourier analysis in fewer than 400 pages necessarily requires a careful selection of material. The choices made by the authors are motivated by the applications in Volume II, and they put this book in the tradition of the Calderón-Zygmund or hard analysis approach to harmonic analysis. Consequently, roughly half of the twelve chapters treat topics such as maximal functions, function spaces such as Hardy spaces and BMO, Littlewood-Paley and multiplier theory, and Calderón-Zygmund theory of singular integral operators. In this respect the book has much in common with, say, the textbooks by Grafakos or Duoandikoetxea.

There are however some noteworthy differences, which are largely motivated by the applications in the second part. Probably the most important difference is the inclusion of probabilistic methods, which are used frequently in the subsequent text. The techniques covered include martingales and stopping time arguments, which will reappear in Volume II. Also, the later chapters on the uncertainty principle, Fourier restriction theorems and the Weyl calculus contain material that is much less often covered in introductory textbooks on Fourier analysis.

2. Multilinear Harmonic Analysis

As mentioned above, the subject matter of the second volume is rather more specialized and (at least in the later chapters) much more recent. The main topics of interest in this volume are paraproducts, commutators and bilinear Hilbert transforms, and their applications to problems in mathematical physics such as the theory of AKNS systems, or to the proof of the Carleson-Hunt theorem on pointwise convergence of Fourier series.

The importance of commutator estimates was originally recognized by Calderón's work on the Cauchy integral on Lipschitz curves, and the central Chapter 4 of this volume contains a treatment of this topic. The preceding chapters are largely concerned with preparing and motivating these results: A very readable first chapter motivates the study of paraproducts, by discussing dispersive estimates for the Korteweg-de Vries equation from certain estimates generalizing the Leibniz rule for the derivative of a product. The first chapter serves as an introduction both to the problems studied in more generality later, and to the language that will be used to address them, namely wave packets and phase-space portraits. Chapter 2 contains a proof of the Coifman/Meyer theorem for paraproducts. Chapter 3 revisits the generalized Leibniz rule, and proves a biparameter version.

The discussion in Chapter 4 highlights the interplay between the Cauchy integral operator and the bilinear Hilbert transform. The connection is further expanded upon in the discussion of a class of differential equations, the so-called AKNS systems, in Chapter 5. The remaining chapters then focus on the bilinear Hilbert transform, with Chapter 6 presenting the boundedness results established originally by Lacey and Thiele. The proof of the Carleson-Hunt theorem on pointwise convergence of Fourier series using the bilinear Hilbert transforms is the subject of Chapter 7.

3. Summary

Volume I is well-suited as a textbook for a two-semester graduate course on Fourier analysis. Volume II presents a unified and self-contained introduction to a very active current research topic. Although the subject matter of this volume has large intersections with research papers by the first author, the pertinent chapters are not just compilations of said papers, but have been very carefully written to fit well into the context developed in the previous parts.

As a rule, the presentation of the more recent research differs significantly from the original sources, often making these results much more accessible.

The authors have a knack of presenting mathematical concepts and arguments in a condensed, but very intuitive and appealing way. Hence, the introductory parts of each chapter are a pleasure to read, and they do a very good job at establishing a general narrative that allows the reader to see the connections between the different chapters, and to follow the overall development. I found these connections very interesting, and the presentation at times surprising. As a particular instance, let me mention Volume I, Chapter 10: Here, the authors present the Malgrange-Ehrenpreis theorem on solvability of PDEs with constant coefficients on bounded domains as a consequence of the Logvinenko-Sereda theorem, and subsume both as instances of the uncertainty principles. A similar use of intuition is made via the concepts of time-frequency localization and phase-space portraits throughout the second volume.

"The authors have a knack of presenting mathematical concepts and arguments in a condensed, but very intuitive and appealing way."

It remains to address the suitability of the books for a student readership. According to the preface of Volume I, it could be studied by a beginning graduate students as independent study over the course of a year. It seems to me that as an assessment of the mathematical maturity and background knowledge of a typical beginning graduate student, this is probably a bit optimistic. The seeming simplicity of the writing is in part bought by the fact that standard technical issues, such as convergence, are often not addressed. A careful student reader (who should pay some attention to these questions) will take a considerable amount of time to work out these details by him/herself. The same may be said of the exercises, which are usually on the challenging side. On the other hand, the scenario of a student working through a given book without taking recourse to other sources is somewhat unrealistic, anyway, and the great expository merits of both volumes is something that will be appreciated by student readers, as well.

In any case, both volumes are highly welcome additions to the harmonic analysis literature.

Call for Nominations — CJM/CMB Associate Editors

The Publications Committee of the CMS solicits nominations for five Associate Editors for the Canadian Journal of Mathematics (CJM) and the Canadian Mathematical Bulletin (CMB). The appointment will be for five years beginning January 1, 2016. The continuing members (with their end of term) are below.

For over fifty years, the Canadian Journal of Mathematics (CJM) and the Canadian Mathematical Bulletin (CMB) have been the flagship research journals of the Society, devoted to publishing original research works of high standard. The CJM publishes longer papers with six issues per year and the CMB publishes shorter papers with four issues per year. CJM and CMB are supported by respective Editors-in-Chief and share a common Editorial Board.

Expressions of interest should include your curriculum vitae, your cover letter and sent electronically to: cjmcmb-ednom-2015@cms.math.ca before **November 15th 2015**.

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Mathematicians on Creativity

by Peter Borwein, Peter Liljedahl, and Helen Zhai (editors)

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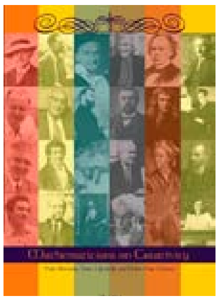
Reviewed by ***Ed Barbeau****, University of Toronto.*



Creativity in mathematics, a vast and fascinating subject in itself, is, fortunately, not a matter of merely taking "any hypothesis that seems amusing" and deducing its consequences. If it were, it could never generate the kind of fire, despair and triumph that shine through the beautiful letters between Bolyai the elder and his son. (Mark Kac)

While Kac, like the other mathematicians quoted in this book, has no doubt about the reality of mathematical creativity, it is not so easy to uncover what it is. Some will share the view of Paul Malliavin that mathematicians "are more interested in doing mathematics than speaking about it." However, there are few who would be as dismissive as Joseph Doob, who averred that "'Creative process' is for the birds. I just sat around and wondered about what I was interested in."

The editors of this volume delved into the nature of creativity by assembling this compendium of quotations of mathematicians past and present on the subject. Inspired in part by a 1902 survey by two French psychologists, Édouard Claparède and Théodore Flournoy, and a more successful follow-up survey by Hadamard, they sent off a questionnaire to contemporary eminent mathematicians in which they asked whether their principal discoveries resulted from deliberate endeavour or arose spontaneously, how much chance, insight, inspiration or illumination played a role, how they differentiated the learning and creation of mathematics, how their practice evolved since student days and whether they analyzed the process that led to their discoveries. A followup pair of questions enquired about the *aha!* or *eureka!* experience.

As for mathematicians of the past, there was no shortage of quotations in the literature as the most famous among them were fascinated by the peculiar attributes of mathematics. Most of these older mathematicians have very little to say about creativity, but quite a bit about the qualities of mathematics, particularly the purity of its truth and beauty. Aristotle's assertion that "the mathematical sciences particularly exhibit order, symmetry, and limitation; and these are the greatest forms of the beautiful" sets the tone. From the modern mathematicians, quite a few themes emerge about the creative process.

Implicit in many of the quotations is that mathematics is in and of itself a superlative environment for creativity. There is ample scope for imagination and the evocation of an aesthetic response to its beauty and elegance. It presents a challenge not just to prove results, but to provide just the right context in which they are to be housed, a factor suggested by the "Proofs from the Book" spoken of by Paul Erdős. While many researchers refer to the suddenness of seeing the light towards solving a problem, they warn that this often follows a period of preparation and gestation. Wendell Fleming mentions that "both chance and insight are important", but that "chance will favour only those who are prepared."

" …there are few who would be as dismissive as Joseph Doob, who averred that "'Creative process' is for the birds."

Many creative mathematicians refer to their persistence and autonomy. Another aspect for many is how one's time is budgeted; they need to have some contrasting activity that will allow for a subconscious period of gestation. This often leads to a sudden sense of seeing the light. Several preferred to check known results for themselves before relying on the literature. This perhaps reflects that for many the solving of a problem is secondary to arriving at an understanding of the situation.

From my own conversations with first-rate mathematicians, I have found that many of them can canvass and evaluate a range of ideas very quickly, going over territory that I would spend much more time exploring. Combined with this is a certain ruthlessness in discarding unproductive lines of enquiry. But the essence of creativity, it seems to me, is the ability to frame a situation in a completely novel way to come up with an approach that few would think of, regardless of the time available. Another possible ingredient is the ability to focus on important problems and ideas. In the words of Poincaré, "Discovery in discernment, choice. … The sterile combinations do not even present themselves to the mind of the creator." ([7]; see also page 107 of the book under review.)

