| b s h m |

SIGMAA –
History of
Mathematics

POM SIGMAA

Joint meeting of:
British Society for the History of Mathematics
Canadian Society for the History and Philosophy of Mathematics
History of Mathematics Special Interest Group of the MAA (HOMSIGMAA)
Philosophy of Mathematics Special Interest Group of the MAA (POMSIGMAA)

Marriott Wardman Park, Washington, D.C.

Wednesday, August 5

8:20 **MAA Centennial Lecture #1** - Room: Salon 2/3
9:30 **Hedrick Lecture #1** - Room: Salon 2/3

Session TCPS#1A: History of Mathematics – Room: Washington 4
Moderator: Amy Ackerberg-Hastings

10:30 Amy Shell-Gellasch, Montgomery College, Maryland
Ellipsographs: Drawing Ellipses and the Devices in the Smithsonian Collection

11:00 Peggy Aldrich Kidwell, National Museum of American History, Smithsonian Institution
Engaging Minds – Charter Members of the MAA and the Material Culture of American Mathematics

11:30 Florence Fasanelli
The History of Mathematics in Washington, D.C.

Session TCPS#1B: History of Mathematics – Room: Washington 5
Moderator: Danny Otero

10:30 Cathleen O'Neil
Eisenhower, the Binomial Theorem, and the $64,000 Question

11:00 S. Roberts
John Horton Conway: Certainly a Piece of History

11:30 E. Donoghue
A Pair of Early MAA Presidents = A Pair of Mathematics Historians: Florian Cajori and David Eugene Smith

12:00 Lunch Break

Session TCPS#1C: History and Philosophy of Mathematics – Room: Washington 4
Moderator: Jim Tattersall

1:00 Charles Lindsey
Doing Arithmetic in Medieval Europe

1:30 Travis D. Williams, University of Rhode Island
Imagination and Reading the Third Dimension in Early Modern Geometry

2:00 Christopher Baltus, SUNY Oswego
The Arc Rampant in 1673: an Early Episode in the History of Projective Geometry

2:30 Andrew Leahy
William Brouncker's Rectification of the Semi-Cubical Parabola

Session TCPS#1D: History and Philosophy of Mathematics – Room: Washington 5
Moderator: Dan Sloughter

1:30 Ann Luppi von Mehren, Arcadia University
Inspiration for Elementary Mathematics Descriptions from a "Heritage" Reading (in the sense of Grattan-Guinness) of "On the Nonexistent" by Gorgias

2:00 Thomas Q. Sibley
Going to the Source

2:30 Cynthia J. Huffman
Scott V. Thuong
Rope Geometry of Ancient India in the Classroom

3:00 Steven J. Tedford
Getting to the Root of the Problem

3:30 Abraham Ayebo
Reenactment of the Calculus Controversy: Newton vs. Leibniz

Session TCPS#1E: The Mathematics of Euler – Room: Washington 4
Moderator: Robin Wilson

3:30 Dominic Klyve, Central Washington University
Olivia Hirschey
Euler and Phonetics: the Untold Story of the Mathematics of Language

4:00 Ronald Calinger, Catholic University of America
Leonhard Euler: the Final Decade, 1773 to October 1783

4:30 William W. Hackborn, University of Alberta
Euler's Method for Computing the Movement of a Mortar Bomb

5:00 Rob Bradley, Adelphi University
Euler on L'Hôpital's Analyse

5:30 Andrew Martin
J. Martin
Euler's Other Constant

Thursday, August 6

Session TCPS#1F: Special Session in Memory of Jackie Stedall – Room: Washington 4
Moderator: Rob Bradley

8:30	June Barrow-Green, Open University *Sylvester's Amphigenious Surface*
9:00	Janet Beery, University of Redlands *Jackie Stedall and the Mathematics of Thomas Harriot*
9:30	Rosanna Cretney, Open University *The Construction of Map Projections in the Works of Lambert and Euler*
10:00	Christopher Hollings, Oxford University *Soviet Views of Early (English) Algebra*
10:30	Steve Russ, University of Warwick, UK Kateřina Triflajová, Centre for Theoretical Studies, Prague, Czech Republic *Bolzano's Measurable Numbers: Are They Real?*
11:00	Robin Wilson, Oxford University *The BSHM 1971-2015*
11:30	**MAA Prize Session** - Room: Salon 2/3
11:30	**CSHPM Council Meeting and Lunch**
12:00	**Lunch Break**

Session TCPS#1G: History and Philosophy of Mathematics – Room: Washington 4
Moderator: Jean-Pierre Marquis

1:00	Richard DeCesare, Southern Connecticut State University *Robert Patterson: American Revolutionary Mathematician*
1:30	Maria Zack, Point Loma Nazarene University *Lisbon: Mathematics, Engineering and Planning in the Eighteenth Century*
2:00	Alejandro R. Garciadiego, UNAM, Mexico *Vera on the Foundations of Mathematics*

Session TCPS#1H: History and Philosophy of Mathematics – Room: Washington 5
Moderator: Sloan Despeaux

1:00 Michiyo Nakane
Yoshikatsu Sugiura: A Good Japanese Friend of Paul Dirac

1:30 J. Nicolas
Jonathan Sondow
Ramanujan, Robin, Highly Composite Numbers, and the Riemann Hypothesis

2:00 Matthew Haines
A Visit to the Vatican Library

Session TCPS#1J: Special Session on Philosophy of Mathematics – Room: Washington 4
Moderators: Bonnie Gold and Dan Sloughter

2:30 Elaine Landry, University of California, Davis
Mathematical Structuralism and Mathematical Applicability

3:00 Jean-Pierre Marquis, University de Montreal
Designing Mathematics: The Role of Axioms

3:30 Alex Manafu, University of Paris-1 Pantheon-Sorbonne
Does the Indispensability Argument Leave Open the Question of the Causal Nature of the Mathematical Entities?

4:00 Carl Behrens
How Does the Mind Construct/Discover Mathematical Propositions?

4:30 Jeff Buechner, Rutgers University-Newark and The Saul Kripke Center CUNY, The Graduate Center
What is an Adequate Epistemology for Mathematics?

POMSIGMAA LECTURE – Room: Washington 4
Moderator: Thomas Drucker

5:00 John Burgess

Friday, August 7

Session TCPS#1K: Special Session on Mathematical Communities – Room: Washington 4
Moderator: Fred Rickey

8:00	Diana White Brandy Wiegers *A Partial History of Math Circles*
8:30	Janet Heine Barnett, Colorado State University-Pueblo *An American Postulate Theorist: Edward V. Huntington*
9:00	Lawrence D'Antonio, Ramapo College of New Jersey *Title: Combating the "legion of half-wits": the Contentious Mathematicians of the Paris Academy of Sciences*
9:30	Jane Wess, Edinburgh University/Royal Geographical Society-Institute of British Geographers *The Mathematics in 'Mathematical Instruments': The Case of the Royal Geographical Society, London, in the Mid to Late Nineteenth Century*
10:00	Amy Ackerberg-Hastings, University of Maryland University College *Did American Professors Form a Mathematical Community in the Early 19th Century?*

KENNETH O. MAY LECTURE AND CENTENNIAL LECTURE #5 - Room: Salon 2/3
Introduction: Victor Katz
Moderator: Adrian Rice

10:30	Karen Parshall *We Are Evidently on the Verge of Important Steps Forward": The American Mathematical Community, 1915-1950*
11:30	**Lunch Break**
12:30	**Annual General Meeting** – Room: Washington 4

Session TCPS#1M: Special Session in Honor of Karen Parshall – Room: Washington 4
Moderators: Sloan Despeaux and Adrian Rice

2:00	Della Dumbaugh, University of Richmond *Leonard Dickson's Other Doctoral Student from 1928*
2:30	Patti Hunter, Westmont College *Spreading the Wealth: The Ford Foundation and Eugene Northrop's Advancement of Mathematics and Science at Home and Abroad*
3:00	Deborah Kent *The Annals of Mathematics: From the Fringes of Civilization to the University of Virginia, 1873-1883*
3:30	David Zitarelli, Temple University *Karen Parshall and a Course on the History of Mathematics in America*
4:00	Joseph W. Dauben, The City University of New York *Fuzzy Logic and Contemporary American Mathematics: A Cautionary Tale*
4:30	Brittany Shields, University of Pennsylvania *American Mathematics Beyond the Iron Curtain: The US-Soviet Interacademy Exchange Program*

HOMSIGMAA RECEPTION – Room: Washington 4
Presiding: Danny Otero

5:00	Reception in Honor of Karen Parshall

Saturday, August 8

Session TCPS#1N: History and Philosophy of Mathematics – Room: Washington 4
Moderator: Larry D'Antonio

8:30	Michael Molinsky, University of Maine at Farmington *Some Original Sources for Modern Tales of Thales*
9:00	Patricia Baggett, New Mexico State University Andrzej Ehrenfeucht, University of Colorado *A Prehistory of Arithmetic*
9:30	Gregg De Young, The American University in Cairo *Adelard's Euclid and the Arabic Transmission Attributed to al-Hajjāj*
10:00	Valerie Allen *Al-Khwarizmi, Anselm, and the Algebra of Atonement*
10:30	Duncan J. Melville, St. Lawrence University *Approaches to Computation in Third Millennium Mesopotamia*
11:00	S. Gholizadeh Hamidi *Famous Mathematicians from Iran but Whom You May Not Know*
11:30	Steve DiDomenico L. Newman *The Quest for Digital Preservation: Will Part of Math History Be Gone Forever?*

