CSHPM SCHPM

Canadian Society for the History and Philosophy of Mathematics
Société canadienne d'histoire et de philosophie des mathématiques

Annual Meeting / Réunion annuelle
Concordia University / Université Concordia
Faubourg (FG) Building
1616 St. Catherine W.
Montréal, Québec, Canada

Programme

Saturday, May 29/samedi le 29 mai

9:00 AM Welcome/ Bienvenue President Duncan Melville

Parallel Session I-A
Room FG B040

Presider: Larry D'Antonio

9:15 David Orenstein, Professional Development Committee of OSSTF, District 12, Toronto
High School History and Philosophy of Mathematics: An Action Research Project

9:45 Andrew Perry, Springfield College
Nicholas Pike's New and Complete System of Arithmetic (1788)

10:15 Break

10:30 Antonella Cupillari, Penn State Erie-The Behrend College
Elisha Scott Loomis and Proof Techniques

11:00 Emil Sargsyan, Indiana University
Mathematical Models and the Mechanical Philosophy in Seventeenth-Century Physiology: Comparing the mathematical theories of muscle contraction of Giovanni Alphonso Borelli and Johannes Bernoulli

11:30 Sandro Caparrini*, IHPS, Toronto, Rossana Tazzioli, University of Lille
Relativity and electromagnetism in the correspondence between T. Levi-Civita and A. Righi

Parallel Session I-B
Room FG B050

Presider: Robert Thomas

9:15 Mark C R Smith, Queen's University
Constraint and the Outskirts of Practice

9:45 Scott Dixon, University of California, Davis
Concrete Modal Structuralism

10:15 Break

10:30 Emerson P. Doyle, University of Western Ontario
Ramsey's Little Argument

11:00 Michael Cuffaro, The University of Western Ontario
Wittgenstein on Prior Probabilities

11:30 Elaine Landry, University of California, Davis
The Genetic Versus the Axiomatic Method: Responding to Feferman '77

12:00 – 2:00 Lunch Break/ Council Meeting

Session II
Room FG B040

Presider: Chris Baltus

2:00 Gregory Lavers, Concordia University
On the Quinean Analyticity of Arithmetical Truths

2:30 Amy Ackerberg-Hastings, University of Maryland University College
What is a Great Book? A Case Study of Legendre's Éléments de Géométrie (1794) and Playfair's Elements of Geometry (1795)

3:00 Larry D'Antonio, Ramapo College of New Jersey
Did Quadratic Forms Spring Full-Blown out of the Head of Gauss?

3:30 Break

Presider: Janet Heine Barnett

3:45 Jim Tattersall, Providence College
E.B. Escott: Mathematican or Actuary

4:15 Bruce Petrie, Institute for the History and Philosophy of Science and Technology University of Toronto
Leonhard Euler's Use and Understanding of Mathematical Transcendence

4:45 Roger Godard, Royal Military College of Canada
La Géométrie des Formes: The Paths to Computational Geometry

End of Saturday Program

Sunday, May 30/ dimanche le 30 mai

Parallel Session III-A
Room FG B040

Presider: Amy-Ackerberg-Hastings

9:00 Jean-Pierre Marquis, Université de Montréal
The metaphysics of homotopy types

9:30 Charlotte Simmons, University of Central Oklahoma
Yesudas Ramchundra: DeMorgan's Ramanujan?

10:00 Janet Heine Barnett, Colorado State University – Pueblo
Mathematics is a Plural Noun: The Case of Oliver Byrne

Presider: Jean-Pierre Marquis

10:30 Marina Vulis
The Life and Work of Andrei Markov

11:00 Francine F. Abeles, Kean University
The Early History of Quasi-determinants

11:30 Craig Fraser, University of Toronto
Thirty-five Years in the Historiography of Mathematics

Parallel Session III-B
Room FG B050

Presider: Jim Tattersall

9:30 Jonathan P. Seldin, University of Lethbridge
Logical Algebras as Formal Systems: H. B. Curry's Approach to Algebraic Logic

10:00 James T. Smith, San Francisco State University
Definitions and Nondefinability in Geometry: Legacies of Mario Pieri and Alfred Tarski

10:30 Ximena Catepillán*, Millersville University of Pennsylvania;
Waclaw Szymanski, West Chester University of Pennsylvania
Maya Calendars

11:00 Ed Cohen, edcohen@sympatico.ca
The Roman Calendars

12:00 – 2:00 Lunch and Annual General Membership Meeting (Room FG B040)

2:00 – 3:00 PM KENNETH O. MAY LECTURE
(Introduced by Duncan Melville, President CSHPM)

Speaker**:** Hardy Grant, York University, Toronto
Mathematics and the Liberal Arts: The Beginnings

Special Session / Session Spéciale IV MATHEMATICS AND THE LIBERAL ARTS
Room FG B040

Presider: Craig Fraser

3:15 Thomas Drucker, University of Wisconsin—Whitewater.
What Makes Mathematics a Liberal Art?'

3:45 Robert Thomas, University of Manitoba
Why a mathematician might be (a bit) interested in Theodosios's Spherics.

Presider: Sylvia Svitak

4:15 David Bellhouse, University of Western Ontario
The Mathematics Curriculum at the British Dissenting Academies in the 18^{th} Century

4:45 Michael Molinsky, University of Maine at Farmington
Mathematics at Amherst College in the Nineteenth Century

President's Reception/Réception de la présidente
Grey Nuns Residence/ Maison mère des Sœurs Grises
1185 St. Mathieu

5:30– 7:00 PM

End of Sunday Program

Monday, May 31/lundi le 31 mai

Special Session / Session Spéciale V MATHEMATICS AND LIBERAL ARTS
Room FG B040

Presider: Thomas Drucker

9:00 William Lindgren*, Slippery Rock University; Thomas Banchoff, Brown University
Flatland and Plato's parable of the cave

9:30 George Styan, McGill University
Philatelic Latin Squares

Parallel Session VI-A
Room FG B040

Presider: Rob Bradley

10:00 Michel Serfati, Université Paris
Irrationality of pi, Squaring the circle, and establishment of the concept of transcendence in Lambert's report (1761).