This book serves the useful function of providing in one place the varied and considered views of many in the mathematical pantheon who have tried to plumb the depths of their achievements. Other authors, such as Poincaré, Hadamard, Davis and Hersh [7, 5, 3] have written at more length on their take on the personal side of mathematical development. Some like Aigner and Ziegler or Stein [1, 9] have sought to uncover attributes of creativity through the examination of particular problems. And then there are those [3, 4, 6, 8] whose goal is a more systematic academic study of the phenomenon. Most readers of this review, regardless of their stature in the mathematical community, will be able to relate to the sentiments expressed in this collection.

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Photo credit: Diana Tyszko

Lifetime CMS member James G. Arthur awarded the 2015 Wolf Prize in Mathematics

University of Toronto professor James Arthur was awarded the 2015 Wolf Prize in Mathematics for "his monumental work on the trace formula and his fundamental contributions to the theory of automorphic representations of reductive groups." Arthur has been a CMS member since 1990.

It is only the second time that a Canadian has won the mathematics prize (Robert Langlands of the Institute for Advanced Study, Princeton was the first). Arthur is the first Canadian recipient who also did his work in Canada.

The full citation and announcement is available on the Wolf Foundation website: **www.wolffund.org.il/index.php?dir=site&page=winners&cs=807**

Appel à candidatures — Rédacteur(trice) associé(e) pour le JCM et le BCM

Le Comité des publications de la SMC sollicite des mises en candidatures pour cinq postes de rédacteurs associés pour le Journal canadien de mathématiques (JCM) et pour le Bulletin Canadien de mathématiques (BCM). Le mandat sera de cinq ans qui commencera le 1er janvier 2016. Les membres qui continuent (avec la fin de leur terme) sont ci-dessous.

Revues phares de la Société depuis plus de 50 ans, le Journal canadien de mathématiques (JCM) et le Bulletin canadien de mathématiques (BCM) présentent des travaux de recherche originaux de haute qualité. Le JCM publie des articles longs dans ses six numéros annuels, et le BCM publie des articles plus courts quatre fois l'an. Le JCM et le BCM ont chacun leur rédacteur en chef et partagent un même conseil de rédaction.

Les propositions de candidature doivent inclure votre curriculum vitae, votre lettre de présentation et doivent être envoyé par courriel électronique à : jcmbcm-rednom-2015@smc.math.ca **au plus tard le 15 novembre 2015**.

Membres Actuels du Conseil de rédaction scientifique pour le JCM et le BCM:

Henry Kim (Toronto)	12/2016	Rédacteur en chef JCM
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Frank Sottile (Texas A&M)	12/2015	Rédacteur associé
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Juncheng Wei (UBC Vancouver)	12/2018	Rédacteur associé
Daniel Wise (McGill)	12/2018	Rédacteur associé
Efim Zelmanov (UCSD)	12/2016	Rédacteur associé

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CMS Notes
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Education Notes brings mathematical and educational ideas forth to the CMS readership in a manner that promotes discussion of relevant topics including research, activities, and noteworthy news items. Comments, suggestions, and submissions are welcome.

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Les articles sur l'éducation présente des sujets mathématiques et des articles sur l'éducation aux lecteurs de la SMC dans un format qui favorise les discussions sur différents thèmes, dont la recherche, les activités et des nouvelles d'intérêt. Vos commentaires, suggestions et propositions sont le bienvenue.

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In this edition of the Education Column we have two articles. The first, by Chantal Buteau and Miroslav Lovric, details discussions from the 2014 Winter CMS Meeting Mathematics Education session. The article provides interesting questions on why we teach the content we teach and asks what we should be teaching in today's world. The second article, by Tom Griffiths, provides some history on the development of a problem solving programme for grades 5 through 12 run by Western University.

Undergraduate Math Curriculum in 21st Century: Dictated by the Job Market?

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At the last CMS Meeting that took place in December 2014 in Hamilton (Ontario), a Mathematics Education session, titled *Undergraduate Mathematics Education in 21st Century: Rethinking Curriculum*, brought together fourteen speakers, four panellists, and many participants around the topic of undergraduate mathematics curriculum and pedagogy[1]. In the following, we, the organizers, reflect on some points raised during the two-day session, and place them in a broader context. To set the stage, we opened with a quote by Hillel (2002), reporting on the working group on "*Trends in Curriculum*" at the 1999 ICMI Study on Teaching and Learning of Mathematics at the University Level. Hillel indicated that despite the rapid changes of communication, technology and information:

> A fairly accurate picture of undergraduate mathematics is that, by and large, it is still dominated by the 'chalk-and-talk' paradigm, a careful linear ordering of course content, and assessment that is heavily based on final examination. Even the highly publicized 'computer revolution' has not really made a sweeping impact on mathematics. … That said mathematics in 1999 looks a lot more like mathematics in 1939 than is the case with any of its sister sciences (Borwein, 1999). (p.64)

Furthermore, Hillel (2002) adds that,

> Steen has written that 'strong departments find that they replace or change significantly half of their courses approximately once a decade' and 'as new mathematics is continually created, so mathematics courses must be continually renewed' (Steen, 1992). These on-going updates to the curriculum can be regarded, in a sense, as 'deterministic' aspects of curriculum change, ones that do not put into question the purpose, goals, and means of undergraduate education. (p. 61)

We asked our presenters and panellists to focus their discussion and comments around some questions, among which: *Does undergraduate mathematics in 2014 look a lot more like undergraduate mathematics in 1939 than is the case with any of its sister sciences? If so, should it and why? Is our undergraduate education in sync with what is needed from us?* As stressed by N. Hardy during her presentation, we are sure that these questions, in one form or another, have been raised numerous times since (and certainly before) 1939[2]. So, are we just continuing the tradition, or are there—presently—really deep reasons why we need to rethink and then change university math curricula? Furthermore, does research exist in mathematics education, or elsewhere, which would inform and, ultimately, support our proposed changes?

The four panelists (H. Ben-El-Mechaiekh, N. Hardy, D. Martinovic and Y. St-Aubin) addressed a number of issues, which are further discussed in this report.

What we all agree on is that the overall education landscape has changed quite a bit since 1939 (and since 1999, when the ICMI study we mentioned earlier was written). We learn that producing 'job-ready graduates' is now what certain provincial governments define to be the most important role of a university. Yet, we have no information from those same people telling us what jobs will be available in four years when our first-year students will leave with fresh-minted diplomas in their hands. We have witnessed a history of poorly made announcements and decisions (think about the huge surplus of teachers in Ontario). As pointed out by Nadia Hardy during the panel discussion, 'who decides' or 'who defines priorities' is in the foreground of the 2014 math landscape.

Evidence suggests that we (mathematicians and mathematics educators) erroneously believe that we can run free from these

[1] For presentation files, see http://ms.mcmaster.ca/lovric/mathedsessioncms2014.html

[2] See Hardy's abstract. It is a sequence of three excerpts each of which covers a different time period: 1928, 1915-54, and 1994.

increasing pressures to 'prepare students for the workplace.' Departmental web pages (with a few exceptions, such as Waterloo) provide no concrete information about jobs and careers in mathematics beyond token statements affirming that math is used almost everywhere.

Obtaining reliable, up-to-date careers and jobs information (in general, and about mathematics and statistics in particular) is a huge challenge. In its July 2013 document "*What has changed for young people in Canada?*" (Galarneau et al, 2013) Stats Canada not only provides important job-related information, but shows how complex the situation is. Among the findings of the document, we read:

- Young people are more educated and are putting off their entry into the labour market longer. In 1976, the maximum full-time employment rate among those age 34 and under was reached at age 25. In 2012, the maximum rate was reached at the age of 31.
- Over the last three decades, the employment conditions of young people changed differently according to sex, age, and place of residence. Some groups, like women age 25 to 34, even experienced improved employment conditions.
- In contrast, employment conditions deteriorated for young people age 24 and under, but less so in oil-producing provinces.

Does this imply that it makes sense for young people to stay at school longer, or come back (even if it takes another student loan) to obtain extra qualifications, and enter the job market later in life? If so, what are we prepared to do—offer the same graduate and professional programs we have been offering for the last few decades?

"Math in 2014" is truly about jobs, and about preparing our students for a *global*, *knowledge-based* economy. In particular, we must think about the fact that young people who will be competing for that dream job in Vancouver or Calgary or St. John's four years from today are building their knowledge and skills not only at Canadian institutions, but also in New Delhi, Manila, Shanghai and Sao Paolo. The Society for Industrial and Applied Mathematics (2012) indicates that, "programming and computer skills continue to be the most important technical skills that new [mathematician] hires bring to their jobs" (p. 25). How many departments in Canada have been thinking about these when discussing their courses and programs?