Session TCPS#1P: History and Philosophy of Mathematics – Room: Washington 5
Moderator: Amy Shell-Gellasch

8:30	Roger Godard, Royal Military College of Canada *Finding the Roots of Non-Linear Equations: History and Robustness*
9:00	Isobel Falconer, University of St. Andrews *J. D. Forbes and the Development of Curve Plotting*
9:30	Gavin Hitchcock, University of Stellenbosch, South Africa *"Remarkable Similarities": A Dialogue Between De Morgan & Boole*

10:00 Francine F. Abeles, Kean University
Clifford, Sylvester, and Peirce on the Development of the Algebra of Relations 1875-1885

10:30 S. Martin
Polygonal Numbers from Fermat to Cauchy

11:00 Troy Goodsell, Bringham Young University, Idaho
Orson Pratt: A Self Taught Mathematician on the American Western Frontier

11:30 Ezra (Bud) Brown
Five Families Around a Well: A New Look at an Ancient Problem

12:00 Lunch Break

Session TCPS#1Q: Special Session in Memory of Ivor Grattan-Guinness – Room: Washington 4
Moderating: Karen Parshall and June Barrow-Green

1:00 Joseph W. Dauben, The City University of New York
Ivor Grattan-Guinness (1941-2014) and his Contributions to the History of Analysis, Set Theory, and Applied Mathematics

1:30 Roger Cooke
Grattan-Guinness's Work on Classical Mechanics

2:00 John Dawson, Penn State York
Ivor Grattan-Guinness's Legacy to History and Philosophy of Logic

2:30 Albert C. Lewis, Educational Advancement Foundation
"Another big book": Ivor Grattan-Guinness as Editor and Organizer

3:00 Adrian Rice, Randolph-Macon College
"Same time next week?": Ivor Grattan-Guinness as a Ph.D. Advisor

Session TCPS#1R: History of Mathematics – Room: Washington 4
Moderating: Duncan Melville

3:30 Joel Haack
T. Hall
Humanistic Reflections on Mathematics Magazine Problem 1951 and a Solution

4:00 Alexander Kleiner, Drake University
The Interplay of "Hard" and "Soft" Analysis in the History of Summability Theory: Preliminary Report

4:30 Howard Emmens
The Life and Letters of William Burnside

5:00 James Parson
Prehistory of the Outer Automorphism of S_6

Abeles, Francine, *Kean University*

Clifford and Sylvester on the Development of Peirce's Matrix Formulation of the Algebra of Relations 1870– 1882

This paper focuses on Charles Sanders Peirce's relational algebra during the period when he and James Joseph Sylvester were publishing articles and giving courses at The Johns Hopkins University. More specifically, the representation of the algebra of relations in matrix form emerged during this period and we shall take a close look at this development.

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

Did American Professors Form a Mathematical Community in the Early 19th Century?

This talk will reflect on the nature of mathematical communities as a historiographical construct and then apply a working definition to a case study from the United States, ca 1790-1840. College professors of mathematics and natural philosophy taught arithmetic, algebra, geometry, and sometimes calculus; trained tutors and other mentees; compiled series of textbooks; read European publications; and wrote about natural phenomena. Surviving correspondence indicates men such as Jeremiah Day, John Farrar, and Charles Davies were personally acquainted. However, Americans during this time period did not contribute original research or demonstrate any inclinations toward collaboration. The paper thus considers the necessary and sufficient conditions for labeling contemporaries as a community.

Allen, Valerie, *John Jay College, CUNY*

Al-Khwarizmi, Anselm, and the Algebra of Atonement

In this paper I compare Persian mathematician al-Khwarizmi's Algebra (c. 830) with what first seems an unlikely companion, St. Anselm's Cur Deus Homo, (c. 1098), which argues for a theory of atonement by satisfaction through Christ's sacrifice. I claim that the two texts exhibit sufficiently similar logic to suggest that Anselm had some general familiarity with algebraic thinking as it had disseminated itself throughout Western Islamic culture. Al-Khwarizmi's text would be translated into Latin, after all, in less than 50 years (Devlin, 48, 57). I will focus on al-Khwarizmi's two main concepts: restoration (al-jabr) and balance (al-muqabala). Al-jabr refers to moving a negative quantity to the other side of the equation so that it becomes positive. The concept of negative number, however, is represented as a positive number in debt (Oakes and Alkhateeb, 53). Anselm also uses debt to reconceive atonement. Al-muqabala, variously translated as balance or confrontation, refers to the movement of like terms onto one side of the equation so that it can properly balance with or "confront" (some Latin translations use opponere) the unlike terms on the other side of the equation. It balances different but commensurable things with each other. Al-muqabala raises the question of what kind of equality informs both al-Khwarizmi's algebraic and Anselm's salvation equations. I argue for a complex concept of balance informing both texts that derives ultimately from Aristotle's notion of the equitable (to epiekes).

Ayebo, Abraham, *North Dakota State University*

Reenactment of the Calculus Controversy: Newton vs Leibniz

Mathematics has a very rich history. To appreciate the mathematics we teach and learn today, both students and teachers should have some experiences related to the historical and cultural aspects of the evolution of mathematics. The National Council of Teachers of Mathematics (NCTM) states that mathematics is "one of the greatest cultural and intellectual achievements of humankind, and citizens should develop an appreciation and understanding of that achievement, including its aesthetic and even recreational aspects" (NCTM, 2000, p. 4). In this talk, I will describe how a history of mathematics course designed for pre-service teachers was taught by having students travel back in time and assume the roles of mathematicians of antiquity. In particular, I will describe how our class reenacted the Newton-Leibniz dispute about who should get credit for the creation of infinitesimal calculus.

Baggett, Patricia, *New Mexico State University*
Andrzej Ehrenfeucht, *University of Colorado*

A Prehistory of Arithmetic

Current beliefs about the development of arithmetic in preliterate societies are that it started with counting, followed by the development of number words and algorithms for arithmetic operations. John Leslie's hypothesis in *The Philosophy of Arithmetic* (1817), that arithmetic originated with needs for dividing resources (partitioning), and not counting, suggests a different trajectory. With simple computing boards, arithmetic could have developed very far before numbers got their names, and before arithmetic procedures (algorithms) were codified. This means that the development of number words and algorithms may have been a final stage of development of arithmetic, dictated by needs for communication within large social groups. All known counting boards (abaci) are efficient computing devices with very narrow ranges of application. John Napier in *Rabdology* (1617) gave an example of a computing board that allows one to carry out all "basic" arithmetic operations, and it does not require that the user know any specific system of number names or follow any specific procedures. So Napier's board is an example of a computing device that makes Leslie's hypothesis more plausible. We will present the principle of the design of such computing boards, and compare them to known examples of ancient computing devices. We will also address a modern question: "Is it possible to acquire arithmetic skills without learning arithmetic algorithms?" References Leslie, Sir John (1817). *The Philosophy of Arithmetic*. Edinburgh & London: A. Constable & Company. Also http://books.google.com/books/about/The˙philosophy˙of˙arithmetic.html?id=qnq4AAAAIAAJ
Napier, John (1617/1990). *Rabdology*. Cambridge, MA: MIT Press

Baltus, Christopher, *SUNY Oswego*

The Arc Rampant in 1673: An Early Episode in the History of Projective Geometry

An arc rampant is a piece of a conic section tangent to three given lines, with given endpoints on two of those tangents. François Blondel (1618–1686) made tracing an arc rampant the second problem in *Résolution des quatres principaux problèmes d'architecture*, 1673. Independently, the young Philippe de la Hire (1640–1718) took up the problem in a short work of 1672, and incorporated it into his first work of projective geometry, *Nouvelle Méthode en Géométrie*, 1673. For both, the problem was suggested by Abraham Bosse, engraver and collaborator of Girard Desargues. Both found that the construction involved harmonic conjugates, and both used, for the first time, the term "harmonic."

Barnett, Janet, *Colorado State University - Pueblo*

An American Postulate Theorist: Edward V. Huntington

Like many American mathematicians of his generation, Edward V. Huntington (1874–1952) began his mathematical studies in the United States, but completed his doctoral work in Germany. With others of his generation, he went on to help create a mathematics research community within the US. Huntington is often remembered today for his efforts to build the infrastructure necessary to support such a community, including the founding of new American professional organizations like the Mathematical Association of America. Of equal importance to the new community were his contributions to the body of mathematical research produced in the US, and especially his work in an entirely new field known today as "American Postulate Theory." In this talk, we discuss Huntington's 1904 paper "Sets of Independent Postulates for the Algebra of Logic" as an exemplar of the research agenda of the American Postulate Theorists. We further consider the role that this research played within the larger development of mathematical logic, and its importance in gaining international recognition for the developing mathematical research community in the US.

Barrow-Green, June, *The Open University*

Sylvester's Amphigenous Surface

On 8 December 1870, the Danish born mathematician Olaus Henrici exhibited "a large model of Sylvester's amphigenous surface" at a meeting of the London Mathematical Society. This ninth order surface, which HJS Smith described as "of great importance in the theory of equations of the fifth order", was later displayed at the great exhibitions of scientific instruments and mathematical models in South Kensington in 1876 and in Munich in 1893. In my talk I shall discuss the history of this curious surface, setting it in the context of Henrici's career and his interest in mathematical models.