10:30 Kosla Vepa, Indic Studies Foundation
The Occident Ignores Historical Contributions to Science from other Geographies & Epistemes

11:00 Josipa Petrunic, University College London
Identifying with the English: Sir William Rowan Hamilton's effort to identify with English symbolical algebraists in the 'Preface' to the Lectures on Quaternions (1853)

11:30 Menolly Lysne, Simon Fraser University
Why do we not remember Laplace's work on singular solutions?

Parallel Session VI-B
Room FG B040

Presider: Thomas Drucker

10:30 Katherine Skosnik*, McGill University; Dirk Schlimm, McGill University
The Many Sides of Zero in Babylonian Context

11:00 Alex Koo, IHPST, University of Toronto
The Middle Road to Nominalism: A Response to Colyvan

11:30 Michael Cuffaro, The University of Western Ontario
Kant and Frege on the Ontological Argument for the Existence of God

12:00 – 2:00 Lunch Break

Session VII
Room FG B040

Presider: Craig Fraser

2:00 Theodore R. Widom*, McGill University; Dirk SchlimmMcGill University
Methodological Reflections on Classifying the World's Numeral Systems

2:30 Rob Bradley, Adelphi University
Series Summation in Cauchy's Algebraic Analysis

Presider: Patricia Allaire

3:00 Christopher Baltus, SUNY College at Oswego
Central Collineations in 1674: Les Plani-coniques of Philippe de la Hire

3:30 Bill Hackborn, University of Alberta
Newton's (Flawed?) Analysis of Motion Resisted in Proportion to Velocity

End of Monday Program and 2010 CSHPM/SCHPM Annual Meeting

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ABSTRACTS

ANNUAL MEETING / Réunion annuelle

Concordia University, May 29–31, 2010

Francine F. Abeles, Kean University, fabeles@kean.edu

The Early History of Quasi-determinants

Arthur Cayley, James Joseph Sylvester, and Charles L. Dodgson were the most important nineteenth century mathematicians whose work has influenced the modern development of quasi-determinants which are determinants of square matrices where the matrix entries are taken from a non-commutative ring. . In this paper I will describe their work and the significance of each mathematical approach, and then I will discuss each algorithm from the standpoint of efficiency of computation.

Amy Ackerberg-Hastings, University of Maryland University College, aackerbe@verizon.net

What is a Great Book? A Case Study of Legendre's *Éléments de Géométrie* (1794) and Playfair's *Elements of Geometry* (1795)

Both *Éléments de Géométrie* and *Elements of Geometry* were wildly popular textbooks in their day and remain well known to mathematicians, educators, and historians. Since they were published so close together in time and were so influential in European and American classrooms, it is logical to juxtapose their content and their authors. Adrien-Marie Legendre of France and John Playfair of Scotland both enjoyed international reputations, although Legendre made more substantial contributions to pure and applied mathematics. Yet, both authors directed these particular works at students, although there is some evidence that they also had larger contributions in mind. This raises questions about how we assess the quality of a textbook and whether we measure its research content or pedagogical approach. In a larger sense, who decides which works are great books in mathematics, and what are the criteria for achieving the status of a great book? This talk, therefore, is an exploration of the themes raised at the 2010 Joint Mathematical Meetings, particularly in the MAA Short Course, "Exploring the Great Books of Mathematics," and the MAA Contributed Papers Session, "Mathematical Texts: Famous, Infamous, and Influential."

Christopher Baltus, SUNY College at Oswego, baltus@oswego.edu

Central Collineations in 1674: *Les Plani-coniques* of Philippe de la Hire

Three Frenchmen of the 17th century introduced, it could be argued, projective geometry. They were Girard Desargues, Blaise Pascal, and Philippe de la Hire. Unfortunately, their work was forgotten, if not lost, until after Poncelet and others developed projective geometry in the early 19th century. Their innovation was in showing and making use of the preservation of certain crucial ratios under projection. For Desargues, it involved sets of points in involution; for La Hire, it was harmonic sets. Desargues was the first, the boldest, the most obscure, and possibly the deepest. The last, La Hire, was a brilliant expositor. Based on his best known work, *Sectiones Conicae* of 1685, La Hire was also the least innovative. So it seems. However, with little attention in the historical literature -- possibly none since 1913 -- he wrote in 1674, as an addendum to his 1673 *Nouvelle Methode en Geometrie pour les sections des superficies coniques* . . . , a 22 page work called *Les Plani-coniques.* In modern terminology, he developed projection of a plane to itself as a *Central Collineation.* His achievement will be discussed, along with suggestions as to why it has remained so obscure.

Janet Heine Barnett, Colorado State University – Pueblo, janet.barnett@colostate-pueblo.edu

Mathematics is a Plural Noun: The Case of Oliver Byrne

Histories of mathematics often focus exclusively on major names and developments, as these appear from the perspective of academic mathematics within the historian's own time. Almost completely hidden from view are the practitioners of "lesser" mathematics who lived and worked alongside these better known names. Often, however, these lesser lights reveal aspects of the history of mathematics that are otherwise hidden from view.

This talk examines the life and work of one such figure: the elusive Oliver Byrne, Esquire, who variously described himself as "a Military, Mechanical and Civil Engineer, Professor of Mathematics, Consulting Actuary, Author of *The Elements of Euclid by Colours* and Many Other Works, Inventor of Dual Arithmetic, A New Art, and of Calculus of Forms, A New Science, Etc, Etc." We also consider the opinion of Byrne's actual accomplishments held by his nineteenth century contemporary Augustus De Morgan, and reflect upon what it may tell us about the state of professional mathematics at the time.

David Bellhouse, University of Western Ontario, bellhouse@stats.uwo.ca

The Mathematics Curriculum at the British Dissenting Academies in the 18th Century

During the eighteenth century, those who did not conform to the Church of England could not enter either Oxford or Cambridge Universities. As a result, religious dissenters that included Presbyterians, Congregationalists and Baptists, set up their own academies for the training of ministers as well as lay people. Anglican priests received an Oxbridge education.