In another report from Stats Canada, named "*Educational and Labour market activities after graduation*" (Ferguson, Wang, 2014), we are told that:

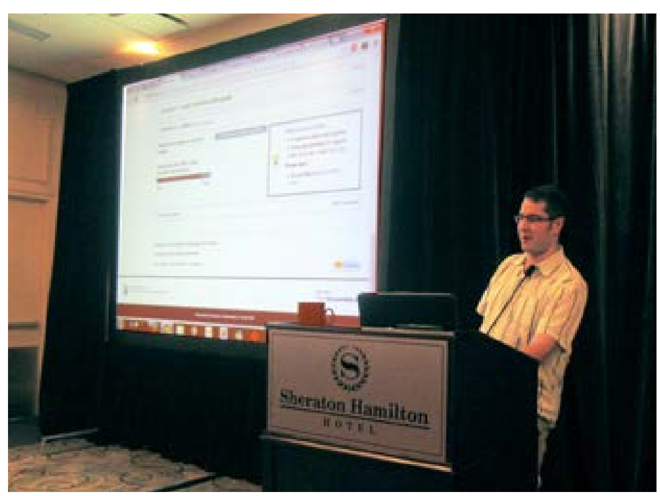
> The NGS (National Graduates Survey) results showed a relationship between employment and the proportion of graduates who pursued further education within three years of graduation. A higher proportion of graduates pursued further education in fields of study where there were lower employment rates. For example, among bachelor graduates, 'biological and biomedical science' (77%) and 'mathematics and statistics' (71%) were among the field of study sub-groupings with the largest proportions of returning students and both had employment rates below the average (88% and 86% compared with 92% overall for bachelor graduates).

So, it seems that we will see (even) more graduate students in mathematics and statistics. These students will come to our departments in the hope that the extra education we will provide (in the form of graduate and/or professional programs) will improve their chances of obtaining good, satisfactory, and well-paid jobs.

Thus, perhaps the most important conclusion–the job situation in Canada (and possibly elsewhere) requires that we rethink curriculum in ways that have not been done before. Are we ready for the challenge? If we are to "train" our students rather than to "educate" them, how do we do that?

We suggest that we translate 'training' (which might provoke negative reactions) into 'providing rich, relevant and diverse opportunities in mathematics and statistics.' These opportunities could be interesting, imaginative courses providing alternatives to, or enriching standard ways (calculus and linear algebra) of advancing through first-year math curriculum. In this context of 'flattening the curriculum' (D. Poole), presenters elaborated on problem-solving opportunities (F. Gourdeau, A. Nahornick), computer programming and using software for math investigations and simulations (C. Buteau, M. Lovric [in education plenary]), a course on 'modern' geometry and geometric reasoning (W. Whiteley), a course combining modern and old ideas for students to develop flexible thinking (M. Kondratieva), and a math reasoning course with number theory as context (M. Lovric [in education plenary]).

But we need to push this further, and engage in a dialogue across campus. For instance, discussing the redesign of the Life Sciences Program at McMaster University, faculty from biology, environmental studies and chemistry agreed that life sciences students need to know about topics such as medical imaging, biomechanics, quantitative methods for health sciences (including working with a variety of math and stats software) and analyzing big data. Needless to say—it's all math! However, at the moment, there are no math nor stats courses at McMaster where these topics are taught *to a sufficient depth and breadth*. In some cases, one could adjust a course (for instance, one math aspect of medical imaging involves finding an approximate solution of an over-determined system of linear equations, accomplished by iterating projections of an initial



guess onto suitably chosen hyperplanes—doable within a linear algebra course). For some topics, brand new courses will have to be designed.

What about pedagogy and research support?

Perhaps it is too much to expect that research in math education will be able to provide definitive answers to our questions (such as: computer programming is gaining in popularity and importance—how exactly do we design a math course (what math?) with a programming component? Or: We live in a knowledge economy, and in particular, our students need certain skills. What skills exactly, and how do we 'teach' skills? What is the right balance between skills and knowledge in a math and stats curriculum?). However, math education research (as well as interdisciplinary research) can certainly provide us with good insights, suggestions and strategies.

In our session we heard about L. Broley's survey on Canadian mathematicians' use and views on the role and need of programming in mathematics. C. Buteau presented her research on programming mathematics for math investigations, applications and simulations, based on the successful implementation at Brock University of their MICA (Math Integrated with Computers and Applications) courses.

Matters of pedagogy were also discussed. A common idea that came across many presentations was to 'make time' to have students 'do mathematics' (Bass, 2011). Diverse implementation ideas were discussed. For example, one weekly lecture hour was voluntarily added to an already existing course for complementing in-class problem solving (F. Gourdeau). This could be seen as an attempt to balance knowledge and skills. A. Mamolo presented about her research and concrete implementation for fostering appreciation and values in and for mathematical thinking. Not surprisingly some pedagogy changes due to technology integration were also discussed, for example through the integration of Sage worksheets in an optimization course (A. Novoseltsev). Also a free, online initiative done by graduate students at UBC aiming at supporting undergraduate math learning was presented (C. Bruni) whereas C. Weatherby provided a national overview of initiatives to support first-year math students.

There is no denying that the many forces of globalization and demands of a market-driven economy will continue to play a fundamental role in shaping our future, and the future of our students. But instead of entertaining apocalyptic scenarios, we need to think of new opportunities that will arise, such as having a larger number of graduate students, creating new courses (some interdisciplinary) and redesigning existing courses. Needless to say, this does not imply diminishing the role of fundamental research, nor the retirement of our analysis, logic or differential geometry courses. On the contrary, their importance (for instance, in the light of increased demands on our graduate programs) could only increase.

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Math Challenge at Western

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Math Challenge at Western is a programme for elementary and secondary school students who like mathematics and wish to learn how to solve mathematical problems. There are 365 students registered so far this year along with 9 teachers and two other members of staff, all volunteers. The programme was started in 1996. I retired in 1995 and started visiting schools to help students who wanted to do well in mathematics contests. I had been involved in setting and marking contests at Waterloo since 1969 as well as having been a coach of the Canadian IMO team. I served for six years on the writing team of the US Mathematics Olympiad and three on the Canadian Mathematics Olympiad when it was set at Western. Since I really enjoy teaching and had a lot of experience with teaching problem solving, it seemed a shame not to continue using the experience.

In the fall of 1996 I heard that Western wanted to start an outreach programme for mathematics. It seemed a good idea to combine our efforts and continue at Western University. I then started a programme with six senior students, as well as continuing to visit schools. The programme grew rapidly. It soon became obvious that

both a junior and senior high school section were needed. Within a year I saw the need to expand to include grades 7 and 8. By this time we had three teachers: myself, Margaret Kemp and Walker Schofield, who is a Descartes medalist. We have since expanded to a grade 5/6 class as well having added a class specifically for those students preparing for Olympiads, the latter taught by two retired university professors. The program is staffed largely by retired high school teachers and university professors, many of whom have a long history of involvement with contests.

Our main source of materials is various mathematics contests. We give the students old papers from the CEMC, CMS Open and Kangaroo contests, which they have time to work on between classes prior to going through solutions during the next class. In the grade 9 and 10 class we spend one of two hours teaching topics such as combinatorics, trigonometry and graph theory. We also teach the basic ideas required in problem solving in all classes as the need arises. An example of a topic that we find most useful in problem solving is modular arithmetic. We also emphasise the idea that mathematics is not only learning and using formulae, but also proving the formulae are valid.

Our *Math Challenge* sessions start at the beginning of October, to give the students a chance to settle into school. They end in April after the Fryer, Galois, Hypatia and Euclid contests are written. Classes are monthly for the elementary students (on Saturdays) and weekly for the high school students (Monday evenings for Grades 9/10 and Tuesday evenings for Grades 11/12). The Olympiad preparation class takes place on Tuesday afternoon. Two teachers lead each of the classes that are 2 hours in duration. The senior class is extended to three hours for those students who want to compete in the CEMC team contest. Students have had many successes in the various mathematics contests, including representation of Canada in the International Mathematics Olympiad. Our schedule of classes and staff can be found at **www.math.uwo.ca/math-challenge**.

If anyone would like to start a similar programme I would be delighted to assist them. I can be contacted at tgriffit@uwo.ca.

La priorisation des programmes et la valeur de la contribution à l'ensemble de l'université, suite de la couverture

quantité d'énergie organisationnelle qui aboutit normalement à quelques recommandations générales, mais qui contient aussi, bien souvent, une catégorisation des programmes par ordre d'importance. Les administrateurs universitaires, par l'entremise de divers organes, dont le sénat de l'université, les conseils de professeurs et le conseil des gouverneurs, utilisent ensuite les résultats de l'exercice pour répartir les ressources de l'établissement. Cet exercice cerne les faiblesses de nombreux départements et programmes de l'université ainsi que les pratiques non viables que les dirigeants universitaires tenteront de corriger. Ce qui est clair dans presque tous les cas, c'est que l'ancienne façon de prendre des décisions sur la répartition des ressources est contestée à la grandeur de l'établissement.