Beery, Janet, *University of Redlands*

Jackie Stedall and the Mathematics of Thomas Harriot

This presentation will survey Jackie Stedall's excellent, thorough, and wide-ranging scholarship on the mathematics of Thomas Harriot (c. 1560-1621), including his algebra, geometry, combinatorics, and interpolation formulas. It will highlight Stedall's distinctive approach to historical research, and her commitment to making source materials more readily available to scholars and students. The influence of other scholars on Stedall, as well as her own influence on the speaker, will be briefly considered.

Behrens, Carl, *Alexandria VA*

How Does the Mind Construct/Discover Mathematical Propositions?

Recent discoveries in cognitive science probe deeply into the mental processes of mathematicians as they practice their art. George Lackoff and Rafael Nunez have focused most extensively on the roots of mathematical subjects, proposing that much advanced mathematics derives from schemas and conceptual metaphors used and developed for more common purposes. But other cognitive scientists, among them Antonio Damasio, Stanley Greenspan, and Stuart Shanker have directed their attention to the role of emotions in the practice of rational thought. Greenspan and Shanker argue that the ability to create symbols and to reason is not hard-wired in the human brain, but is actually learned through emotional signaling beginning in the first year of life. This presentation will attempt to tie together these various threads from cognitive science into a view of how mathematics develops and is practiced.

Bistafa, Sylvio, *University of São Paulo*

Euler's Dissertation on Logic

In October 1720, the 13 years old Leonhard Euler entered the Philosophical Faculty at University of Basel. In the summer of 1722, he obtained the prima laurea with a lecture De Temperantia [On moderation]. In January of the same year, the 14 years old Euler appeared as respondent, with a discourse in Latin on Logic, consisting of 21 Propositions and 12 Corollaria. In the Propositions section, Euler considers that Logic is an art, mainly occupied with the discovery of the truth,which teaches us how to properly employ our reason. Reason, says Euler, is that human capacity to perceive 'things' within and beyond oneself, in order to establish the relations among them by making comparisons, and by judging to what extent the relations are in agreement. He then considers that 'our' Logic differs from the Dialectics of the ancients, and since it can more effectively provide what needs to be demonstrated, Logic has its maximum employment in all Sciences. Euler opens the Corollaries section speculating on the remembrance of the soul separated from the brain after death. He then moves on to consider that the study of Physics is useful to the Philosopher as well as to the Theologian, and that the Physics method can even expose to us evidences of the Divine Force, Virtue, and Wisdom, and that with reason, we can gradually see very clear evidences of the existence of God. After attributing the main role of Ethics that of pursuing happiness, he then closes the section digressing on apparently disconnected themes such as the usefulness of oriental history to scholars, controversies about biblical passages and languages, and the usefulness of Philology to the Theologian.

Bradley, Robert, *Adelphi University*

Euler on L'Hôpital's *Analyse*

The Marquis de l'Hôpital was Johann Bernoulli's first student and Leonhard Euler was one of his last. During the first half of the seventeenth century, de l'Hôpital's *Analyse des infiniment petits* (1696) was the standard introduction to the differential calculus in the French-speaking world and beyond. In fact, only the first four chapters of the *Analyse*, which were based on the lessons given to the Marquis by Bernoulli in 1691–92, were introductory in nature - the later chapters dealt with matters of active research in the 1690s. At various times during his career, Euler worked on problems that arose from de l'Hôpital's textbook. In this talk, I will consider some of these results, relating to topics including cusps, evolutes, and foundational matters.

Brown, Ezra, *Virginia Tech*

Five Families Around a Well: A New Look at an Ancient Problem

The title problem comes from Chapter 8 of the ancient Chinese classic "Nine Chapters of the Mathematical Art." It involves solving five linear equations in six unknowns, and many scholars have described the techniques used in the "Nine Chapters" for solving this and similar problems, and have shown that the techniques anticipated nineteenth century methods by almost two millennia. This talk is a two-part story about a feature of the problem's answer that may have previously gone unnoticed. The first part is about what happens when you look at a historically interesting problem through non-historical eyes. The second part is about a student who got excited about the problem and proved a theorem that gives the answer for *n* families.

Buechner, Jeff, *Rutgers University-Newark*

What is an Adequate Epistemology for Mathematics?

If we accept a mathematical epistemology in which we can know mathematical propositions with less than mathematical certainty, new possibilities become available for what counts as mathematical knowledge. For instance, if there are formal systems susceptible to the Gödel incompleteness theorems in which the consistency of Peano arithmetic is proved with less than mathematical certainty and the epistemic modality in which it is proved satisfies a reasonable notion of justification, then the limitations of the Gödel theorems will have been dramatically circumvented. In a 1972 paper, Georg Kreisel parenthetically remarks on the cogency of such an epistemology, but without developing it, while subsequent literature simply ignores it. A stumbling block for a mathematical epistemology that licenses knowing mathematical propositions with less than mathematical certainty is the necessity of mathematical propositions. But 72 B work by Saul Kripke in his epochal *Naming and Necessity* severed the connection between the metaphysical notion of necessity and the epistemic notion of certainty, which opened the possibility of knowing a mathematical proposition in a different epistemic modality than mathematical certainty. In my talk I will examine various conceptions of mathematical proof that answer to different views of what is an adequate epistemology for mathematics, as well as different mathematical epistemologies. I'll argue that the resulting framework allows one to provide different characterizations (each relative to a different mathematical epistemology) of the difference between informal and formal mathematical proofs, and the difference between informal and formal rigor.

Calinger, Ronald, *Catholic University of America*

Leonhard Euler: The Final Decade 1773 to October 1783

This paper briefly examines highlights of Euler's research from 1773 to 1783 on number theory, especially prime numbers, vibrating chords in competition with d'Alembert, magic squares, the rings of Saturn, and mechanics, including moments of forces. It covers interactions with Lagrange and Euler's circle, especially with Nicholas Fuss. It continues with Euler's contributions to forming modern mathematical cartography, his second ship theory for Turgot, and response to Kulibin's proposal for a bridge across the Neva. On a personal level, it explores Euler's relations with Denis Diderot, his second marriage, his interactions with Frederick the Great, and his departure from the Imperial Academy in 1777. It closes with Euler's election to the American Academy of Arts and Sciences, his role in the inauguration of Princess Catherine Dashkova as director of the Imperial Academy, and his final days.

Cooke, Roger, *University of Vermont*

Grattan-Guiness's Work on Classical Mechanics

Over a long career spanning 45 years, Grattan-Guinness evinced an interest in nearly everything in the universe that had even the remotest connection with mathematics: philosophy (especially epistemology), logic, physics, religion, music, art, education, economics, psychology, and much more. Although it could be said that his strongest area was logic and its history, his fundamental contributions to our understanding of the history of classical mechanics are a recurring theme throughout his brilliant career, beginning with the first of his works that brought him to the attention of Mathematical Reviews, his 1969 paper "Joseph Fourier and the revolution in mathematical physics", which was followed soon by a short paper discussing whether Fourier anticipated linear programming in 1970, and then, two years later, by the magisterial monograph on Fourier's life and work that established him as one of the leading lights among historians of mathematics. From this root, he branched out into a general study of nineteenth-century French mathematicians, culminating in his definitive three-volume masterpiece *Convolutions in French Mathematics*, published in 1990. His interest in this area never left him, and the last of the 153 papers by him reviewed or indexed in Mathematical Reviews 117 were given full reviews published in 2014, was on Poinsot's theories of the couple in mechanics.

Cretney, Rosanna, *The Open University*

The Construction of Map Projections in the Works of Lambert and Euler

Prior to the eighteenth century, though many different map projections were proposed and used, no theory was known that aided the development of new projections or explored connections between existing ones. However, in 1772, a memoir published by Johann Heinrich Lambert marked the beginning of a general mathematical theory of cartography. This was quickly followed by further papers on the same subject by Leonhard Euler (three papers, 1777) and Joseph-Louis Lagrange (two papers, 1779). These advances were enabled by various new developments and trends in mathematics over the preceding century, such as the growing preference for analytic mathematics over classical geometrical methods, and the development of calculus, in particular, the theory of partial differential equations. The historical exposition at the beginning of Lagrange's 'Premier m´emoire sur la construction des cartes g´eographiques' allows one to know which other authors influenced his work. However, it is not as easy to determine the influence of other authors on Euler: though he probably read Lambert's memoir on map projections, he made no direct reference to it in his own papers. In this talk, I will compare and contrast Euler's work on map projections with that of Lambert, with a view to exploring the connections between the two.

D'Antonio, Lawrence, *Ramapo College*

Combatting the "Legion of Half-Wits": the Contentious Mathematicians of the Paris Academy of Sciences

The title of this talk is a quote from Samuel Formey, referring to the duty of the scientific academies of the Enlightenment to drive out superstition and ignorance by establishing secure knowledge, of which mathematics is the most perfect model. In this talk we will consider the role of mathematicians in the history of the Paris Academy of Sciences. We will examine several episodes of confrontations involving members of Academy. For example, the Rolle-Varignon debate on the metaphysics of calculus, in which conservative forces, led by Rolle, argued that the recently introduced calculus lacked rigor. Academicians such as l'Hôpital and Varignon defended the new analysis by emphasizing its elegance and effectiveness. A later episode is the long battle fought by Cartesians, led by Fontenelle, who fought against the introduction of Newtonianism, whose champions were Maupertuis, d'Alembert, and Clairaut.