I am a member of an international collaboration called the Dissenting Academies Project that is centred at the University of Sussex and Dr. Williams's Library in London. We are researching all aspects of these academies; my part in the project is the mathematics curriculum. The surviving manuscript evidence shows that mathematics was taught in these academies as an exercise in logical thinking that rounded out a liberal arts education necessary for the ministry and as a preparation for the study of the new science, Newtonian natural philosophy. For the dissenting minister, understanding the new science was one aspect of understanding God's work in creation.

The curriculum is discussed and compared to other mathematics curricula, particularly at Cambridge. Topics covered in the mathematics curriculum at the academies include arithmetic, elementary algebra, Euclidean geometry and conic sections. The newly developed differential and integral calculus, fluxions and quadrature as developed by the Newtonian school are not part of the curriculum until perhaps 1170 or later.

Rob Bradley, Adelphi University, bradley@adelphi.edu

Series Summation in Cauchy's Algebraic Analysis

From the 17th century onwards, mathematicians could expand a wide variety of functions into power series without explicit use of methods from the differential calculus, such as Taylor's Theorem. Such "precalculus" techniques were taught into the 20th century. We consider Cauchy's approach to making such derivations rigorous, as presented in his *Cours d'analyse*.

Sandro Caparrini*, IHPS, Toronto, caparrini@libero.it
Rossana Tazzioli, University of Lille, rossana.tazzioli@math.univ-lille1.fr

Relativity and electromagnetism in the correspondence between T. Levi-Civita and A. Righi

Between 1901 and 1929, the mathematician T. Levi-Civita (1873-1941) and the physicist A. Righi (1850-1920) carried on an extensive correspondence (about 60 surviving letters). For historians of early theoretical physics, these letters are especially valuable. They deal with the fundamental equations of electromagnetism and with the interpretation of Michelson-Morley experiment. Since Levi-Civita was one of the founders of the theory of relativity, this correspondence is of some importance to a reconstruction of the history of this theory.

Ximena Catepillán, Millersville University of Pennsylvania, ximena.catepillan@millersville.edu
Waclaw Szymanski, West Chester University of Pennsylvania, wszymanski@wcupa.edu

Maya Calendars

The ancient Maya, who were sophisticated astronomers, developed a positional number system with base twenty along with the concept of zero, which they used to build their roads, monumental architecture, and to carry out astronomical computations. They also developed a number of calendars to keep track of time. In this talk, the Tzolkin (sacred) calendar, the Haab (solar) calendar, the Round Calendar, which combines both the Tzolkin and Haab calendars, and the Long Count Dates used by the Maya to mark events over long periods of time, will be discussed. Some of the conversions among the calendars will be presented as well as classroom activities used in the Ethnomathematics course "Mathematics in Non-European Cultures" for non mathematics and science majors offered at Millersville University of Pennsylvania.

Ed Cohen, edcohen@sympatico.ca

The Roman Calendars

Romulus, the nebulous figure, supposedly founded Rome on the 21st of April 753 BCE. About the same century the second king of Rome, Numa Pompilius (715BCE - 673BCE), with the help of some astronomers, formed a calendar, which, with some modifications, lasted until 46BCE. At that time Julius Caesar, with the help of the Egyptian Sosigenes, made a more accurate calendar. This lasted essentially until Pope Gregory XIII (1582CE) wanted Easter to come out more precisely according to the moon. This calendar is the civil one that is used today by most of the world. The Numan calendar is mainly discussed as the others are treated elsewhere.

Michael Cuffaro, University of Western Ontario, mcuffaro@uwo.ca

Kant and Frege on the Ontological Argument for the Existence of God

Kant's refutation of the ontological argument for the existence of God - his argument that "being is not a real predicate"- is held by many philosophers to be definitive. According to others, however, the ontological argument is only successfully refuted as a result of Frege's argument (in his *Foundations of Arithmetic*) that existence, like number, is a *second-level* predicate – a predicate of concepts, not of things.

Recently, J. William Forgie has argued that Kant's and Frege's respective refutations are more similar than has hitherto been suspected. Forgie shows how, in a lesser known work written eighteen years prior to the first Critique, Kant anticipates Frege's claim that existence is a second-level predicate. Forgie criticizes Kant's and Frege's views, however, on the grounds that they allow the ascription of existence to a concept to be formulated in a such a way as to amount to ascribing to the concept the second-level predicate of belonging to something having the first-level predicate of existence, and that therefore existence is a first-level predicate (i.e., something possible to predicate of a *thing*).

In this paper, I argue that Forgie is correct to note the similarity between Kant's and Frege's views on existence, but that it is misleading to characterize what Forgie refers to as the 'first-level property of existence' as the property of a thing. I will argue that, for both Kant and Frege, this 'first-level property of existence' corresponds to a mode of presenting an object and that this expresses the relation between an object and the subject, not the property of an object, and I will show how both Kant's and Frege's views avoid Forgie's objection when considered in this light.

Michael Cuffaro, University of Western Ontario, mcuffaro@uwo.ca

Wittgenstein on Prior Probabilities

Wittgenstein did not write very much on the topic of probability. The little we have comes from a few short pages of the Tractatus, some `remarks' from the 1930's, and the informal conversations which went on during that decade with the Vienna Circle. Nevertheless, Wittgenstein's views were highly influential in the later development of the logical theory of probability. This paper will attempt to clarify and defend Wittgenstein's conception of probability against some oft-cited criticisms that stem from a misunderstanding of his views. Max Black criticises Wittgenstein for formulating a theory of probability that is capable of being used only against the backdrop of the ideal language of the Tractatus. I argue that on the contrary, by appealing to the `hypothetical laws of nature', Wittgenstein is able to make sense of probability statements involving propositions that have not been completely analysed. G.H. von Wright criticises Wittgenstein's characterisation of these very hypothetical laws. He argues that by introducing them Wittgenstein makes what is distinctive about his theory superfluous, for the hypothetical laws are directly inspired by statistical observations and hence these observations indirectly determine the mechanism by which the logical theory of probability operates. I argue that this is not the case at all, and that while statistical observations play a part in the formation of the hypothetical laws, these observations are only necessary, but not sufficient conditions for the introduction of these hypotheses.