Bien que je me réjouisse personnellement d'un vaste examen des programmes d'une université et que j'appuie entièrement ce genre d'exercice, je nous recommande aussi, en tant que communauté mathématique, de faire preuve de prudence. Je suis prêt à parier que la plupart des départements de mathématiques universitaires du pays n'ont pas suffisamment d'étudiants en spécialisation au premier cycle et d'étudiants aux cycles supérieurs dans leur programme pour justifier leur nombre de professeurs. Naturellement, si le nombre d'étudiants en spécialisation au premier cycle et d'étudiants aux cycles supérieurs ne suffit pas à couvrir les coûts de fonctionnement et frais généraux du département, on jugera vraisemblablement que ces programmes ne sont pas viables dans leur forme actuelle. En fait, ce qui assure la viabilité d'un département de mathématiques n'est pas le nombre de ses étudiants à chaque cycle, mais les cours qu'il offre au reste de l'université. On constate déjà les lacunes méthodologiques de certains exercices de priorisation des programmes, comme en témoigne cet extrait d'un article du Macleans : « Par exemple, des professeurs de mathématiques peuvent enseigner à des milliers d'étudiants en commerce, mais le département ne se classera tout de même pas bien à l'exercice de priorisation parce qu'il n'a pas lui-même autant d'étudiants en spécialisation. »[1]

Or, bien que les programmes de premier cycle et d'études supérieures de nos départements de mathématiques ne soient pas toujours viables, ils le deviennent davantage si l'on tient compte de la très forte vocation pluridisciplinaire de ces départements, ce qui leur confère, dans certains cas, une valeur très appréciable pour l'université.

J'hésite à dire ceci, mais nous devons nous rendre à l'évidence que dans presque toutes les universités du pays, les départements de mathématiques sont des départements « contributifs ». Nous sommes tous conscients que les départements de mathématiques offrent des cours de

1 http://www.macleans.ca/education/university/saskatchewan-isnt-only-school-doing-program-prioritization/

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Research Notes brings mathematical research ideas forth to the CMS readership in a generally accessible manner that promotes discussion of relevant topics including research (both pure and applied), activities, and noteworthy news items. Comments, suggestions, and submissions are welcome.

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Les articles de recherche présente des sujets mathématiques aux lecteurs de la SMC dans un format généralement accessible qui favorise les discussions sur divers sujets pertinents, dont la recherche (pure et appliquée), les activités et des nouvelles dignes de mention. Vos commentaires, suggestions et propositions sont le bienvenue.

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Gray Matter Is Matter For Math

P. Holmes, *Program in Applied and Computational Mathematics, Department of Mechanical and Aerospace Engineering and Princeton Neuroscience Institute, Princeton University, NJ 08544.*

Neuroscience and mathematics. In 1980 a chance meeting at a copy machine in Cornell's Math department drew me into a series of collaborations with neuroscientists that now occupy my research life. By describing mathematical models of some elements of nervous systems, I argue that many areas can contribute: deterministic and stochastic differential equations (ODEs and SDEs), analysis, probability, graph theory, information theory, statistics, machine learning and more.

To biologists a *model* is a simple organism (think nematode, fruit fly, mouse) from which we learn about more complex organisms, e.g., ourselves. For me, a model is a mathematical summary of observations and experimental data, usually having a computational realization. Neuroscientists are learning that these are also useful, and both types were on stage at the November 2014 kickoff for research funded under President Obama's Brain Initiative [1]. In fact, mathematics entered neuroscience 70+ years ago: Norbert Weiner [2] and John von Neumann [3] were pioneers.

Brains and nervous systems. The human brain contains $\mathcal{O}(10^{11})$ *neurons:* electrically active cells that communicate by emitting *action potentials* (APs). These brief ($\mathcal{O}(1)$ msec) voltage spikes travel along axons to release neurotransmitter molecules at *synapses* with other cells, either promoting or delaying their APs. Each neuron connects to $\mathcal{O}(10^4)$ others in a dynamic network. In the central nervous system (CNS) as many other neurons control our physiological rhythms.

Neurons. In a series of beautiful papers that won them a Nobel prize, Alan Hodgkin and Andrew Huxley (HH) created the first biophysically-based model of a neuron by viewing it as a homogeneous mixture of ionic species (atoms carrying electrical charges) and writing Kirchhoff's current law for the time-dependent potential difference $v(t)$ across the cell membrane [4]:

$$C\dot{v} = -\sum g_j(v - V_j) - I_{syn}. \tag{1}$$

Here C is the membrane capacitance, the sum is taken over channels with conductances g_j carrying different ions, V_j is the reversal potential for ionic specie j (so called because the current reverses direction at $v = V_j$), and I_{syn} is the current due to synaptic inputs from other neurons.

Eqn. (1) seems linear: for constant I_{syn}, $v(t)$ should settle on a stable *resting potential* determined by g_j's and V_j's. Alas for analysis, but happily for brain function, it is not so: the g_j's depend on v. HH modeled this by adding ODEs for *gating variables*

$$\tau_k(v)\dot{w}_k = w_{k,\infty}(v) - w_k, \tag{2}$$

where $w_{k,\infty}(v)$ and $\tau_k(v)$ characterize the fraction of open channels and their timescales governing approach to $w_{k,\infty}(v)$. The conductances are typically polynomials $g_j(w_k)$ and $w_{k,\infty}(v)$, $\tau_k(v)$ are sigmoidal functions. Thus the HH ODEs (1-2), describing how v varies as channels open and close, are *nonlinear* and insoluble in closed form, but both brains and Eqns. (1-2) can produce interesting dynamics: sustained and even chaotic trains of APs.

Synapses. Neurons possess *axons* and *dendrites*: long extensions that carry outgoing and incoming signals. An AP in a pre-synaptic cell arriving at a synapse releases neurotransmitters that diffuse to nearby receptors on dendrites of post-synaptic cells. ODEs like (2) can also model this, with a variable $s_k(t)$ denoting neurotransmitter concentration, $\tau_k(t)$ its timescale and $s_{k,\infty}(v)$ its maximum concentration. A pre-synaptic cell k can make multiple synapses with a post-synaptic partner l, but these are often simplified to an overall connection strength g_{kl} with synaptic current

$$I_{l,syn} = \sum_k g_{kl} s_k(t)(v - V_{k,syn}), \tag{3}$$

where $V_{k,syn}$ is the synapse's reversal potential.

Circuits and reduced models. The HH and synapse ODEs provide components for modeling circuits in the CNS and brain, but a dozen distinct ionic currents may be active in each cell, so a network of only 10 neurons may require $\mathcal{O}(10^2)$ ODEs and many more if complex dendritic and axonal morphology is represented by dividing the cell into compartments ($\mathcal{O}(10^2)$ may be needed). With conductances, reversal potentials, $w_{k,\infty}$'s, τ_k's and $s_{k,\infty}$'s, the 10-cell circuit may have $\mathcal{O}(10^3)$ parameters, few of which can be measured directly.

Integrate and fire models offer dimension reduction in replacing APs by delta functions, "fired" when v crosses a threshold. This neglects the cell's ionic dynamics, assuming they are much faster than those of the circuit or brain region of interest. Since APs last a millisecond and the quickest reaction times to stimuli are $\mathcal{O}(10^2)$ msec, this is often acceptable, and removes many parameters.

Alternatively, networks of bursting neurons that create regular rhythms (heartbeat, breathing, walking) can be reduced to *phase oscillators*: scalar ODEs that track progress on limit cycles and encode the effect of coupling to other cells and circuits by *phase response curves*.

One can also *average* over n subpopulations of similar cell types to obtain *firing-rate models*:

$$dx_j = [f_j(x_1, \ldots, x_n) + I_j]dt + \sigma dW_j. \qquad (4)$$

In this SDE the I_j's are inputs to each population, the x_j's their activities, the f_j's quantify their interactions and the dW_j's are i.i.d. Wiener increments, representing effects of unmodeled brain areas. Such derivations are often based on mean field theories that lack rigor, but SDEs like Eqn. (4) also appear as continuum limits of sequential probability ratio tests (SPRTs) [5], thus linking an abstract description of choice behavior with a neural mechanism. In the simplest case of choosing between two alternatives, the SPRT is optimal in that, for given accuracy rate, it delivers the fastest possible decision, thus offering a standard to assess cognitive performance.

Models like (4) can accurately describe behavioral, electrophysiological and imaging data throughout neuroscience, so it is important to create better theories linking cellular scale mechanistic models with those of cortical columns and brain areas.

Probabilistic methods. Eqn.(4) exemplifies a class of models that are widely used in animal and human studies. Randomness can enter due to chaotic or poorly-characterized brain activities, to noise in the environment and sensory pathways, or inherently stochastic neural dynamics; indeed, inter-spike intervals are often modeled as Poisson processes. Among such models, a more abstract approach to sifting evidence and making decisions appeals to Bayes' rule:

$$P[A|B] = P[B|A]P[A]/P[B], \qquad (5)$$

where $P[A]$ is the probability of an event A and $P[A|B]$ the probability of A conditional upon B. Here $P[A]$ encodes *prior information*, $P[B|A]$ represents an observation, e.g. of sensory data, and $P[A|B]$ is the *posterior estimate*. Iterative application of Eqn. (5) typically improves accuracy. Successful models of motor control and learning in both motor and cognitive tasks have been built on Bayes' rule. More generally, Markov processes with "hidden variables'' can model multi-electrode recordings in terms of transitions among brain states, and there is evidence that brains can encode probability distributions and perform Bayesian updates, possibly via cortico-basal ganglia circuits.