Dauben, Joseph, *City University of New York*

Fuzzy Logic and Contemporary American Mathematics: A Cautionary Tale

Fuzzy Logic was inaugurated in 1964 by a professor at the University of California, Berkeley, Lotfi Zadeh, who was interested in the mathematics of complex systems and the role mathematics might play in behavioral, social, and environmental sciences, as well as medicine and technological applications, especially artificial intelligence, pattern recognition, etc. The article that first put fuzzy logic on the map, “Fuzzy Sets,” was sent to the journal *Information and Control* in November of 1964, and published the following year, in 1965. Earlier Zadeh had presented the gist of his ideas about fuzzy set theory during a seminar at Berkeley, to which the reaction was mostly negative. As one of its major critics, Rudolph E. Kálmán (who won the National Medal of Science in 2009) objected: “No doubt Professor Zadeh’s enthusiasm for fuzziness has been reinforced by the prevailing political climate in the U.S.—one of unprecedented permissiveness.” Other critics argued that there were no useful applications of fuzziness, that there was nothing that fuzzy logic or set theory offered that could not be done just as well by ordinary probability theory. Nevertheless, the first dramatic applications of fuzzy logic were made in Japan, and soon China followed suit. Why was fuzzy mathematics so slow to find an appreciative audience in the US? Why does it continue to attract vehement critics? The battle to establish fuzzy logic as a viable part of contemporary mathematics in America, and to decide whether it represents a revolutionary paradigm shift in doing so, as some have claimed, will be the focus of this presentation.

Dauben, Joseph, *City University of New York*

Ivor Grattan-Guinness (1941-2014) and his Contributions to the History of Analysis, Set Theory, and Applied Mathematics

Ivor Grattan-Guinness was always adamant that the foundation of the history of mathematics should be the mathematics itself, whereas its wider social context should also be kept in mind. How these factors played out in his early research in the 1960s and 70s will be the focus of this presentation. Beginning with his early archival work in Germany and Sweden, his first books reflect his primary interests in various ways: *The Development of the Foundations of Mathematical Analysis from Euler to Riemann* (MIT Press, 1970); *Joseph Fourier, 1768-1830. An account of his life and work, based on a critical edition of his monograph on the propagation of heat, presented to the Institut de France in 1807* (MIT Press, 1971); and *Dear Russell–Dear Jourdain: a Commentary on Russell’s Logic, Based on His Correspondence with Philip Jourdain* (Duckworth, 1977). Ivor’s research on Fourier was undertaken in collaboration with his mentor and colleague, Jerome Ravetz, whose own book, *Scientific Knowledge and its Social Problems* (Oxford, The Clarendon Press) also appeared in 1971. How that collaboration influenced Ivor’s thinking, as well as the influences in those early years of Thomas Whiteside, Sir Karl Popper, and Sir Edward Collingwood, among others, will help to describe the larger framework within which Ivor’s interests were developing in the 1970s. When it appeared in 1997, Ivor’s *The Rainbow of Mathematics: A History of the Mathematical Sciences* (Fontana, 1997) represented the other end of the spectrum of the history of mathematics to which he devoted his scholarly career, not only to the exemplary writing of that history, but to its professional development as well, on which this presentation will also touch.

Dawson, John, *Penn State York*

Ivor Grattan-Guinness's Legacy to History and Philosophy of Logic

Historians and philosophers of logic are greatly indebted to Ivor Grattan-Guinness, not only for his books, articles and reviews on those topics, but for documents he unearthed in archives, for his founding and editing of the journal History and Philosophy of Logic, and for his steadfast promotion of the study of history and philosophy of logic through courses he taught at Middlesex University and lectures he delivered at conferences worldwide. This talk will briefly survey those contributions.

De Young, Gregg, *The American University in Cairo*

Adelard's Euclid and the Arabic Transmission Attributed to al-Hajjāj

Adelard of Bath created the earliest Latin version of the Elements in the first half of the twelfth century, translating from one or more Arabic manuscripts. The Latin text was edited by Busard, who suggested that Adelard had relied primarily on an Arabic manuscript containing features of the al-Hajjāj transmission because his translation differs in several significant ways from the translation made by Gerard of Cremona (whose characteristics reflect mainly the extant IsHāq-Thābit Arabic transmission). In the three decades since Busard produced his edition, further studies of the Arabic transmission attributed to al-Hajjāj have appeared. Using evidence ranging from verbal quotations to diagram construction techniques ascribed to al-Hajjāj found in several primary and secondary Arabic transmission sources, we can now offer a more nuanced analysis of the Arabic source(s) upon which Adelard based his Latin translation. In doing so, we are able to situate Adelard's Latin translation more precisely within the convoluted landscape of the medieval Euclidean transmission.

DeCesare, Richard, *Southern Connecticut State University*

Robert Patterson: American 'Revolutionary' Mathematician

Robert Patterson was an Irish-born mathematician who came to the United States just before the American Revolution, served in the war, and taught at the University of Pennsylvania. Among his other accomplishments, Patterson was elected President of the American Philosophical Society, appointed Director of the U.S. Mint, and carried on a long correspondence with Thomas Jefferson, before, during, and after Jefferson was president. Patterson's mathematical accomplishments, in the context of the Colonial Period in American history, will be illustrated with excerpts from his published works and his correspondence with Jefferson.

DiDomenico, *Steve Northwestern University Library*
Linda Newman, *University of Cincinnati Libraries*

The Quest for Digital Preservation: Will Part of Math History Be Gone Forever?

Libraries, archives, and museums have traditionally preserved and provided access to many different kinds of physical materials, including books, papers, theses, faculty research notes, correspondence, and more. These items have been critical for researchers to have a full understanding of their fields of study as well as the history and context that surround the work. However, in recent years many of these equivalent materials only exist electronically on websites, laptops, private servers, and social media. These digital materials are currently very difficult to track, preserve, and make accessible. Future researchers may very well find a black hole of content: discovering early physical materials and late electronic records, but little information for the late 20th though early 21st Centuries. In other words, a portion of history, including the field of Mathematics, may be lost unless this electronic content–perhaps some content you have right now–is cared for properly. The presenters will cover the issues surrounding Digital Preservation, including steps needed to make sure data is reasonably safe. Additionally they will pose a small number of discrete challenges and unsolved problems in the field of Digital Preservation, where Mathematicians may be able to help with analysis and new algorithms.

Donoghue, Eileen, *City University of New York/CSI*

A Pair of Early MAA Presidents = A Pair of Mathematics Historians: Florian Cajori and David Eugene Smith

In this centennial year, it should be noted that two early presidents of MAA, Florian Cajori (1917) and David Eugene Smith (1920), were influential historians of mathematics whose notable works are available in print today. This paper will discuss links between Cajori and Smith, including an exploration of their pioneering initiatives to survey the state of academic mathematics in late 19th century America. Cajori's wide-ranging survey solicited faculty responses from 168 universities and colleges, 45 normal schools (for teacher training), and 181 secondary schools. University respondents included Simon Newcomb at Johns Hopkins, Thomas Fiske at Columbia, and G. B. Halsted at Texas. Smith surveyed normal school students regarding their experiences in mathematics, including their attitudes toward and perceived success in the subject. He also analyzed thousands of examination results to determine what differences, if any, might be found between male and female performance in mathematics. Smith's and Cajori's initiatives offer a glimpse into what are often obscure arenas: mathematics classrooms in the late 19th century.

Dumbaugh, Della, *University of Richmond*

Leonard Dickson's Other Doctoral Student from 1928

In 1928, Leonard Dickson's most celebrated student, A. Adrian Albert, earned his Ph.D. from the University of Chicago. Often recognized as Dickson's "best" student, Albert went on to become a professor at the University of Chicago and President of the American Mathematical Society. In that same year, Ko-Chuen Yang, Dickson's first— and only—Chinese student earned his Ph.D.

with a dissertation on "Various Generalizations of Waring's Problem." This talk explores the content and critical importance of this dissertation.

Emmens, Howard, *BSHM*

The Life and Letters of William Burnside

William Burnside (1852–1927) is remembered today primarily as a group theorist. The changes between the 1897 and 1911 editions of his book Theory of Groups of Finite Order show how far the subject developed during that period and the extent of Burnside's own contributions. He came to group theory in mid-career; it was not his first area of interest, nor his last: his published papers (almost two hundred of them) also include other contributions in algebra and in analysis and geometry. His early work was in applied mathematics, which he taught throughout his career, spent mainly as a professor at the Royal Naval College. Perhaps to compensate for his relative academic isolation there he was an active member and for two years president of the London Mathematical Society. In retirement he became interested in statistics, writing a textbook on probability (published posthumously - his only book apart from the two editions of his group theory text) and corresponding with the statistician R A Fisher. A series of twenty-three letters to Fisher forms a significant part of his known surviving correspondence: only about fifty other items are known, mostly isolated letters to H F Baker or to Joseph Larmor (mainly on mathematical problems but some to do with university appointments), but there are indications in these and elsewhere that he may have been a more prolific correspondent than this paucity suggests. If other letters to or from Burnside could be found they could help to illuminate the development of his mathematical thought.