Antonella Cupillari, Penn State Erie-The Behrend College, axc5@psu.edu

Elisha Scott Loomis and Proof Techniques

Elisha Scott Loomis' booklet *Original Investigation; or How to Attack an Exercise in Geometry* appeared in 1901. Loomis (1852-1940), who started his life as a farmer in Ohio and then became an engineer, was by that time a professor and the head of the mathematics department at Cleveland West High School. He is better known for the book *The Pythagorean Proposition*, a collection of more than 250 proofs of the famous theorem. The "monograph," as its author called *Original Investigation*, was reprinted several times, with the ninth printing appearing in June 1954. It includes a variety of geometry problems and theorems, with a full discussion of the steps required for their solution, as to be expected from the title. But the *Original Investigation* also includes interesting discussions on logic methods and suggestions for both teachers and students, generated by Loomis' long teaching experience. The talk will present a biography of Loomis and a look at the contents of the monograph, to see if there is anything we can learn and bring to our "transition courses." After all, Loomis wrote in the preface "Pupils and students unnumbered, all over this land of high schools and colleges, often fail to demonstrate successfully an original in geometry." And then he stated hopefully "Those who learn to proceed analytically, and, in addition, can analyze with facility the conditions of concrete questions, can stand the egg on end."

Larry D'Antonio, Ramapo College of New Jersey, ldant@ramapo.edu

Did Quadratic Forms Spring Full-Blown out of the Head of Gauss?

The theory of quadratic forms presented by Gauss in his Disquisitiones Arithmeticae is a truly stunning achievement. What are the origins of this theory? We will examine the two possible answers to the question posed by the title of this talk. The simplest answer to the question is, yes, Gauss alone is responsible for the theory of quadratic forms. What Gauss presents us is a complete, brilliantly constructed theory with no historical precedent. The next simplest answer is, no. For is it truly conceivable that anyone, even such a genius as Gauss, could develop a theory as complex and as mature as his theory of quadratic forms without having relied upon previous work? We will sift through the work of Euler, Lagrange and Legendre to see if we find any intimations of Gauss's theory.

Scott Dixon, University of California, Davis, tsdixon@ucdavis.edu

Concrete Modal Structuralism

Geoffrey Hellman is a mathematical structuralist. He is also a nominalist. Hellman's nominalism leads him to a unique account of structuralism, known as modal structuralism. The goal of this paper is not to evaluate nominalism, but to highlight what some may take to be an important problem facing Hellman's modal structuralist account, and to demonstrate that this problem can be overcome without having to abandon nominalism. On Hellman's account, an arbitrary statement of a mathematical theory is true just in case it is possible that there exists a system of which the axioms of that theory hold. In this way, mathematical truth is reduced to modal truth. Although Hellman provides a model-theoretic semantics of the modal operators, he does not provide an interpretation of those models. Rather, Hellman takes the modal operators as primitive. There has been, however, in the literature concerning the metaphysics of modality, a common tendency to prefer a reductive account of modality. Those who find unacceptable the approach of taking the modal operators as primitive will undoubtedly find modal structuralism, as formulated by Hellman, unacceptable as well. I argue that there is an alternative to taking the modal operators as primitive, which does not conflict with the nominalistic commitments of modal structuralism. Specifically, one can adopt a concrete modal realist account of modality as the foundation of modal structuralism.

Emerson P. Doyle, University of Western Ontario, edoyle8@uwo.ca

Ramsey's Little Argument

In the "Foundations of Mathematics" (1925), Frank Ramsey briefly sketches what amounts to a model-theoretic proof that the axiom of reducibility is not a logical truth. I trace the history of this proof---from Ramsey, through the work of Wittgenstein, Russell, Waismann, Black, and eventually Quinton---and suggest that it offers insight into Ramsey's reinterpretation of the *Principia Mathematica*. More generally I argue that the proof can be seen to occupy a peculiar place between a universalist and more modern model-theoretic understanding of logical languages. This is especially interesting in light of recent work by Awodey, Carus, and Goldfarb on Carnap's intellectual development during the late 1920s.

Thomas Drucker, University of Wisconsin--Whitewater, druckert@uww.edu.

What Makes Mathematics a Liberal Art?

Mathematics is often presented in the classroom by uninspired teachers as the business of choosing which formula to apply to a problem and which numbers to insert. Such an enterprise does not appear to have anything free or liberal about it. It is also an unfair representation of the features that make mathematics a distinctive enterprise worth the time of 'a free man', as Bertrand Russell argued. This talk will look at some of Russell's well-known writings about the philosophical essence of mathematics to see why he found it so in accord with freedom. A contrast will be drawn with the notion of free creation in L.E.J. Brouwer's writings that laid the foundation for intuitionism. Finally, the Platonic heritage to which both men were responding will be examined for what it offers by way of justifying the position of mathematics in an education for those who would be free.

Craig Fraser, University of Toronto, cfraser@chass.utoronto.ca

Thirty-five Years in the Historiography of Mathematics

In an article published thirty-five years ago in Historia Mathematica Michael Crowe wrote "Whereas the present state of the historiography of mathematics differs little (except in quality) from what it was nearly a century ago … the historiography of science has undergone far reaching changes…" Crowe referred to the "revolution in the historiography of science" that had been underway since at least the early 1960s and noted the absence of any corresponding renewal in the historiography of mathematics. Much has happened since these words were written, but it is fair to say that today there is still something of a divide between the historiography of science on the one hand and the historiography of mathematics on the other. The present paper examines some of these differences. Subjects that will be considered include the role of narrative in historical writing and issues associated with the explication of the technical content of past science and mathematics.