Networks, graphs and big data. Much excitement in neuroscience is due to new experimental methods and the tsunami of *very big data* they are already delivering. Optogenetics, multi-electrode recording and imaging techniques are revealing the functions of individual cells and brain areas. The *connectome* of every neuron and synapse in a brain area, or in an entire small animal, can be extracted by electron microscopy. Analysis of the resulting graph, with nonlinear dynamical nodes and evolving edges, will demand all that statistics and the growing array of geometrical and analytical data-mining tools can offer (for a thoughtful discussion of this approach, see [6]).

But I doubt that machine learning and its many relatives will suffice. Models have revealed much about components and circuits: they should not be abandoned. Even a partial understanding of neural mechanisms will require creation and integration of models across the scales from molecules through cells to organisms. Neglect of inessential data, not inclusion of all, will be important, to complement dimension reduction. Support for this belief appears at greater length in [7].

"Much excitement in neuroscience is due to new experimental methods and the tsunami of *very big data* they are already delivering..."

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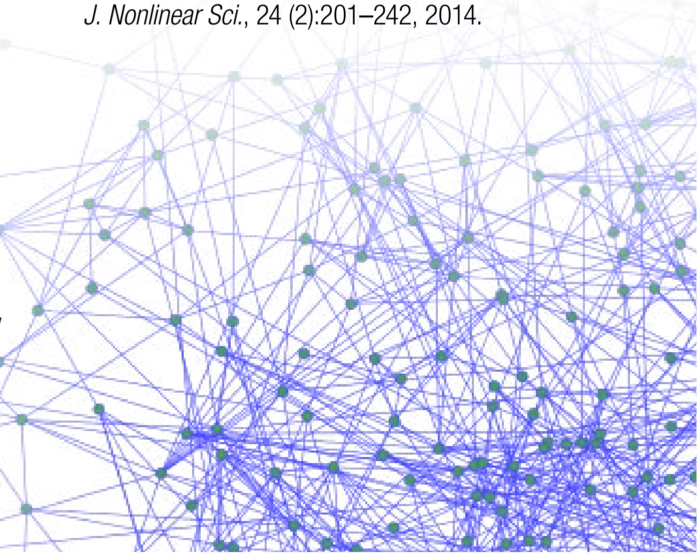


Weak Solutions of the Binormal Curvature Flow

Robert L. Jerrard, *Department of Mathematics, University of Toronto*

The binormal curvature flow is a geometric evolution equation for curves in 3-dimensional Euclidean space that arises as an approximation of the evolution of very thin vortex filaments in an inviscid, incompressible fluid. Its simplest nontrivial solution is given by a circle that propagates with constant velocity in the direction perpendicular to the plane in which it sits; the corresponding motion of vortex filaments can be seen in smoke rings, for example, which may be said to evolve "to leading order" by the binormal curvature flow (which we will often abbreviate as BCF).

The equation for binormal curvature flow may be written

(0.1) $$\partial_t\gamma = \partial_s\gamma \times \partial_{ss}\gamma, \qquad |\partial_s\gamma|^2 = 1.$$

The second condition states that the $s \mapsto \gamma(t,s)$ is an arclength parametrization for every t. Given this, we recall that $t = \partial_s\gamma$ is the unit tangent and $|\partial_{ss}\gamma|$ is the curvature. Where the curvature is nonzero, we further define the normal $n := \partial_{ss}\gamma/|\partial_{xx}\gamma|$ and binormal $b = t \times n$. Thus the equation may be rewritten

$$\text{velocity vector} = \kappa\, b.$$

This equation was first derived in a 1906 paper of L.S. da Rios [1], based on his PhD dissertation research, carried out under the supervision of T. Levi-Civita. The equation was subsequently forgotten, and has been rederived at least twice. A *rigorous* justification of the BCF as a description of vortex filaments in solutions of equations of ideal fluid dynamics (for example the incompressible Euler equations, as considered by da Rios) is still very largely open, and seems to be out of reach for now. However, direct observation of vortex filaments in superfluid Helium in recent virtuoso experiments [5] has revealed good qualitative agreement with the BCF.

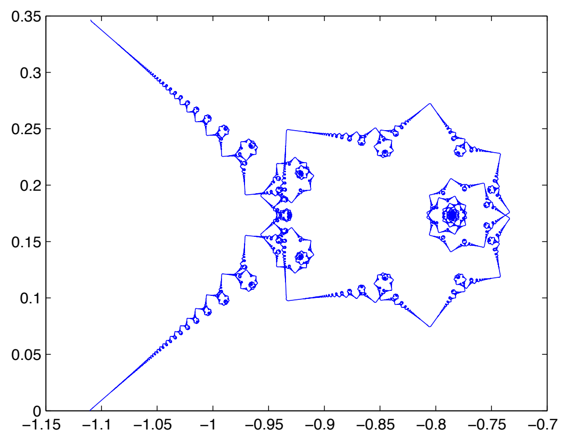
There are a number of reasons that one might want to study weak solutions of the BCF. One is that vortex filaments in certain fluids are observed to self-intersect and change topology, and in doing so to form kinks and lose smoothness. Although the connection between the BCF and actual vortex filaments in fluids remains obscure, this suggests that it could be worthwhile to develop a framework in which one can make sense of solutions of the BCF that exhibit these sorts of behaviour, which is very much *not* the case for the classical parametric formulation (0.1).

Another source of interest in non-smooth solutions of the BCF comes from numerical results and heuristic arguments, which indicate that these solutions, if they exist, may exhibit very rich behaviour. In particular, a recent paper of de la Hoz and Vega [2] carries out an in-depth study of solutions of the BCF for initial data $\gamma_0(s) = \gamma(0,s)$ parametrizing a regular planar polygon. In this situation, based on a mixture of numerical, formal, and rigorous considerations, de la Hoz and Vega find a rather explicit candidate γ for a solution of the BCF with such initial data, with the following properties:

- $s \mapsto \gamma(t,s)$ is piecewise affine for rational t, so that the image of $\gamma(t,\cdot)$ is a polygon in $\mathbb{R}^3$.
- $s \mapsto \partial_s\gamma(t,s)$ is fractal, in a precise sense, for t irrational.
- $t \mapsto \gamma(t,0)$ is multifractal, again in a precise sense, for coordinates in which $(t,s) = (0,0)$ corresponds to a vertex of the planar polygonal initial data (see Figure 1).

Note, however, that it is far from clear what "a solution of the BCF" means in this setting. For a piecewise affine curve, the curvature vanishes everywhere except at the vertices, where it is formally infinite. Due to the nonlinear structure of equation (0.1), it is difficult to bring to bear notions such as the Dirac delta function, which in more linear problems might be used to handle the formal infinities that occur. Curves with fractal tangents are no easier to handle.

Figure 1. Fractal behaviour of BCF with polygonal initial data – the trace in the $x = y$ plane of the curve $t \mapsto \gamma(t,0)$, from numerical simulations of de la Hoz and Vega [2].



Recent work [3, 4] of the author and D. Smets uses ideas from geometric measure theory to develop a notion of weak solutions of the binormal curvature flow. This allowed us to prove the existence of solutions for initial data which is merely a rectifiable curve. As a result, it is meaningful to discuss solutions with polygonal initial data — a fact that de la Hoz and Vega were aware of, as our work preceded theirs. (However, showing that their *candidate* solution is actually a weak solution in our sense remains an open, and possibly difficult, problem). Our framework also allows for solutions that change topology, and it is easy to prove that this can in fact occur.

In the weak setting in which we work, one does not expect uniqueness of solutions. However, our solutions enjoy a *weak-strong uniqueness* property: a weak solution that coincides at time $t = 0$ with a sufficiently smooth solution will continue to do so until the first time at which the smooth solution develops a self-intersection. In fact, more is true: a weak solution that is initially close to a smooth solution (in a very weak topology, a sort of geometric H^1 norm) will remain close, again as long as the smooth solution remains embedded. This is a new sort of stability property, hitherto unexpected, of the binormal curvature flow.

None of our results have any direct implications for the conjecture that the BCF governs vortex filaments in the incompressible Euler system and other related models, in certain limits. Nonetheless, our definition of a weak solution is based solely on certain integral identities associated to the binormal curvature flow, and there is a strong formal similarity between these and corresponding integral identities satisfied by the vorticity vector field in a solution of the incompressible Euler equations. This formal affinity suggests that a geometric measure theory perspective on binormal curvature flow might at least be a useful ingredient in studying the dynamics of vortex filaments in fluids.