Falconer, Isobel, *University of St Andrews*

J. D. Forbes and the Development of Curve Plotting

When, in 2012, experimental evidence for the Higgs boson was announced, it came in the form of a curve with a blip, immediately understood by the audience. Yet 190 years earlier, in 1823, the practice of curve plotting was so unusual that S. H. Christie felt it necessary to explain not only the meaning of the curve for magnetic variation that he presented in the Philosophical Transactions but also the process of defining the axes, representing the data as dots, and drawing the curve. The development of curve plotting as a technique for relating observational data to mathematized theory appears to have been surprisingly difficult. Early promoters, such as Lambert, were not followed, and not until the 1830s did the method start to spread, following the work of Playfair and Quetelet in statistics, and Herschel and Forbes in natural philosophy (Beniger & Robyn 1978; Hankins, 1999; Tilling 1975). Tilling identifies a step change in the ubiquity of curve plotting among scientists, initiated by J.D. Forbes, Professor of Natural Philosophy at Edinburgh 1833-1859. Beginning in 1834, he used curves both to present and to analyse observational results relating to heat, meteorology, and glacial flow. Based on an investigation of Forbes' notebooks, this paper discusses the role of curve plotting in Forbes' science, his practices in plotting, and the influences on his use of curves. The investigation gives new insights into why the development of curve plotting may have been so difficult, and why, finally, it took off in the 1830s. References Beniger, J., & D.Robyn. ‘Quantitative Graphics in Statistics’. Am. Statistician 32 (1978) 1-11 Hankins, T. ‘Blood, Dirt, and Nomograms’. Isis 90 (1999) 50-80 Tilling, L. ‘Early Experimental Graphs’. BJHS 8, (1975) 193-2

Fasanelli, Florence, *MAA*

History of Mathematics in Washington, DC

Known for its inside-the-beltway politics, Washington DC, has also been the place for mathematical achievements including the invention of tabulating machines by Herman Hollerith resulting in the organization of IBM; the demonstration of the Morse Code in 1844 by the artist whose painting of the House Chamber was used to restore the building in 1958; the astronomical work of the first Black man of science resulting in the somewhat square layout of the city; and the only observatory in the United States where fundamental positions of the sun, moon, planets, and stars are continuously determined in a building formerly staffed by the U. S. Navy Corps of Professors of Mathematics. The people, the institutions established in the Federal City and the mathematics will be explored.

Garciadiego, Alejandro, *UNAM*

Vera on the Foundations of Mathematics

Francisco Vera (1888–1967) lived, subsequently, in France, Dominican Republic, Colombia and Argentina in his attempt to elude Franco’s dictatorial regime. He is, perhaps, one of the most prolific authors of mathematical literature in Spanish language, at least of the XXth century. He wrote more than fifty books, some of them multivolume items, covering a wide spectrum of themes. His production includes elementary textbooks, biographies, dictionaries, general treatises on the history mathematics, as well as others discussing the evolution of some of its specific branches. He also wrote on science, music, religion and, even, fiction. A polyglot character, he translated into Spanish works by Apollonius, Archimedes, Eudemus, Euclid, Hippocrates, Pappus, Proclus, Pythagoras, among many others. He published an advance textbook on theory of sets at the time some of the Latin-American mathematical communities first G 101 emerged. On this occasion, our goal is to examine his thoughts on the foundation of mathematics, spread over several of his works that were extremely original and influential among his peers.

Gholizadeh Hamidi, Samaneh, *Brigham Young University*

Famous Mathematicians from Iran but Whom You May Not Know

Iranians have made several significant contributions to mathematics. However, both Iranians mathematicians and their contributions are not well known in the U.S. In this talk, we will present some of these contributions including the Persian Mathematician and Father of Modern Algebra, Muhammad ibn-Musa Al-Khwarizmi; the Persian Mathematician and Poet, Omar Khayyam; and the Persian Mathematician Nasir al-Din Tusi who formulated the famous law of sines.

Godard, Roger, *RMC*

Finding the Roots of a Non-Linear Equation: History and Reliability

Finding the roots of a non-linear equation is one of the most commonly occurring problems of applied mathematics. This work concerns the fixed point and the bisection methods. We present the linear convergence properties of the fixed point technique as explained by Sancery in 1862 and Schröder in 1870. Our research on the bisection was oriented by the following sentence written by Richard Hamming in 1973: "One of the best, most effective methods for finding the real zeros of a continuous function is the bisection method... The method is robust in the sense that small round-off errors will not prevent the method from giving an interval with a sign change, and if round-off is misleading you, it is not the fault of the method but of the program that evaluates the function." Because the bisection is linked to the intermediate value theorem, we shall comment Bolzano (1817), Cauchy (1821), and Sarrus (1841) approaches. We found that the history of the bisection was not covered by historians of mathematics. But in the 1940's Turing and Wilkinson became interested by the half-interval analysis. A major breakthrough came with Wilkinson's analysis of the bisection in 1963 and the genesis of "robust" algorithms in root findings by a Dutch team.

Goodsell, Troy, *Brigham Young University-Idaho*

Orson Pratt: A Self Taught Mathematician on the American Western Frontier

In this talk we will look at the life and mathematical works of Orson Pratt (1811-1881). Pratt had no formal education beyond elementary school and from a young age his life was very nomadic. He was one of the leaders of the pioneer movement that settled Utah in 1847 and was the first white settler to enter the Salt Lake Valley. In spite of this he became a leader in education in the early days of Utah and pursued his own studies in science, specifically mathematics and astronomy. In 1866 Pratt published a book entitled New and Easy Method of Solution of the Cubic and Biquadratic Equations. We will discuss the content of this book and look at what it accomplishes and how it fits in context with what was already known about this area of algebra.

Haack, Joel, *University of Northern Iowa*
Timothy Hall, *PGI Consulting*

Humanistic Reflections on Mathematics Magazine Problem 1951 and a Solution

The humanistic side of mathematics considers mathematics as a human endeavor. Discoveries can arise in surprising ways. Solutions and proofs can be approached in a variety of ways, depending in part on what tools are available to the solver. One reason to carry out a proof is to establish mathematical truth, but another is to provide insight into why something is true. Reflecting on any particular solution can suggest extensions. We will present a particular case exemplifying these statements, based on a *Mathematics Magazine* problem and one of its proposed solutions, namely, characterize those integers whose 100th power ends in 376.

Hackborn, William, *University of Alberta*

Euler's Method for Computing the Movement of a Mortar Bomb

This paper addresses Euler's efforts to "determine the movement of a bomb, or of a cannonball", published in *Memoirs of the Berlin Academy of Sciences*, 1755 (E217). Euler begins E217 by deriving a solution—first found and expressed using quadratures more than three decades earlier by Johann Bernoulli — for the trajectory of a projectile subject to uniform gravity and a drag force proportional to an arbitrary power of its speed; he then uses this solution to devise a numerical method with which the significant attributes (e.g. range, time of flight) of a mortar shot can be calculated by artillery officers on the battlefield. Typically a mortar bomb, intended to fly over enemy fortifications and explode in the air a short distance above its target, is shot at a relatively steep angle and low (subsonic) speed: in this case, the air resistance on the bomb is roughly proportional to the square of its speed, and the method incorporates this fact. According to a 1953 U.S. textbook on exterior ballistics, Euler's technique was used as recently as World War II.

Haines, Matthew, *Augsburg College*

A Visit to the Vatican Library

This presentation provides an overview of my positive experience of studying mathematical manuscripts and incunabula at Vatican Library.

Hitchcock, Gavin, *University of Stellenbosch*

"Remarkable Similarities": A Dialogue Between De Morgan & Boole

We enlist other participants in a theatrical presentation aiming to bring to life the friendship and mathematical communion between Augustus De Morgan and George Boole. Commentary by an older De Morgan (1864) intersperses a dialogue between Boole and De Morgan over the years 1843–1864 based very closely on their correspondence. The dialogue displays the crucial role of De Morgan as Boole's encourager and mentor, and highlights the fellowship of minds and affinities in thought development. Frank and poignant exchanges give insight into personal struggles, contemporary publishing issues, institutional problems, religious divisions, intellectual isolation, and the excitement of creating the new mathematical logic. The dialogue also exhibits lesser-known aspects of the human side of De Morgan — his generosity, integrity and humour.

Hollings, Christopher, *University of Oxford*

Soviet Views of Early (English) Algebra

The history of mathematics emerged as a significant discipline in the USSR during the 1930s, apparently building on an earlier Russian interest. In its early stages, it was marked by two major characteristics: a nationalist tenor, and a concern over ideology. The former led to a focus on the contributions of Russian mathematicians, whilst the latter, occasionally at odds with the former, sought to reinterpret the works of historical Russian mathematicians in terms of Soviet ideology. However, as the Soviet study of the history of mathematics opened up after Stalin's death, we find the names of other (non-Russian) historical mathematicians beginning to appear as the subjects of published works. In this talk, I examine the treatment of early algebraists (particularly those in England) at the hands of Soviet authors.

Huffman, Cynthia, *Pittsburg State University*
Scott V. Thuong, *Pittsburg State University*

Rope Geometry of Ancient India in the Classroom

Whether intentional or not, mathematics permeated many aspects of life for various ancient cultures, including religious aspects. For example, the Pythagoreans believed "All is number." A working knowledge of basic geometry was needed by ancient Egyptian engineers to build the pyramids and religious temples. In this presentation, we take a look at ancient Indian rope geometry which was used in the design of altars for different fire sacrifices. Geogebra applets are included for illustration and exploration. The talk will conclude with related activities that can be used in the classroom.