Roger Godard, Royal Military College of Canada, godard-r@rmc.ca

La Géométrie des Formes: The Path to Computational Geometry

Methods in Computational Geometry or Discrete Geometry can be classified in three categories: 1) juxtaposition of elementary volumes ("solid modeling") with its direct links to "Greek" geometry, 2) 2D or 3D interpolation between points or lines, 3) direct conception by successive approximations. Since its main mathematical tools are the "geometry of position", tessellations and topology, we tried to trace back the symbols of a point from Antiquity, and its successive definitions from Euclid to Alexandroff (1928). If the famous Euclid's definition of a point: "a point is that which has no part" has prompted many reflections about definitions, from Proclus to Felix Klein and Poincaré; then for Alexandroff, a point is just a simplex with zero dimension. For Français (1813), the Geometry of Position studied the length and the position of lines, their ratios between the different lines composing a figure. Then, in his 1834 essay on the philosophy of science, Ampère proposed the term: "Géométrie des Formes" (Geometry of Shapes).

Concerning interpolations, we shall comment upon the 1851 Dirichlet contribution, the 1908 Voronoï diagrams, and his concepts of "parallélogrammes primitifs" and Delaunay (1931) diagrams. In conclusion, the history of Computational Geometry is directly linked to the progress of vector calculus, the contribution of the combinatorial topology, the finite element method, and the techniques of decomposition of a problem into smaller tasks, as it was already started during Archimedes' times. Finally, the "Géometrie des Formes" has suggested or prompted many links between Mathematics and abstract painting that we would like to present.

Hardy Grant, York, University, Toronto, hardygrant@yahoo.com

Mathematics and the Liberal Arts: The Beginnings

I shall try to introduce this special session of the CSHPM by tracing the (considerable) presence of mathematics in the ancient and medieval liberal-arts tradition, and I shall consider what aspects of that legacy remain vital in our time.

Bill Hackborn, Augustana Campus, University of Alberta, hackborn@ualberta.ca

Newton's (Flawed?) Analysis of Motion Resisted in Proportion to Velocity

Although the contents of Books I and III of Newton's *Principia* are widely known to physicists and historians of science, fewer scholars are aware of the material in Book II, which deals largely with the motion of bodies through resisting mediums. This talk will look closely at Section I of Book II in which Newton describes via four propositions (with related lemmas and corollaries) the motion of a projectile through a medium whose resistance is proportional to the projectile's velocity. This section, while its contents are simpler mathematically than some other sections of Book II (notably Section II, which analyzes motion subject to resistance varying as the velocity squared), provides a nice example of how

Newton uses proportionality and his infinitesimal calculus to represent physical quantities as indefinite lines and areas. However it appears that Newton makes an error in the third corollary of Proposition 4 when he attempts to relate the initial velocity of the projectile to the scaling of the diagram describing its trajectory.

Alex Koo, IHPST, University of Toronto, alex.koo@gmail.com

The Middle Road to Nominalism: A Response to Colyvan

In his forthcoming paper 'There is No Easy Road to Nominalism', Mark Colyvan attacks three attempts to circumvent the Quine-Putnam Indispensability Argument (QPIA) for mathematical realism. The QPIA depends on the claim that mathematics is indispensable in our best scientific theories, and concludes that we should be mathematical realists. The most famous attack on the QPIA comes from Hartry Field [1980] where he attempts to show that we can do science without mathematical objects, and hence the claim of mathematical indispensability is false. Despite Field's tremendous effort, most commentators believe that his 'hard road' to nominalism was unsuccessful. The three more recent attempts to refute the QPIA accept the indispensability claim, and thus take what Colyvan dubs an 'easy road' to nominalism. Colyvan argues that in actuality these 'easy roads' depend on the success of a 'hard road' Field-like project which is unlikely to succeed. My paper takes issues with Colyvan's claim that one particular argument against the QPIA relies on the 'hard road'. I will show that Colvan's attack on Joseph Melia's [2000, 2002] argument against the QPIA is flawed and that Melia's road to nominalism is still viable and represents a serious problem for the QPIA. I argue that Colyvan has mistakenly lumped Melia's argument amongst those that reject the possibility of mathematical realism outright. Instead, Melia's position represents a 'middle road' that can be taken by nominalist and realists alike.

Elaine Landry, University of California, Davis, emlandry@ucdavis.edu

The Genetic Versus the Axiomatic Method: Responding to Feferman '77

It is clear that Feferman's 1977 paper has set the stage for much of the debate about whether category theory can act as a foundation for a structuralist account of mathematics. What is not so clear, however, is whether 1) the challenges set forth in his paper have been/need be met and 2) we are still acting on the same stage. Feferman [1977] argues that category theory cannot stand on its own as a structuralist foundation for mathematics: he claims that, because the notions of operation and collection are both epistemically and logically prior, we require a background theory of operations and collections. Recently [2009], I have argued that in rationally reconstructing Hilbert's organizational use of the axiomatic method, we can construct a pure algebraic version of mathematical structuralism. That is, in reply to Shapiro [2005], we do not have to appeal to some background theory to guarantee the truth of our axioms. In this paper, I again turn to Hilbert; I borrow his [1900] distinction between the genetic method and the axiomatic method to argue that even if the genetic method requires the notions of operation and collection, the axiomatic method does not. Even if the genetic method is in some sense epistemically or logically prior, the axiomatic method stands alone. Thus, if the claim that category theory can act as a structuralist foundation for mathematics arises from the organizational use of the axiomatic method, then it does not depend on the prior notions of operation or collection.

Greg Lavers, Concordia University, glavers@gmail.com

On the Quinean Analyticity of Arithmetical Truths

This paper investigates the relation of Carnap and Quine's views on analyticity on the one hand, and their views on philosophical analysis or explication on the other. I argue that the stance each takes on what constitutes a successful explication largely dictates the view they take on analyticity. I show that although acknowledged by neither party (in fact Quine frequently expressed his agreement with Carnap on this subject) their views on explication are substantially different. I argue that this difference not only explains their differences on the question of analyticity, but points to a Quinean way to answer a challenge that Quine posed to Carnap. I then argue that the result is a Quinean view of analyticity according to which arithmetical truths are analytic---in a sense that is different from what Carnap would mean by this, but is in keeping with other quite standard views.