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La priorisation des programmes et la valeur de la contribution à l'ensemble de l'université, suite de la page 13

toutes sortes aux départements ou facultés de physique, de génie, de chimie, d'économie, de commerce et de nombreuses autres disciplines. Ces entités apprécient la valeur ajoutée de nos départements à leurs programmes respectifs lorsque des spécialistes du domaine (des mathématiciens) donnent les cours obligatoires (de mathématiques). Le fait de pouvoir compter sur des spécialistes d'une matière rehausse en outre la qualité des programmes, un atout sous-estimé dont on ne tient pas toujours compte dans ces exercices de priorisation des programmes. Ainsi, le fait de pouvoir compter sur des professeurs de mathématiques hautement qualifiés accroît la crédibilité du programme récepteur, du département et de l'université.

S'il est un point à souligner, c'est que les mathématiques sont une matière absolument essentielle à tellement de programmes qu'avec tous leurs propres programmes (cours aux autres départements, programmes de spécialisation et programmes de recherche), les départements de mathématiques sont un peu plus immunisés contre les fluctuations annuelles liées aux choix de programmes des étudiants. Bref, comme notre offre de cours est diversifiée, nous ne sommes pas aussi sensibles aux petites variations dans les programmes que choisissent les étudiants sur plusieurs décennies. Ce que nous enseignons et à qui nous l'enseignons peut varier légèrement, mais, dans l'ensemble, nous ne devrions pas constater de déclin massif du nombre total d'étudiants qui suivent des cours de mathématiques.

Donc, si nous sommes des départements « pourvoyeurs » ou mieux, « à forte vocation pluridisciplinaire », nous devrions nous efforcer de devenir les meilleurs dans ce créneau dans nos facultés et établissements respectifs. Comment y parvenir? Mettons nos meilleurs enseignants dans ces classes et donnons-leur les outils nécessaires à leur succès. Cet élément est aussi important parce que c'est notre façon de veiller à ce que chaque étudiant acquière une base solide, quel que soit le concept mathématique enseigné. Nous rejoindrions ainsi un vaste auditoire, auquel nous communiquerions la valeur et la beauté des mathématiques. Peut-être parviendrons-nous ainsi à mieux faire comprendre notre discipline à un plus vaste public.

Ne sous-estimez pas l'importance d'offrir d'excellents services à l'ensemble de l'université. C'est signe que le département de mathématiques contribue de façon exceptionnelle à l'université et à son bien-être général. En offrant aux étudiants des cours marqués par l'excellence, nous alimentons leur amour des mathématiques. Des commentaires d'étudiants comme celui-ci : « Bien que les maths n'étaient pas ma matière préférée, j'ai été impressionnée par toute l'attention que mon professeur m'a accordée même si je ne suis pas une étudiante du département de mathématiques », marquent grandement les dirigeants d'une université. L'obtention de ressources supplémentaires pour offrir des expériences d'apprentissage exceptionnelles aux étudiants des cours offerts aux autres départements a des retombées qui alimenteront les programmes de spécialisation et les programmes d'études supérieures en mathématiques. La plus évidente de ces retombées étant bien sûr l'embauche d'un plus grand nombre de professeurs.

Je ne dis pas qu'il faut éliminer les programmes de spécialisation ou de cycles supérieurs en mathématiques de nos établissements respectifs, bien au contraire. Il est absolument essentiel d'assurer l'excellence de ces programmes pour préserver la motivation des professeurs et les aider à répondre aux exigences de plus en plus élevées en recherche et en travail universitaire qui leur sont imposées. En l'absence de tels programmes robustes, il faudrait modifier les attentes vis-à-vis des professeurs en recherche. L'université aurait beaucoup de difficulté à retenir d'excellents professeurs pour donner les cours aux autres départements ou facultés si elle n'avait pas de programme de spécialisation ou de cycles supérieurs en mathématiques. Nous devons toutefois reconnaître que c'est la qualité élevée des cours offerts au reste de l'établissement qui fait la précieuse contribution du département à l'université et qui nous permet de faire ce que nous aimons : des mathématiques.

Au moment où vous lisez ces lignes et préparez vos cours pour la prochaine année, songez à rendre visite à la direction de votre département pour lui demander de quelle façon vous pouvez contribuer davantage à assurer la viabilité du département.

CSHPM Notes brings scholarly work on the history and philosophy of mathematics to the broader mathematics community. Authors are members of the Canadian Society for History and Philosophy of Mathematics (CSHPM). Comments and suggestions are welcome; they may be directed to either of the column's co-editors,

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Hardy Grant, *York University [retired] (hardygrant@yahoo.com)*

Les articles de la SCHPM présente des travaux de recherche en histoire et en philosophie des mathématiques à la communauté mathématique élargie. Les auteurs sont membres de la Société canadienne d'histoire et de philosophie des mathématiques (SCHPM). Vos commentaires et suggestions sont le bienvenue; ils peuvent être adressées à l'une des co-rédacteurs,

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Online Collections of Mathematical Objects

Amy Ackerberg-Hastings, *University of Maryland University College*

Illustrating one's teaching with physical objects is often desirable but sometimes not feasible. Over the past decade or so, museums have stepped into the gap by offering online access to their collections to the public. The Smithsonian Institution is one of the organizations gradually digitizing its entire collection (collections.si.edu). Additionally, staff and volunteers at the Smithsonian's National Museum of American History (NMAH) have made it easier to take a virtual tour of like objects by grouping them into a sort of encyclopedia of apparatus relevant to U.S. history (americanhistory.si.edu/collections/object-groups).

Mathematics is especially well-represented in these "object groups," with over 25 examples, thanks to the efforts of curator Peggy Aldrich Kidwell and volunteers such as Judy Green (Marymount University) and Amy Shell-Gellasch (Montgomery College). Ed and Diane Straker, American slide rule collectors, generously funded a 27-month half-time position from 2011 to 2013, during which I completed ten groups. A few highlights, with suggestions for classroom use, are provided here.

Figure 1 Keuffel & Esser (K&E) slide rule, 1955–1961, SI neg. no. DOR2010-0909-2174.

This rare slide rule is a 10-inch model 4081-3, manufactured by K&E of New York City, to which metal rivets have been affixed to form Braille numerals. An oversized cursor, or indicator, and a customized case have also been added. The adaptations were probably made by the American Foundation of the Blind in the late 1950s. Moritz Otto Shollmier (1931–1972), an American mechanical engineer, received this rule after he lost his sight in 1961, allowing him to continue his career for another decade. Slide rules can be used in precalculus classrooms to help students visualize logarithmic calculations. Similarly, specialized slide rules, such as those with scales for electronics, could be effective visual aids in upper-level physics and engineering courses. Instructors can also use the slide rule object group to identify slide rules they find in storage at their institutions.

Figure 2 Station pointer, 20th century, SI neg. no. DOR2011-8523.

Making a protractor can provide hands-on experience with the issues involved in dividing the circle to geometry students and pre-service teachers. The protractors object group shows that, in addition to posing mathematical problems, dividing the circle raises technological questions. Early examples were marked by hand with increasingly sophisticated techniques, before dividing machines mechanized the process around the turn of the 19th century. The NMAH collection can also help students think about relationships between mathematics and work. For example, navigators measured the angles between their ship and three landmarks with a sextant. They then laid a station pointer on top of a chart, set its arms to the angle measurements on a circular protractor attached to the arms, and read off their position through the viewer at the center.

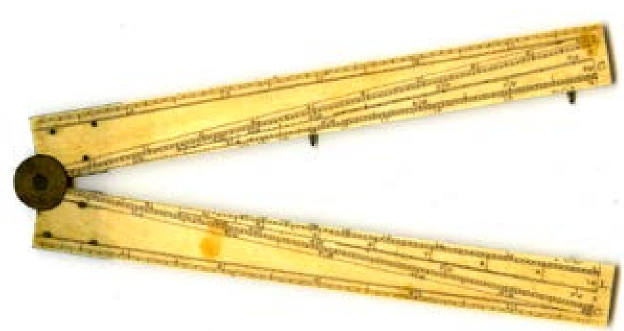

Figure 3 English-style sector, owned by Alexander Matheson, ca 1800, SI neg. no. AHB2011q05551-000001.

While most of the objects at NMAH were collected for their ability to illuminate the history of the United States, a few have Canadian connections. Alexander Matheson (1788–1866) carried two sectors, a rectangular protractor, and a parallel rule while he served in the British army in the West Indies, fought in Canada during the War of 1812, and settled near Perth, Ontario, where he helped build the Rideau Canal. This ivory sector with a brass hinge measures nearly 13 inches when it is fully unfolded. On one side, it has a 12-inch ruler, a line of lines for making proportional calculations by constructing similar triangles, and a line of chords for constructing angles. The other side has trigonometric scales for sines and tangents and logarithmic scales for tangents, sines, and numbers. Sectors thus illustrate early modern efforts to simplify calculation. They also can foster discussions of national differences in the history of mathematics, since sectors made on the Italian peninsula and in France were used mainly for military engineering, while those made in England were employed in sundial manufacture, navigation, and general-purpose calculating.