Hunter, Patti, *Westmont College*

Spreading the Wealth: The Ford Foundation and Eugene Northrop's Advancement of Mathematics and Science at Home and Abroad

In 1934, Eugene Northrop finished his Ph.D. in mathematics at Yale, and was competing for scarce jobs with his classmate, Saunders Mac Lane. He settled for a position at the private boarding school, Hotchkiss, where he stayed until 1943. That year, Northrop took up a post at the newly founded College of the University of Chicago. Partnering with the dean at the time, F. Champion Ward, Northrop developed and taught in the college's mathematics program. A year spent as an education consultant for the NSF and the Ford Foundation's Fund for the Advancement of Education in 1955, along with his connections to Ward, who joined had joined the foundation a few years earlier, positioned Northrop to move from the world of American liberal arts education to a role in which he helped shape the funding activities of what had become the richest philanthropic foundation in the world. This talk will consider Northrop's work at the University of Chicago, and his contributions to the development of university science in Turkey through his position at the Ford Foundation.

Kent, Deborah, *Drake University*

***The Annals of Mathematics*: From the Fringes of Civilization to the University of Virginia, 1873-1883**

Most nineteenth-century attempts to produce mathematical periodicals in the U.S. hinged on editorial efforts and financial backing from a few dedicated individuals. In 1873, Joel Hendricks founded *The Analyst* (later renamed *The Annals of Mathematics*) in the unlikely location of Des Moines, Iowa. Before its transfer to the University of Virginia – and, later, world renown as The Annals – this publication was the longest-running privately-funded mathematical journal in nineteenth-century the U.S. *The Analyst* illustrates the challenges of specialized publication intended for an audience of nineteenth-century mathematical practitioners in America.

Kidwell, Peggy, *Smithsonian Institution*

Charter Members of the MAA and the Material Culture of American Mathematics

In the early twentieth century, growing use of numbers, combined with burgeoning high school enrollments and expanding technical education, encouraged the expansion of college mathematics teaching in the United States. It was an era when like-minded educators banded together in professional associations. In 1915, mathematicians met to establish the Mathematical Association of America. Physical objects associated with several charter members of the MAA survive in the collections of the Smithsonian's National Museum of American History. They well represent the diverse concerns of the early membership. These ranged from research on prime numbers to creating geometric models in and for the classroom to encouraging recreational mathematics to exploring aspects of the history of mathematics.

Kleiner, Alexander, *Drake University*

The Interplay of "Hard" and "Soft" Analysis in the History of Summability Theory: Preliminary Report

If x is a sequence and T is a sequence to sequence transformation then T is said to sum x if $T(x)$ converges. T is called a summability method. For example, if A is an infinite matrix and $T(x) = Ax$, then T (or A) is a matrix method of summability. The study of such transformations is called Summability Theory. Starting in 1911, L. L. Silverman, Otto Toeplitz and others developed basic results that transformed (matrix methods of) summability froma collection of special methods used in other areas into a general area of study. Two decades later, Stefan Banach's use of the

Uniform Boundedness Principle to prove the Silverman-Toeplitz conditions represented a whole new approach. Thereafter both classical and functional analysis techniques were used to develop and prove new results. This paper will discuss the use of these two approaches in the development of several theorems that clarified the structure of the space of sequences summed by a particular matrix.

Klyve, Dominic, *Central Washington University*
Olivia Hirschey, *Central Washington University*

Euler and Phonetics: The Untold Story of the Mathematics of Language

It is well known that Euler made seminal contributions to a wide range of fields. Recent scholarship demonstrates that he contributed to as least one other which has not been described in the literature. In this paper we will describe two fascinating contributions to the field of articulatory phonetics. First, it was Euler who convinced the St. Petersburg Academy to make the nature of the vowels an annual prize question, leading directly to one of the most influential works in the history of phonetics, the Tentamen of Kratzenstein. Second, Euler himself wrote a short work, the *Meditatio de formatione vocum*, which, as an article on articulatory phonetics, strikingly presages 20th-century work in vowel classification. Euler's rather mathematical treatment of vowels as existing in two-dimensional "vocal space" was two centuries ahead of its time. This talk will survey Euler's work in this area.

Landry, Elaine, *University of California, Davis*

Mathematical Structuralism and Mathematical Applicability

I argue that taking mathematical axioms as Hilbertian is not only better for our account of mathematical structuralism, but it yields a better account of mathematical applicability. Building on Reck's [2003] account of Dedekind, I show the sense in which, as mathematical structuralists, we ought to dispense with metaphysical/semantic demands. Moreover, I argue that it is these problematic demands that underlie both the Frege/Hilbert debate and the current debates about category-theoretic structuralism. At the heart of both debates is the metaphysical/semantic presumption that structures must be constituted from/refer to some primary system of elements, either sets or collections, platonic places or nominalist concreta, so axioms, as truth about such systems, must be prior to the notion of structure. But what we ought have learned from Dedekind [1888] and Hilbert [1899], respectively, is that we are to "entirely neglect the special character of the elements", and so axioms are but implicit definitions, and, consequently "every theory is only a scaffolding or schema of concepts together with their necessary relations... and the basic elements can be thought of in any way one likes... [A]ny theory can always be applied to infinitely many systems." The first thing to note is that no primitive system is necessary, the second is that any system, be it mathematical or physical, can be said to have a structure. Thus, applicability is just the claim that a physical system has a mathematical structure, i.e., that it satisfies the axioms, in certain respects and degrees for certain physical purposes.

Leahy, Andrew, *Knox College*

William Brouncker's Rectification of the Semi-Cubical Parabola

One of Jackie Stedall's contributions to the history of mathematics was drawing attention to the work of William Brouncker. Though Brouncker is relatively unknown today, he was a mathematical collaborator of John Wallis and the founding President of Britain's Royal Society. Mathematically, he is perhaps best remembered for his work on continued fractions, but if you look carefully at his portrait in the National Portrait Gallery in London he appears to be pointing to a diagram showing his rectification of the semicubical parabola. Brouncker wasn't the first to solve the rectification problem, but his work, which followed immediately after William Neile's original result, is arguably much more algebraic and easier to understand than Neile's original proof. In this talk we will look at the details of Brouncker's solution to the rectification problem.

Lewis, Albert, *Educational Advancement Foundation*

"Another Big Book": I Grattan-Guinness as Editor and Organizer

Grattan-Guinness's first large work was the three-volume *Convolutions in French mathematics, 1800-1840* (1990) while another was *The Norton history of the mathematical sciences: the rainbow of mathematics* (1998). As solo productions these showed his ability to carry out major projects on his own. However, he also had the ability to marshal the talents of other historians in collaborating on even larger projects. This required not only a certain degree of authority, but also the capability of effectively selecting and working with experts across the full range of history of mathematics. His techniques for garnering this cooperation, and his way of operating with publishers, resulted in the *Companion encyclopedia of the history and philosophy of the mathematical sciences* (2003) and *Landmark writings in Western mathematics 1640–1940* (2005). These skills were undoubtedly sharpened earlier by his experience as the editor of the journal *Annals of Science* from 1974 to 1981.

Lindsey, Chuck, *Florida Gulf Coast University*

Doing Arithmetic in Medieval Europe

The period between roughly 500 CE and 1000 CE is still a fairly obscure time in the development of mathematics in Western Europe. We will survey what is known about European mathematics during this interval, especially in terms of the development and dissemination of techniques for arithmetical calculation. Finally, we will look at the contributions of Gerbert d'Aurillac in the context of other contemporary developments in the art of calculation on the abacus and the influence of Gerbert's methods in the 11th and 12th centuries.

Manafu, Alexandru, *IHPST Paris*

Does the Indispensability Argument Leave Open the Question of the Causal Nature of Mathematical Entities?

Colyvan has claimed that the indispensability argument leaves open the question of the causal nature of mathematical entities (2001, p. 143). He defended this position by arguing that not all explanations are causal, and that some mathematical entities may play important explanatory roles even though they are causally idle in the ontology (in the sense that they do not interact with the particulars posited by that ontology). I argue that Colyvan cannot maintain such an open attitude. I formulate an argument which shows that even if one grants the existence of mathematical entities which are explanatorily indispensable but causally idle in the ontology, Colyvan's conclusion still doesn't follow. If sound, the argument I offer shows that the question of whether the indispensability argument delivers causally active entities becomes settled. This result rehabilitates an argument offered previously by Cheyne and Pigden (1996). References Cheyne, C., and Pigden, C. (1996) Pythagorean Powers or a Challenge to Platonism, Australasian Journal of Philosophy, 74(4): 639-645. Colyvan, M., 2001, The Indispensability of Mathematics, New York: Oxford University Press

Marquis, Jean-Pierre, *Université de Montréal*

Designing Mathematics: the Role of Axioms

The use of axioms in mathematics was more or less reintroduced in the 19th century and became a central tool at the end of that century and at the beginning of the 20th century. Already during this period, axioms had different functions. For Hilbert, it is first a tool for conceptual clarification and then, a more general tool for conceptual analysis. The American postulationists used axioms as logical knives and cutters. Noether and others introduced the axiomatic method and a way of abstracting, unifying and simplifying large portions of mathematics. My claim in this talk is that some mathematicians started using the axiomatic method not only in a new context, namely the context of categories, but that they also put the axiomatic method to a new usage. I will concentrate on Grothendieck's introduction of a 138 M host of types of categories, e.g. abelian categories, derived categories, triangulated categories, pretoposes, toposes, etc., in his quest to prove Weil's conjectures. In Grothendieck's head, the abstract character of the concepts involved is taken for granted and the purpose of the axiomatic method is primarily to construct the proper context for some tools, namely cohomological theories, to be used properly. Although Grothendieck's work marks a radical shift in mathematical style and some might even want to talk about a paradigm shift, he was soon followed by others who showed how this could be done for other problems. I will argue that this usage of the axiomatic method must be seen as an instance of *conceptual design*. The latter expression underlines the artifactual dimension of these parts of mathematics, as emphasized by Grothendieck himself, and allows us to contrast mathematical knowledge from scientific knowledge.