William Lindgren*, Slippery Rock University, william.lindgren@sru.edu
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Flatland and Plato's parable of the cave

Edwin Abbott Abbott's *Flatland* is the story of a two-dimensional universe as told by one of its inhabitants, a square who is introduced to the mysteries of three-dimensional space by a sphere. Since the time of its publication in 1884, the book has been a standard introduction to higher-dimensional geometry. Nonetheless, Abbott was not a mathematician, and he did not mean to write a geometry text but an extended metaphor in the language of mathematics. Abbott was not the first person to posit a two-dimensional universe inhabited by geometric figures; however, he was the first to describe such a space endowed with a highly developed social and political structure. We have shown earlier that Abbott's primary model for this structure is not late-Victorian England, which is unquestionably the target of his satire, but rather classical Greece. In this talk we discuss the most significant "Greek connection" in *Flatland*—its many parallels with Plato's parable of the cave.

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Why do we not remember Laplace's work on singular solutions?

In 1772 and 1774 respectively, Laplace and Lagrange wrote memoirs on determining singular solutions of differential equations, but when people look back, often Laplace's paper is forgotten. While there are obvious similarities to the memoirs, they presented their work completely differently and used different methods. In comparing these two papers, I will investigate whether Lagrange is remembered just because his method was superior, or if the reason may also have something to do with the presentation that Lagrange gave; one that made the method clearer and more easily reproduced.

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The metaphysics of homotopy types

Homotopy types constitute fundamental geometric entities. In this talk, I want to discuss their ontological status. At first sight, it seems reasonable to assume that they are simply equivalence classes of topological spaces. However, this characterization quickly turns out to be inadequate. First, it certainly does not reflect their fundamental status. Second, Freyd has already showed in the sixties that the homotopy category of topological spaces is not concrete. I will explain and comment on this result. Third, homotopy types are closely related to groupoids, more specifically higher-dimensional groupoids. Thus, they are naturally modelled in the context of higher-dimensional categories (although this has still to be fully developed). All this suggests that 1) homotopy types are not, as individual entities, best represented by sets with a structure and 2) as a totality, it is not best represented as a set with a structure either. In both cases, we are lead to abandon a purely extensional point of view and adopt an intentional point of view of mathematical entities.

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Mathematics at Amherst College in the Nineteenth Century

Amherst is one of the oldest colleges in Massachusetts, and is consistently ranked as one of the top liberal arts colleges in the United States. This talk will examine the mathematical aspects of an Amherst education from the time of its founding in 1821 through the end of the nineteenth century, including the college entrance requirements, textbooks, and the relationship between mathematics and the other liberal arts disciplines in the curriculum.

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High School History and Philosophy of Mathematics: An Action Research Project

As announced in 2009 at Memorial, I've been exploring the possibilities of HPM implementation from my high school mathematics classroom in downtown Toronto.

Having called on my friends and colleagues in the HPM community, here are the results: successes, failures, untried possibilities, and ongoing opportunities. The nearby campus of the University of Toronto has provided major support, especially its Institute for the History and Philosophy of Science and Technology, but also its other departments and its extensive library system. The Professional Development network of my union, the Ontario Secondary School Teachers Federation, served as a route for sharing HPM with my colleagues.

Efforts ranged from my classroom practice, such as daily calendrics, through workshops for teachers, to influencing provincial curriculum. Topics included arithmetic in Swahili, statistics of Assyrian weaponry, determining the length of the Roman mile, comparison of the Abrahamic calendars, planetary calculations for Kepler's Laws and the history of Pi.

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Nicholas Pike's New And Complete System of Arithmetic (1788)

Abstract: Nicholas Pike's New and Complete System of Arithmetic (1788) was by far the most widely-used and also by far the most comprehensive American arithmetic book of its time, the early days of the United States of America and the Constitution. We consider the content and context of this excellent work, including a discussion of competing books.

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Leonhard Euler's Use and Understanding of Mathematical Transcendence

Paul Erdös and Underwood Dudley (1983) suggested that Leonhard Euler was the first to define transcendental numbers as numbers which are not roots of algebraic equations. In contrast to Feldman and Shidlovskii's (1967) claim that major achievements in the theory of transcendental numbers were linked to the emergence of new mathematical methods, Erdös and Dudley suggested that Joseph Liouville's (1844) proof of the existence of transcendental numbers was well within Euler's reach in the eighteenth century. The paper analyzes these claims in relation to Euler's original use and apparent understanding of mathematical transcendence.

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Identifying with the English: Sir William Rowan Hamilton's effort to identify with English symbolical algebraists in the 'Preface' to the *Lectures on Quaternions* (1853)

William Rowan Hamilton first met with George Peacock, Charles Babbage and William Herschel in Cambridge in the early 1830s. Following that meeting, Hamilton declared the English mathematicians were "building castles in the sky". Throughout the 1830s and 1840s, Hamilton, Professor of Astronomy in Trinity College and Royal Astronomer of Ireland, disdained the "symbolical algebraic" philosophy of mathematics then becoming popular at Cambridge. Advocated for by Peacock and a small cohort of mathematical "reformists", symbolical algebra was as much a political/social statement as it was a mathematical methodology. In his *Algebra as the Science of Pure Time* (1835), Hamilton reflected his belief in the *a priori* nature of mathematical axioms, in particular with regards to geometrical matters. By 1853, however, Hamilton had changed his view substantially—or, at least, his publicly stated view. In his *Lectures on Quaternions*, Hamilton offered a "Preface" replete with apologia for his past dismissal of the symbolical algebraic approach. In an effort to demonstrate his allegiance to some version of Peacock's "Principle of the Permanence of Equivalent Forms", he demonstrated how his development of quaternions was based, ultimately, upon abstract symbolical algebraic considerations (i.e. "equivalences", in Peacock's terms) that had little if anything to do with geometrical demonstrations. In this paper, I will analyze Hamilton's 1853 "Preface" and demonstrate that the account he offers there of his symbolical algebraic generation of quaternions constituted an explicit effort to ingratiate himself with the prominent cadre of English analysts who had come to dominate British mathematics by the mid-century—a situation radically different from the one Hamilton had perceived in the 1830s.