Other object groups include abaci and numeral frames, adders, adding machines, arithmetic teaching apparatus, bookkeeping machines, calculating machines, cash and credit registers, counters, dividers and drawing compasses, electronic desktop calculators, ellipsographs, kinematic models, mathematical charts and tables, the mathematical paintings of children's author Crockett Johnson, metric system demonstration apparatus, parallel rules, pens and pencils, planimeters, scale rules, sets of drawing instruments, spherometers, tabulating equipment, triangles and squares, and aspects of the personal and professional lives of women mathematicians. A more extensive discussion of classroom applications for online museum collections appears in MAA *Convergence* (www.maa.org/publications/periodicals/convergence/online-museum-collections-in-the-mathematics-classroom).

Amy Ackerberg-Hastings teaches historical research methods and writing for University of Maryland University College. Besides this column, she edits the CSHPM newsletter and frequently gives presentations on historical calculating and drawing instruments.

CMS Member Profile

Irena Papst

HOME: Hamilton, Ont. (McMaster University)

CMS MEMBER SINCE: 2012

RESEARCH: I currently study problems in mathematical biology, specifically modelling infectious disease spread. Running experiments in epidemiology is often either impractical or unethical and so we use mathematical models to uncover the underlying biological mechanisms that give rise to patterns of disease spread.

SELECTED ACHIEVEMENTS: I won an NSERC Alexander Graham Bell Canada Graduate Scholarship for the first year of my Master's degree, and a McGraw-Hill Ryerson Student Scholarship Award for my undergraduate thesis on the development of "mathematical maturity" in math undergraduates at McMaster University. I also recently learned to bike with no hands.

HOBBIES: Culinary experiments (especially pizza-based ones), discovering new music, and sampling espresso.

LATEST BOOK READ: I've been working on David Foster Wallace's Infinite Jest for almost a year. It's great, but lengthy!

LATEST PUBLICATION: I'm currently working on a paper about forced dynamical systems – specifically in the context of modelling childhood infectious diseases – with my supervisor, Dr. David Earn.

MEMORABLE "MATH MOMENT": In first grade, we would regularly be subjected to arithmetic drills; the teacher would have us complete a sheet of one hundred addition or subtraction problems in a limited amount of time while she prepared the next lesson. I'd often find myself more interested in what my teacher was doing than the drills, and so my attention would wander, meaning I'd turn in a sheet with only a few answers. My teacher was so concerned that I was struggling with the problems that she called my parents to tell them about the situation. My parents simply asked my teacher to send some extra drill sheets home and they'd take care of it. I remember being bitterly stuck in my room, doing drills, while my friends played outside my window. I never had trouble focusing on the drills in class again.

CMS ROLES: Chair of the Student Committee, organizer of a Scientific Session for graduate students at the 2014 CMS Winter Meeting in Hamilton, ON.

WHY I BELONG TO THE CMS: The community! What keeps me working hard on society projects are the fantastic people I get to meet and work with.

CMS Notes
Volume 47 No. 2, March-April 2015

December 4-7, 2015, Montreal (Quebec)
Site: Hyatt Regency Montreal
Host: McGill University

CALL FOR SESSIONS 2015 CMS Winter Meeting

The Canadian Mathematical Society (CMS) and McGill University welcome and invite proposals for sessions for the 2015 Winter Meeting in Montreal from December 4 to 7, 2015.

Proposals should include a brief description of the focus and purpose of the session, the expected number of speakers, as well as the organizer's name, complete address, telephone number, email address, etc.

All sessions will be advertised in the CMS NOTES, on the website and in the AMS Notices. Speakers will be requested to submit abstracts, which will be published on the web site and in the meeting program. Those wishing to organize a session should send a proposal to the Scientific Director by **April 15, 2015**.

Scientific Director:

Louigi Addario-Berry: **louigi.addario@mcgill.ca**

Du 4 au 7 décembre 2015, Montréal (Québec)
Site : Hyatt Regency Montréal (Québec)
Hôte : Université McGill

APPEL DE PROPOSITIONS DE SÉANCES Réunion d'hiver 2015 de la SMC

La Société mathématique du Canada (SMC) et l'Université McGill vous invitent à proposer des séances pour la Réunion d'hiver 2015 qui se tiendra à Montréal du 4 au 7 décembre 2015.

Ces propositions doivent compter une brève description de l'orientation et des objectifs de la séance, le nombre de conférenciers prévu, de même que le nom, l'adresse complète, le numéro de téléphone et l'adresse électronique de l'organisateur.

Toutes les séances seront annoncées dans les *NOTES* de la SMC, sur le site web et dans les AMS Notices. Les conférenciers devront présenter un résumé, qui sera publié sur le site web et dans le programme de la réunion. Toute personne qui souhaiterait organiser une séance est priée de faire parvenir une proposition au directeur scientifique au plus tard le **15 avril 2015**.

Directeur scientifique :

Louigi Addario-Berry: **louigi.addario@mcgill.ca**

Photo : Tourisme Montréal

This year the CMS will be electing twelve (12) officers and directors. Candidates have to agree to the nomination and provide the committee with biographical information.

You are invited to nominate members to be candidates. Nominations will be accepted by the Nominating Committee, provided that each person nominated: (i) is supported in writing by at least five (5) other members of the CMS; and (ii) has given written acceptance to stand for office and to supply biographical information.

Nominations together with supporting materials should be emailed to **nominations-2015@cms.math.ca** or mailed to the address below by April 4, 2015:

Nominating Committee Chair
Canadian Mathematical Society
209 - 1725 St. Laurent Blvd.
Ottawa, ON K1G 3V4 Canada

Nominations are being solicited for the following slate of candidates for the Executive Committee:

- President-Elect;
- Vice-President – Atlantic Provinces (N.B., P.E.I., N.S., N.L.);
- Vice-President – Quebec;
- Vice-President – Ontario;
- Vice-President – West (Alta., Sask., Man., N.W.T., Nunavut);
- Vice-President – Pacific (B.C., Yukon).

Nominations are also being solicited for Board of Directors members:

- Quebec – 1 member to be elected;
- West – 2 members to be elected;
- Pacific – 2 members to be elected;
- Student – 1 member to be elected.

For 2015, the CMS will hold an advance electronic poll to be tallied at the June AGM in Charlottetown, P.E.I. Information and voting instructions will be communicated to all individual CMS members. Updated information will be periodically e-mailed to members and posted on the CMS website at **http://cms.math.ca/Elections/2015/**.

Tom Salisbury
Chair, CMS Nominating Committee

Cette année, la SMC élira douze (12) dirigeants et administrateurs. Les candidats doivent s'entendre sur la nomination et de fournir au Comité des informations biographiques.

Vous êtes invités à nommer des membres à titre de candidat. Le Comité des mises en candidature acceptera les candidatures, à condition que chaque personne nommée : (i) ait reçu l'appui par écrit d'au moins cinq (5) autres membres de la SMC et (ii) ait accepté par écrit d'être candidat(e) et de fournir ses renseignements biographiques.

Les candidatures et les documents d'appui doivent être transmis par courrier électronique à **nominations-2015@smc.math.ca** ou envoyés par la poste au plus tard le 4 avril 2015:

Président du Comité des mises en candidature
Société mathématique du Canada
209 – 1725, boul. St. Laurent
Ottawa (Ontario) K1G 3V4 Canada

On demande des candidatures aux postes suivants au sein du Comité exécutif :

- Président élu;
- Vice-président – provinces de l'Atlantique (N.-B., N.-É., T.-N.-L., Î.-P.-É.);
- Vice-président – Québec;
- Vice-président – Ontario;
- Vice-président – Ouest (Alb., Sask., Man., N.W.T., Nunavut);
- Vice-président – Pacifique (C.-B., Yukon).

On demande également des candidatures aux postes suivants au sein du Conseil d'administration :

- Québec – 1 membre à élire;
- Ouest – 2 membres à élire;
- Pacifique – 2 membres à élire;
- Étudiant – 1 membre à élire.

Pour 2015, la SMC tiendra un scrutin d'anticipation par voie électronique, dont les résultats seront analysés au cours de l'AGA de juin à Charlottetown, à l'Île-du-Prince-Édouard. Les renseignements et les consignes du scrutin seront communiqués à tous les membres de la SMC. Des mises à jour seront communiquées régulièrement par courrier électronique aux membres et affichées sur le site Web de la SMC au **http://cms.math.ca/Elections/2015/.f**.

Tom Salisbury
Président du Comité des mises en candidature

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2015 CMS Summer Meeting
Charlottetown - June 5-8
#2015CMSsummer

June 5 - 8, 2015, Charlottetown (P.E.I.)

Site: University of Prince Edward Island

Hosts: University of Prince Edward Island and the Atlantic Association for Research in the Mathematical Science (AARMS)

cms.math.ca/events/summer15

5-8 juin 2015, Charlottetown (Î.-P.-É.)