Martin, Andy, *Kentucky State University*

Euler's OTHER Constant

The base of the natural logarithm is the most commonly used constant which might fairly claim Euler as its eponym. But what of the constant γ (gamma), also laughably referred to as Mascheroni's constant? This talk will describe Euler's earliest published discussion of gamma, and explain how Lorenzo M. got his name in the history books.

Martin, Susan, *Kentucky Employers' Mutual Insurance*

Polygonal Numbers from Fermat to Cauchy

In 1638, Fermat conjectured that every positive integer is a sum of at most three triangular numbers, four square numbers, five pentagonal numbers, and, in general, *n n*-gonal numbers. This talk will focus on the eventual proof by Cauchy in 1813, which promoted the conjecture to a theorem.

Melville, Duncan, *St. Lawrence University*

Approaches to Computation in Third Millennium Mesopotamia

Mesopotamian mathematics was profoundly computational. The goal was always to compute some quantity. How the processes to achieve those goals were conceived, and how scribes approached different kinds of computations in different domains has been a topic of recent scholarly debate. In this talk we will discuss what is known about computational techniques at various points in the development of abstraction of the concept of number during the third millennium.

Molinsky,Michael, *University of Maine at Farmington*

Some Original Sources for Modern Tales of Thales

There are many recent history of mathematics books written for general audiences that provide information and anecdotes about the ancient Greek mathematician, astronomer and philosopher Thales of Miletus, and in some cases these books even include quotations which are ascribed to Thales. But these general resources do not always include citations to the ancient sources from which these stories are being drawn. This talk will provide a brief outline of some stories about Thales that appear in modern publications, tracing each item back to much older, existing sources.

Nakane, Michiyo, *Nihon University Research Institute of Science and Technology*

Yoshikatsu Sugiura: A Good Japanese friend of Paul Dirac

After finishing his Dr. Thesis, Paul Dirac started as a researcher at Bohr's Institute in Copenhagen in September of 1926. At that time, several Japanese research workers were also staying at the institute. Dirac moved to Göttingen at the end of January 1927. About four months later, one of the Japanese physicists who had been staying at Bohr's institute, Yoshikatsu Sugiura (1895-1960),moved to Göttingen. He worked under Born's supervision and stayed at the Cario family house with Dirac and Oppenheimer. As a pioneering Japanese quantum physicist, Sugiura wrote several good papers on experimental and theoretical physics during his stay in Europe from 1924 to 1927. His most famous work, the completion of the Heiter and London calculation, was performed in Göttingen. Sugiura's recollection of the fruitful days in Göttingen showed that Dirac, Oppenheimer, and Sugiura established a close friendship that continued after World War II. Just after coming back to Japan, Sugiura gave a public lecture on the new quantum mechanics in 1928. In this lecture, Sugiura introduced Dirac's latest work involving the delta function, which led to confusion among Japanese physicists. Often referring to the works of Dirac and Oppenheimer, Sugiura continued his work and lectures on the new quantum mechanics in Japan during the period of time from 1928 to 1935. Although Yoshio Nishina, who 148 N had met Dirac in Copenhagen, arranged to invite him to Japan with Heisenberg, it is not doubted that Dirac's best Japanese friend was Sugiura.

O'Neil, Cathleen, *Johnson County Community College*

Eisenhower, the Binomial Theorem, and the $64,000 Question

At MathFest 2013, Robert Rogers shared a letter with SIGHOM from President Eisenhower to his son, John Eisenhower, thanking John for his letter that gave the President the clue he needed about how the "quiz lad" answered a mathematical question. With the help of Kevin Bailey, a reference archivist at the Eisenhower Presidential Library, we have been able to recover the letter that John wrote to his father, which contains a simple explanation of the Binomial Theorem. By following newspaper stories and TV Guide articles of the 1950's, as well as lucky guesses on the Internet, I have been able to positively identify the quiz lad. With his help I have been able to make a good guess about the nature of the question he was asked on the quiz show and how President Eisenhower happened to be watching.

Parshall, Karen, *University of Virginia*

MAA Centennial Lecture 5/CSHPM Kenneth O. May Lecture "We Are Evidently on the Verge of Important Steps Forward": The American Mathematical Community, 1915-1950

The American mathematical community experienced remarkable changes over the course of the thirty-five years from the founding of the Mathematical Association of America (MAA) in 1915 to the establishment of the National Science Foundation in 1950. The first fifteen years witnessed not only the evolution of the MAA with its emphasis on the promotion of mathematics teaching but also the "corporatization" and "capitalization" of the American Mathematical

Society as mathematicians worked to raise money in support of research-level mathematics. The next decade, one characterized by the stock market crash and Depression, almost paradoxically saw the building of mathematics departments nationwide and the absorption into those departments of European mathematical refugees. Finally, the 1940s witnessed the mobilization of America's mathematicians in the war effort and their subsequent efforts to insure that mathematics was supported as the Federal government began to open its coffers in the war's immediate aftermath. This talk will explore this period of optimism in which the American mathematical community sensed, as Roland Richardson put it, "we are evidently on the verge of important steps forward."

Parson, James, *Hood College*

Prehistory of the Outer Automorphism of S_6

The symmetric group S_6 is unique within the family of the groups S_n in admitting automorphisms that do not come from conjugation by elements of the group, so-called outer automorphisms. Otto Hölder is generally credited with the discovery of outer automorphisms of S_6 in a paper published in 1895. In this talk, we discuss the prehistory of Hölder's observations, both in the tradition of the Lagrangian theory of equations and in Sylvester's *tactic*.

Rice, Adrian, *Randolph-Macon College*

"Same Time Next Week?": Ivor Grattan-Guinness as a Ph.D. Advisor

In addition to his work as a researcher, editor, and university lecturer, Ivor Grattan-Guinness also served as a Ph.D. advisor during his career at Middlesex University. Between 1975 and 2007, he successfully supervised nine doctoral dissertations on the history of mathematics, on topics ranging from Niccolò Guicciardini's study of the 18th-century development of the Newtonian fluxional calculus to Abhilasha Aggarwal's survey of higher mathematics education in British India. This talk will include a brief overview of these dissertations, a discussion of their impact on Ivor's own research trajectory, and an account – based on personal experience – of just what it was like to work with the man himself.

Roberts, Siobhan, *Freelance Writer, Math & Science Journalist, Biographer*

John Horton Conway: Certainly a Piece of History

Wherein the author of the forthcoming biography "Genius At Play, The Curious Mind of John Horton Conway" (Bloomsbury, July 2015) recounts her subject's own penchant for history – specifically revisionist history, Conway being *the most* unreliable narrator of his own life – with the loops of expository tales he tells about his myriad contributions to the mathematical canon, surveying the Conway groups, the aptly named surreal numbers, the Game of Life, as well as tangents touching upon the likes of Thomas Cromwell, Georg Cantor, Stephen Hawking, John Bunyan, Salvador Dali, Germaine Greer, and Kurt G¨odel, among others...

Russ, Steve, *University of Warwick*
Katerina Trlifajova, *Centre for Theoretical Studies, Prague*

Bolzano's Measurable Numbers: Are They Real?

Bolzano's measurable numbers: are they real? Bolzano's work on measurable numbers has had a chequered history. It was roughly 130 years before it was published in 1962 by Rychlík as Theorie der reellen Zahlen. Since that time there have been more than a dozen papers or books which have included some assessment of his work but with little consensus. They range from sustained criticism (van Rootselaar) to enthusiastic endorsement (Laugwitz, Spalt) with the most recent judgements from Bolzano scholars Sebestik and Rusnock being decidedly cautious and qualified. We shall explain some of the background to this variety of opinion and also describe a new way of showing how Bolzano's introduction of measurable numbers, as numbers permitting arbitrarily close approximation, can be described in terms of sequences of nested closed intervals with lengths converging to zero. We show that equivalence classes of such 'nets' can be mapped directly onto Dedekind cuts, and also onto the equivalence classes of Cauchy sequences used in Cantor's theory. Some commentators have suggested that because measurable numbers included infinitesimals Bolzano should be hailed as a forerunner of non-standard analysis. We claim that while infinitesimals allowed him to have a mathematical description of a richer continuum than that of the later 19C, they could not have been adequate to provide a foundation for analysis in the manner of modern non-standard analysis.We conclude with some remarks on the relationship between Bolzano's work, the so-called 'alternative set theory' due to the Czech mathematician Vopěnka, and some of the ideas associated with phenomenology.