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Mathematical Models and the Mechanical Philosophy in Seventeenth-Century Physiology: Comparing the mathematical theories of muscle contraction of Giovanni Alphonso Borelli and Johannes Bernoulli.

Before his work on differential equations and the notable brachistochrone problem, Johannes Bernoulli studied medicine at Basil University, and in 1690 applied Leibniz' freshly invented differential calculus to biology for the first time. Armed with new mathematical techniques, Bernoulli was able to utilize Boyle's Law in offering an explanation for the shape of the invisibly minute globules responsible for muscle contraction. However, Bernoulli was building on the earlier work of the Italian mathematician and iatromechanical writer Giovanni Alphonso Borelli. Writing a few decades earlier, unlike Bernoulli, Borelli did not have the calculus at his disposal, nor was he utilizing algebraic techniques.In my talk I focus on how these distinct mathematical tools reflected the different ways in which the two writers depicted the microscopic apparatus responsible for muscle contraction. In a sense, the mathematics determined the underlying corpuscular mechanism. This latter claim is significant because neither Borelli nor Bernoulli had empirical evidence for the actual shape of the microscopic structures they were describing. My talk is in part a contribution to the history of applied mathematics in the seventeenth-century and about the then short-lived enthusiastically high epistemic status it achieved in various circles.

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The Many Sides of Zero in Babylonian Context

Of the ten digits of our numeral system, the *zero* has received by far the most attention, mainly because it appears intimately connected to the place-value system. In this paper we distinguish four different roles that zero can play in a place-value system, and we discuss these various uses of zero in the Babylonian (Old and Late) sexagesimal system to show that they are indeed independent of each other. Moreover, since the Old Babylonian system lacked a distinct symbol for zero, it is often described as being difficult to use and error-prone. By analyzing the computations involving zero that can be found in a large set of Babylonian tablets, paying particular attention to the mistakes that were made on the one hand, and to the cases in which no mistakes were made on the other hand, we argue that this view is misguided. In an attempt to explain the surprisingly low number of computational errors involving zero, we try to make some inferences regarding the means of calculation used on the basis of our analysis of computation.

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Theodore R.Widom*, McGill University

Methodological Reflections on Classifying the World's Numeral Systems

Past and present societies worldwide have employed well over 100 distinct notational systems for representing natural numbers, some of which continue to play an important role in human intellectual and cultural development even today. While an extensive anthropological and historical literature exists on numerical notations, cognitive scientists and philosophers have also turned their attention to them in recent years. This renewed interest in the development and use of numeral systems has prompted the need for classificatory schemes, or typologies, to put some order into the plethora of different systems and to provide a systematic starting point for their discussion and appraisal.

In the present paper we discuss some desiderata for typologies of this kind, and provide a general framework within which they can be assessed. Using this framework, we discuss two of the most influential typologies, namely those of Zhang and Norman (1995) and Chrisomalis (2004). Based on this discussion, we present a new typology that takes as its starting point the principles by which each numeral system represents multipliers (the principles of cumulation and cipherization), and bases (those of integration, parsing, and positionality). We argue at the hand of many different examples that this provides a more refined classification of numeral systems than the ones put forward previously, and allows for a more nuanced discussion of their similarities and differences.

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Logical Algebras as Formal Systems: H. B. Curry's Approach to Algebraic Logic

Nowadays, the usual approach to algebras in mathematics, including algebras of logic, is to postulate a set of objects with operations and relations on them which satisfy certain postulates. With this approach, one uses the general principles of logic in writing proofs, and one assumes the general properties of sets from set theory. This was not the approach taken by H. B. Curry. He took algebras to be formal systems of a certain kind, and he did not assume either set theory or the ``rules of logic''. I have not seen this approach followed by anybody else. The purpose of this paper is to explain Curry's approach.

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Irrationality of pi, Squaring the circle, and establishment of the concept of transcendence in Lambert's report (1761)

This talk is devoted to mathematical aspects of a theorem of J.-H. Lambert, who showed for the first time in history (1761), the irrationality of pi. As he writes in his explanatory statement, "the ratio of circumference to diameter is not as an integer to an integer". This demonstration was new and complex for its time (it uses generalized continued fractions and was meticulously analyzed by Lebesgue); however it was not quite the first proof of irrationality of a transcendental number. Lambert had in fact been preceded by Euler (1737) who, using ordinary continued fractions, had concluded, somewhat confusedly however, the irrationality of e and various quantities associated with the exponential. The idea of Lambert, however, was quite remarkable, showing that V and tan V (respectively e^V) cannot both be rational. But the report (a «Mémoire») is remarkable for another reason: in its last lines, Lambert gives indeed the first truly modern definition of the transcendence of an arbitrary number (despite of their various attempts, Leibniz and Euler had never preceded Lambert with respect to this point!). This was a fact epistemologically capital.

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Yesudas Ramchundra: DeMorgan's Ramanujan?

Augustus De Morgan (1806-1871) was a nineteenth century mathematician and prolific writer who authored more than 160 papers, 18 textbooks, and 850 Penny Cyclopedia articles. Yet, known for "his desire for justice and scorn of all pretense" and as a "champion of the underdog," some of his most important contributions to mathematics took place behind the scenes. We will examine De Morgan's efforts to bring Ramchundra (1821-1880), a twenty-nine year old self-taught Indian mathematician, to the notice of scientific men in Europe so that he might receive "acknowledgment of his deserts." We will also explore the extent to which De Morgan's efforts have been successful, as well as the interesting life and contributions of Ramchundra: a "meek, keen-eyed" man who blossomed "as a rose among the thorns" and who loved mathematics so passionately that he "did not even care for his food."