Site : l'Université de l'Île du Prince-Édouard

Hôte : Université de l'Île-du-Prince-Édouard et l'Association pour l'avancement de la recherche mathématique en Atlantique (AARMS)

smc.math.ca/reunions/ete15

Prizes and Lectures | Prix et conférences

Coxeter-James Prize and Lecture
Prix Coxeter-James et conférence
recipient to be announced | lauréat à confirmer

Excellence in Teaching Award and Lecture
Prix d'excellence en enseignement et conférence
Jamie Mulholland (SFU)

Krieger-Nelson Prize Lecture
Prix Krieger-Nelson et conférence
recipient to be announced | lauréat à confirmer

Public Lecture | Conférence publique

Richard Nowakowski (Dalhousie)

Plenary Lectures | Conférences plénières

Nilima Nigam (SFU)
Christiane Rousseau (Montréal)
James Yorke (Maryland)
Andrew Toms (Purdue)

Education Plenary Lecture
Éducation conférence plénière

Robert Ghrist (Pennsylvania)

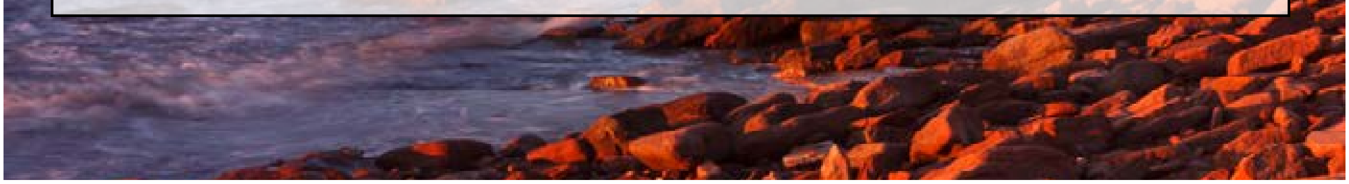
Scientific Directors | Directeurs scientifiques

Gordon MacDonald : gmacdonald@upei.ca
Shannon Fitzpatrick : sfitzpatrick@upei.ca

Related Events | Événements liés

The CMS Annual General Meeting (AGM) will occur on Saturday, June 6, from 12:30 - 14:00. The CMS Executive is inviting all members and meeting participants to join them at an informal luncheon to focus on what was achieved in 2014. There will be a short presentation followed by questions and answers and the 2015 CMS Election. | **L'Assemblée générale annuelle (AGA)** de la SMC auront lieu le samedi 6 juin, à partir de 12h30-14h00. Le Comité exécutif de la SMC invite tous les membres de la Société et les participants à la Réunion à se joindre à lui pour le dîner, question de savoir ce que la SMC a prévu en 2015 et discuter de vos intérêts ou de vos préoccupations. L'assemblée générale annuelle, qui porte surtout sur ce qui s'est fait l'année précédente 2014 et l'élection de la SMC 2015.

The Canadian Mathematical Society invites you to their **awards banquet** on Saturday, June 6, to highlight exceptional performance in the area of mathematical research and education at New Glasgow Lobster Suppers. Prizes will be awarded during the event. | La Société mathématique du Canada vous invite à son **banquet** le samedi le 6 juin pour souligner des contributions exceptionnelles en recherche mathématique et en enseignement des mathématiques au New Glasgow Lobster Suppers. Les prix seront remis durant la soirée.



Réunion d'été de la SMC 2015
Charlottetown - 5-8 juin
#étéSMC2015

Regular Sessions | Sessions générales

Advances in Nonlinear Partial Differential Equations
Avancées en équations différentielles partielles non linéaires
George Chen (Cape Breton), Scott Rodney (Cape Breton)

Contributed Papers | Communications libres
David Horrocks (UPEI)

Graduate Student Research Presentations
Exposés de recherche par les étudiants gradués
Svenja Huntemann (Dalhousie)

Operators Theory on Analytic Function Spaces | Théorie des opérateurs et espaces de fonctions analytiques
Javad Mashreghi (Laval)

Reaching our Students: Increased Participation and Persistence in First-Year Mathematics Courses | Rejoindre les étudiants: hausse de la participation et de la ténacité dans les cours de mathématiques de première année
Darja Kalajdzievska (Manitoba), Gordon MacDonald (UPEI)

Undergraduate Student Research Presentations
Exposés de recherche d'étudiants au premier cycle
Nathan Musoke (Waterloo)

AARMS-CMS Sessions | Sessions ARRMS-SMC

C*-algebras | C*-algèbres
Cristian Ivanescu (Alberta), Dan Kucerovsky (UNB)

Dynamical Systems with Applications to Biology and Ecology
Systèmes dynamiques avec applications en biologie et en écologie
Lin Wang (UNB), Yuan Yuan (Memorial)

Ergodic Theory, Dynamical systems and Applications
Théorie ergodique, systèmes dynamiques et applications
Pawel Gora (Concordia), Shafiqul Islam (UPEI)

Games and Pursuit Games on Graphs
Jeux et jeux de poursuite sur des graphes
Richard Nowakowski (Dalhousie)

Graphs, Designs and Hypergraphs
Graphes, designs et hypergraphes
Robert Bailey (Grenfell Campus, Memorial), Andrea Burgess (UNB Saint John), Margaret-Ellen Messinger (Mount Allison)

Interplay of Convexity and Geometric Analysis | Interactions entre la convexité et l'analyse géométrique
Jie Xiao (Memorial), Deping Ye (Memorial)

Number Theory | Théorie des nombres
Amir Akbary (Lethbridge), Karl Dilcher (Dalhousie)

Recent Advances in the Mathematics of Electromagnetic and Acoustic Imaging | Avancées récentes dans les mathématiques de l'électromagnétisme et de l'imagerie acoustique
Peter Gibson (York), Michael Haslam (York)

Optimization and Nonlinear Analysis
Optimisation et analyse non linéaire
Mohamed Tawhid (Thompson Rivers University)

Rigorous computation for differential-equation problems
Calcul rigoureux pour les problèmes d'équations différentielles
Roberto Castelli (VU Amsterdam), Holger Teismann (Acadia)

Singularities and Phase Transitions in the Calculus of Variations and PDE | Singularités et changements de phase dans le calcul des variations et les EDP
Lia Bronsard (McMaster), Ihsan Topaloglu (McMaster)

Poster Session | Présentations par affiches

AARMS-CMS Student Poster Session | Présentations par affiches pour étudiants - AARMS-SMC
Muhammad Ali Khan (Calgary)

Registration is now open! Early bird deadline is April 10!

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2016 CMS Summer Meeting – Call for Scientific Directors and Scientific Committee

The Canadian Mathematical Society (CMS) welcomes and invites proposals for Scientific Directors to organize the scientific programming of the 2016 CMS Summer Meeting. The meeting is to be held in June in Canada, at a site to be determined. One or two Scientific Director(s) will be selected to establish, organize and lead a Scientific Committee which will consist of representatives from a breadth of academic, regional and professional backgrounds. A typical meeting consists of a public lecture, four (4) plenary lectures and at least 18 scientific research and education sessions.

Ideal Scientific Directors and Scientific Committee representatives will hold a faculty position or influential role in a Canadian university or institution. Proposals demonstrating potential for multi-disciplinary and multi-institutional participation are strongly encouraged.

Proposals should include a summary of the expressed interest, background information for the Scientific Directors, and considerations for a proposed Scientific Committee.

Those wishing to serve as Scientific Directors should send a proposal to the CMS by emailing **meetings@cms.math.ca** by **April 17, 2015**.

Réunion d'été de la SMC 2016 – Appel de candidatures : directeurs scientifiques et comité scientifique

La Société mathématique du Canada (SMC) sollicite des candidatures aux postes de directeurs scientifiques pour l'organisation du programme de la Réunion d'été de la SMC 2016. L'événement se tiendra en juin, au Canada, et l'endroit demeure à déterminer. Un ou deux directeurs scientifiques seront choisis et auront comme responsabilité de former, d'organiser et de diriger un comité scientifique composé de représentants d'origines diversifiés (universitaires, membres régionaux, professionnels, etc.). Le programme type d'une Réunion propose une conférence publique, quatre conférences plénières et au moins 18 sessions scientifiques et en éducation.

Idéalement, les directeurs scientifiques et les membres du comité scientifique occupent un poste de professeur ou jouent un rôle prépondérant dans une université ou un autre type d'établissement au Canada. Nous encourageons vivement les personnes qui démontrent un enthousiasme particulier à favoriser la participation multidisciplinaire et multiétablissement.

Le dossier de candidature doit comprendre un résumé de l'intérêt pour le poste, de l'information sur le candidat au poste de directeur scientifique et des idées concernant la composition du comité scientifique.

Les personnes intéressées aux postes de directeurs scientifiques doivent faire parvenir leur candidature à la SMC à l'adresse **reunion@smc.math.ca** au plus tard le **17 avril 2015**.

If undelivered, please return to:
Si NON-LIVRÉ, prière de retourner à :

CMS Notes / Notes de la SMC
209 - 1725 St. Laurent Blvd Ottawa, ON K1G 3V4 Canada