Shell-Gellasch, Amy, *Montgomery College*

Ellipsographs: Drawing Ellipses and the Devices in the Smithsonian Collections

We all learned how to draw and ellipse using two pins and a string, but there are other methods for drawing ellipses. Technical drawings created by engineers, architects, surveyors and machinists required drawing ellipse. In the 19th and early 20th centuries, various devices known as ellipsographs were used to draw these curves. The Smithsonian National Museum of American History owns several such objects. In this talk I will describe different ways to draw ellipses and showcase several of the Smithsonian ellipsographs.

Shields, Brittany, *University of Pennsylvania*

American Mathematicians Beyond the Iron Curtain: The US-Soviet Interacademy Exchange Program

Under the Lacy-Zarubin Exchange Agreement between the US and the Soviet Union established in 1958, the two countries agreed to participate in cultural, technical and educational exchanges. The US National Academy of Sciences and the Soviet Academy of Sciences served as the organizational clearinghouses for the exchange of research scientists. Under the interacademy exchange program, the mathematician Richard Courant (1888–1972) participated in a series of exchanges, including serving as chair for a delegation of two dozen American mathematicians visiting the "Science City" of Akademgorodok, about twenty miles outside of Novosibirsk, Siberia for a two-week symposium on Partial Differential Equations. This paper will consider the social and political context of Courant's visits to the Soviet Union and the ways in which mathematics was employed as an object of cultural exchange.

Sibley, Thomas, *St. John's University, College of St. Benedict*

Going to the Source

Reading Euclid, Descartes, and others (in translation) gives students different perspective from a standard history of mathematics course. Future secondary teachers and all mathematics majors benefit from wrestling with what earlier mathematicians said and didn't say. Textbooks and secondary sources often short circuit this discernment process. The long development of algebra and geometry from roots in Babylon, Egypt, and elsewhere shows the variety of influences and ideas over 4000 years. It can also correct the misperception of the march of history leading to the "correct" (our) way to do math. I have taught history of math as two-credit independent studies and as a four-credit seminar.

Sondow, Jonathan, *Independent Scholar*
Jean-Louis Nicolas, *University of Lyon, France*

Ramanujan, Robin, Highly Composite Numbers, and the Riemann Hypothesis

I provide an historical account of equivalent conditions for the Riemann Hypothesis arising from the work of Ramanujan and, later, Guy Robin on generalized highly composite numbers. The first part of my talk is on the mathematical background of the subject. The second part is on its history, which includes several surprises. In particular, I will S 173 explain how Robin avoided the fate of many mathematicians who have found that "Ramanujan reaches his hand from his grave to snatch your theorems from you." Our paper is available at http://arxiv.org/abs/1211.6944 on the arXiv.

Tedford, Steven, *Misericordia University*

Getting to the Root of the Problem

Throughout history, different cultures have found their own methods for finding the square root of a number. However, without a calculator, today's students are unable to approximate closely a square root. We will consider some methods used by a variety of cultures, including Indian, Babylonian, and Greek cultures to name a few. Additionally, we will introduce some "new" methods for approximating a square root, leading to the potential for a student research project.

von Mehren, Ann, *Arcadia University and University of Houston*

Inspiration for Elementary Mathematics Descriptions from a "Heritage" Reading (in the Sense of Grattan-Guinness) of *On the Nonexistent* by Gorgias

Lessons for elementary mathematics concepts may be developed by a heritage reading of an early Greek text, *On the Nonexistent*, by the fifth-century B.C.E. Greek Sophist philosopher and rhetor Gorgias. The history versus heritage source distinction made by Ivor Grattan-Guinness, when applied to this text by Gorgias, defines the approach. *On the Nonexistent* by Gorgias is not considered to be a historical math text by historians of mathematics. Grattan- Guinness, for example, makes no reference to it. However, my paper suggests that this work by Gorgias can be probed successfully by elementary mathematics educators. I now understand how to explain, thanks to Grattan-Guinness, that my suggestions about the possibility of the heritage use in a contemporary math classroom of the language used by Gorgias does not mean that I think similar math lessons were taught by Gorgias. Nonetheless, Grattan-Guinness notes that giving attention "to the broad features of history may well enrich the inheritance" of mathematics education (Grattan-Guinness, 2004(a), p.168). Teachers should, however, be warned by Grattan-Guinness's concerns about notions "photocopied onto the past" (Grattan-Guinness, 2004(a), p.165). If mathematics educators delve into Gorgias's intricate thought, for their own contemporary teaching purposes, then they must seek to find their own rewards, rather than search for math history, when grappling to understand the meaning of this great Sophist teacher.

Wess, Jane, *Edinburgh University/Royal Geographical Society-IBG*

The Mathematics in 'Mathematical Instruments': The Case of the Royal Geographical Society, London, in the Mid to Late Nineteenth Century

The RGS, London, was founded in 1830 with a remit to acquire instruments suitable for exploration. Twenty years later it had accumulated a range of artefacts for measuring length, direction, position, for making surveys in the field, and for drawing and calculating back in the Map Room in London. These were all 'mathematical' instruments as opposed to 'philosophical' instruments. These mathematical instruments were lent out to explorers repeatedly, in a manner which accords closely with actor network theory. The instruments embodied considerable resource, an aspect of which was the mathematical relationships assumed and utilised. While some of the mathematics was basic, such as trigonometric formulae, the explorers were also relying on the very considerable efforts of mathematicians such as Newton, Halley, Cotes, D'Alembert, Clairaut, Euler, and Maskelyne for longitude astronomically. They were relying on Francis Wollaston for work on the relationship between boiling point and height, using various map projections, assimilating the four colour theorem on which Cayley wrote in the Society's Journal, and the calculations with respect to the magnetic pole by Young, Sabine and others.Another resource expended in order to utilise the latent knowledge within the instruments was that of training the explorers. The RGS spent a considerable sum on this mathematical training. The paper will expose the mathematics inherent in the instruments and investigate the mathematical training given to potential explorers. It will argue that even in difficult circumstances the instruments had embedded value which the explorers recognised and exploited to the best of their ability.

White, Diana, *University of Colorado Denver*
BrandyWiegers, *University of Central Washington*

A Partial History of Math Circles

Originating in Eastern Europe, Math Circles migrated to the United States in the 1980s. Starting approximately at the same time on both the east and west coast, they have grown to several hundred today. While the inaugural Math Circles in the United States started with a focus on preparing mathematically talented high school age youth for advanced mathematical competitions, their focus has now broadened in scope. There are now Math Circles for all ages of children (preschool through high school) as well as for teachers. In addition, while some focus on preparing for local or national competitions, others focus on providing non-competitive mathematical enrichment experiences for all interested students. In this talk, we provide an overview of this history, focusing on inter-relationships between various Math Circles and how they have both contributed to the development of mathematical communities as well as benefited from it.

Williams, Travis, *University of Rhode Island*

Imagination and Reading the Third Dimension in Early Modern Geometry

Philosophical, rhetorical, and historical evidence increasingly shows that the imagination is an essential component in the technical and rhetorical development of mathematical concepts, and of a reader's ability to comprehend a 190 W mathematical text. Early modern mathematical writers struggled with the problems of three-dimensional textuality, since the two-dimensional page could, at best, provide only a partial representation of a solid object. Among the solutions they implemented was the inclusion of paper models of solid objects, to be constructed by readers. The traditional interpretation of these paper models is that readers constructed them as tools that would permit easier comprehension of the principles of solid geometry. In this interpretation, the model comes first, and the understanding (with and through imagination) comes second. Using evidence of well and poorly constructed paper models extant in sixteenth-century geometry books, this paper will argue, conversely, that readers had to understand the principles of solid geometry with great proficiency in order correctly to construct the models. The constructed model therefore serves as a mark of successful comprehension of solid geometry and not an instrumental means to achieve it. In this interpretation, spatial components of mathematical imagination possess fundamental importance in mathematical pedagogy and autodidacticism, since the reader must thoroughly imagine the solid object taking shape before it can be physically constructed.

Wilson, Robin, *Oxford University, UK*

The BSHM, 1971–2015

Over the past 45 years the British Society for the History of Mathematics has grown from a relatively small group of enthusiasts to a lively association holding up to ten meetings per year. In this illustrated talk I present its development fromits founding in 1971 to the present day, describing its range of activities and mentioning some of the distinguished people who have been involved with it, including the late Jackie Stedall and Ivor Grattan-Guinness.

Zack, Maria, *Point Loma Nazarene University*

Lisbon: Mathematics, Engineering and Planning in the Eighteenth Century

In 1755 the commercial district of Lisbon was destroyed by an earthquake followed by a fire and tsunami. This catastrophe along with an interesting constellation of political circumstances provided an opportunity for Lisbon to be completely rebuilt from first principles. This talk looks at the rebuilding of Lisbon in light of the mathematics of materials that emerged seventeenth and eighteenth centuries.We will consider specific attributes of Lisbon's reconstruction in light of the scientific advances of the day and the lack of sophisticated mathematics being taught in Portugal in the first half of the eighteenth century.

Zitarelli, David, *Temple University*

Karen Parshall and a Course on the History of Mathematics in America

This talk describes a course on the history of mathematics in the U.S. and Canada from 1492 to 1958. The central period for research took place 1876–1900, so ostensibly the "textbook" for the course is the Emergence of the American Mathematical Research Community, which Karen Parshall coauthored with David Rowe. Topics from the eras that preceded this quarter century and the major lines of development over the first half of the 20th century will be outlined. Along the way, suggestions for student projects based on original works in mathematics as discussed in papers by Parshall, her students, and several other American historians of mathematics will be presented.