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Definitions and Nondefinability in Geometry: Legacies of Mario Pieri and Alfred Tarski

This talk traces development of the modern axiomatic method by Pasch, Peano, Pieri, and Tarski, and their efforts to minimize the number and complexity of primitive concepts sufficient for a foundation of geometry. By 1900, Peano and Pieri had reduced that number to two: point and direct motion. But the latter is an involved set-theoretic concept. Veblen tried point and betweenness of point triples in 1904, but his system seemed inadequate. Pieri succeeded in 1908 with point and equidistance of a point from two others. His axioms were frightfully complicated but laid bare the logic required for their manipulation, and used sets only sparingly. He avoided projective methods. Pieri's work attracted little attention except in Poland. In the late 1920s, applying modern logical techniques to geometry, Tarski followed Pieri's approach to develop a much simpler system that has since become a standard in foundations of geometry. It permitted formulation of a theory of definition, which Tarski used to show clearly that Veblen's 1904 attempt had to fail. Further, he showed that Pieri's single ternary primitive relation among points was in a sense optimal: no family of binary relations could suffice. Tarski's work has led to deeper recent studies, particularly by Pambuccian.

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Constraint and the Outskirts of Practice

A large portion of contemporary philosophy of mathematics seeks, in one way or another, to tether the notion of mathematical objectivity to the kinds of practices that are operative in mathematics, practices which are engaged in and justified for reasons which are themselves largely non-mathematical. Such is the case, though in very different ways, with intuitionism in the manner of Dummett, instrumentalism of Hartry Field's kind, and mathematical fictionalism (for instance, Balaguer 2009).

I argue, however, that all of these accounts are inadequate in the light of what I dub the 'argument from constraint', an example of which is the explanation of why it's impossible to square the circle. (It has to do with a very interesting property of π.). I examine this argument, and contrast it with the familiar indispensability argument, which holds that mathematics is indispensable to natural science and therefore

brings commitment to mathematical objects. This argument comes in for some criticism more or less on grounds of its irrelevance to its own purported conclusion.

In the end, I argue that the idea of objectivity as conformity with conceptual practices is too thin actually to do the duty demanded of it, and I sketch out some elements of a notion of objectivity as a relation to an autonomous subject-matter. Mathematical objectivity cannot be just an internal, but must also be an external, relation.

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Philatelic Latin squares

Postage stamps are occasionally issued in sheetlets (mini-sheets) of n different stamps printed in an n by n array containing n of each of the n stamps. Sometimes the n by n array forms what we call a philatelic Latin square (PLS): each of the n stamps appears exactly once in each row and exactly once in each column. In this talk we will report on our PLS findings: as of 12 March 2009 we have identified 35 PLS with $n = 3$; 165 with $n = 4$ and 17 with $n = 5$: There are also many PLS with $n = 2$ (with many embedded in panes printed in checkerboard fashion) but we have so far found no PLS with $n = 6, 7, \ldots$ As observed in our article in *Chance* [vol. 23 (1), 55–60, Winter 2010], the 165 PLS with $n = 4$ come from 75 countries (stamp-issuing authorities) with 96 PLS issued for the World Wide Fund for Nature (WWF) and 32 from Macau (Macao, China). Only 10 of the possible 24 standard-form 4 by 4 Latin squares are represented, the one-step backwards circulant being the most popular with 56. [This talk is based on joint research with Peter D. Loly (The University of Manitoba, Winnipeg).]

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E.B. Escott: Mathematican or Actuary

Edward Brind Escott was an avid number theorist who contributed solutions to Prouhet-Tarry-Escott Problem. Escott was educated at Harvard, contributed to the Mathematical Department of the *Educational Times*, and devised an ingenious sliding block puzzle. In 1914, he resigned his position at the University of Michigan to become an actuary for the Peninsular Life Insurance Company in Detroit, Michigan. He retired to Oak Park, Illinois where he carried on a lengthy mathematical correspondence with a distant relative, Arthur Porges, a teacher of mathematics, active Sherlockian, and author of numerous fantasy short stories. We focus on Escott's mathematical contributions and the Escott-Porges correspondence.

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Why a Mathematician might be (a bit) interested in Theodosios's Spherics

While it held its place in the quadrivium for as long as that long tradition lasted, the Spherics of Theodosios has fared less well since. Much of a talk on the three books must attempt to convey what they are about, but I shall try also to give some idea of the interest in the way it is done based on my new translation. It is truly a document designed by a committee, but there remains, I think, the mark on it of the first person said to have written on the topic, the enigmatic Eudoxos.

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The Occident Ignores Historical Contributions to Science from Other Geographies and Epistemes

In 1284 in a little village called Cambridge north west of London, a group of workmen began constructing structures to house Peterhouse. The writings of the ancient Greeks were largely lost, and it was only after Toledo and its world famous library was reconquered in 1085 CE that Europe was able to make strides. For example, Ptolemy's Almagest (from the Arabic Al Majisti) was translated into Latin from Arabic reputedly by a Gerard of Cremona in 1175 CE.

In 1068 CE **Saad Al-Andalusi**, wrote ***Kitab Tabaqut al-Umam*** *in Arabic.* The text was produced in Spain in the 11th century in which Saad made the observation that only eight nations were interested in and comprehended Science. These eight people were the **Hindus, the Persians, the Chaldeans, the Jews, the Greeks, the Romans, the Egyptians, and the Arabs.** **'*Les Indous, entre tout les nations, a traverse le siècle et depuis l'antiquité, furent la source de la sages', de la justice et de la modération. Ils furent un peuple, donne de vertus pondératrices, créature de pensées sublimes, d'apologues universel d'inventions rares et de traits d'esprit remarquables'*,** the Indics commanded a high reputation throughout the countries of the Mediterranean and in Asia for most of recorded history. The talk will focus on attempts by the Occident to emasculate the nature, extent and antiquity of the Indic heritage, especially on matters relating to Science and Mathematics.

Marina Vulis, The Life and Work of Andrei Markov, mlv88@earthlink.net

The life and work of Andrei Markov

Russian Mathematician Andrei Markov made great contributions to the development of several areas of mathematics, ranging from stochastic processes and probability theory to mathematical analysis to number theory. Andrei Markov lived in turbulent political times and often made political statements. He was also widely admired for his political activities and the struggle against tyranny in Russia. Markov Chains set the foundation for the of theory stochastic processes which played an important role in applications to quantitative finance.