CSHPM Annual Meeting 1998

Rooms: FRIDAY, MAY 29: **MCD 146**
SATURDAY AND SUNDAY, MAY 30-31: Gendron Building, **GNN 017**

FRIDAY, MAY 29
Morning Session: Ancient Mathematics

8:50 - 9:00 Welcome; Introduction
9:00 - 9:30 D. Melville, *Weighing Stones in Ancient Mesopotamia*
9:30 - 10:00 J. Seldin, *Euclidean Geometry Before Non-Euclidean Geometry*

10:00 - 10:15 BREAK

10:15 - 10:45 J. Tattersall, *Greek Arithmetic According to Nicomachus and Theon*
10:45 - 11:15 C. Fraser, *Theories of Quantity in Euclid's Elements*
11:15 - 11:45 G. Moore, *From Euclid to Veronese: The Evolution of "Magnitude"*

11:45 - 1:15 LUNCH; EXECUTIVE MEETING I

Afternoon Session: From Medieval Islam to the Early 19th Century

1:15 - 1:45 I. Garro, *The Paradoxes of Yahya ibn Adi and Bertrand Russell*
1:45 - 2:15 G. Van Brummelen, *Persian Miniatures from the Geometrical Work of Abū Sahl al-Kūhī*

2:15 - 2:30 BREAK

2:30 - 3:00 J. Lefebvre, *Mathematics in the 17th Century: Essays on Human Thinking by Descartes, Pascal, Arnauld and Nicole, and Spinoza*
3:00 - 3:30 C. Baltus, *Lagrange and the Fundamental Theorem of Algebra*

3:30 - 3:45 BREAK

3:45 - 4:15 P. Allaire, *The Roots of British Symbolical Algebra in the "Problem of the Negatives"*
4:15 - 4:45 A. Ackerberg-Hastings, *John Farrar: Forgotten Figure of Mathematics in the Early Republican United States*

SATURDAY, MAY 30
Morning Session I: Philosophy of Mathematics

8:45 - 9:15 E. Landry, *Category Theory as a Framework for Mathematical Structuralism*
9:15 - 9:45 P. Laverty, *Predicativism in Weyl's Das Kontinuum*
9:45 - 10:15 C. Panjvani, *On Wittgenstein and Identity: Why Identity is not a relation*

10:15 - 10:30 BREAK

Morning Session II: JOINT SESSION WITH THE CSHPS

10:30 - 11:00 D. Cutler, *Frege, Metatheory and the "Logocentric Predicament"*
11:00 - 11:30 R. DiSalle, *Reconsidering Conventionalism*
11:30 - 12:00 A. Reynolds, *Peirce and an Early Statistical Model of Darwinian Evolution*

12:00 - 2:00 LUNCH; ANNUAL GENERAL MEETING

Afternoon Session: JOINT SESSION WITH THE CSHPS

2:00 - 2:30 D. Lehoux, *Ancient Egyptian Astrometeorology*
2:30 - 3:00 A. Jones, *The frame of reference in Greek astronomical papyri*

3:00 - 3:15 BREAK

3:15 - 3:45 I. Garro, *Space, Time and Motion --- Bridging the Gap Between Aristotle, the Arabs, and Einstein*
3:45 - 4:15 P. Griffiths, *The Velocity of Celestial Bodies is Determined by Kepler's Distance Law Rather than by Newton's Principia*

4:30 - 6:30 RECTOR'S RECEPTION

SUNDAY, MAY 31
SPECIAL SESSION ON LATE 19TH CENTURY MATHEMATICS

8:50 - 9:00 Welcome, Introduction of keynote speaker
9:00 - 10:00 Prof. V. Peckhaus, *19th Century Logic: Between Philosophy and Mathematics*

10:00 - 10:15 BREAK

10:15 - 10:45 F. Abeles, *Henry J. S. Smith, An Extraordinary Victorian Mathematician*
10:45 - 11:15 H. Grant, *Edouard Lucas and the History of Primality Testing*
11:15 - 11:45 I. Kleiner, *Highlights in the Evolution of Field Theory*

11:45 - 1:15 LUNCH; Executive Meeting II

1:15 - 1:45 S. Kunoff, *A Brief Look at Hilbert's Problems and Hilbert's Contributions to 19th Century Mathematics*
1:45 - 2:15 E. Kreyszig, *Tendencies of Functional Analytic and Topological Developments During the Last Quarter of the 19th Century*

2:15 - 2:30 BREAK

Afternoon Session: 20th Century Mathematics

2:30 - 3:00 R. Godard, *An Historical Analysis of Time Series*
3:00 - 3:30 S. Svitak, *The "Chicago Connection" in the Mathematical History of Factor Analysis, 1930-1948*

3:30 - 3:45 BREAK

3:45 - 4:15 R. Adams, *Early Applications of General Topology (Outside of Mathematics)*
4:15 - 4:45 E. Cohen, *Elisabeth Achelis: Calendar Woman*

END OF CSHPM '98

CSHPM 1998: ABSTRACTS

The abstracts below are listed in alphabetical order by author. They include all talks from the general session, special session, and the joint sessions with the CSHPS.

F. Abeles, Kean University
Henry J. S. Smith, An Extraordinary Victorian Mathematician

Henry J.S. Smith (1826-1883) was Savilian Professor of Geometry at Oxford beginning in 1860. He was awarded the Steiner Prize of The Berlin Academy, and Grand Prize in Mathematical Sciences by the French Academy. As President of the London Mathematical Society, and earlier as Head of the Mathematics and Physics Section of the British Association, he gave two addresses framing the current state of and possible future directions for mathematics in Britain. In this paper I will present and discuss the main points of these addresses.

A. Ackerberg-Hastings, Iowa State University
John Farrar: Forgotten Figure of Mathematics in the Early Republican United States

John Farrar (1779-1853) is a casualty of the historical tradition which claims American mathematics was of negligible quality until the end of the nineteenth century. Some historians of mathematics are aware that Farrar was one of Benjamin Peirce's professors, while others have mentioned his role in reforming mathematics education by translating French textbooks. Yet, there is as yet little accessible published information on Farrar's entire life and career at Harvard. This paper, then, provides the beginning of a biography of Farrar. It will also help show that there was activity taking place in mathematics in the American college setting in the early nineteenth century which is worthy of historical study.

R. Adams, Southern California College
Early Applications of General Topology (Outside of Mathematics)

The history of general topology exhibits that its development during the first half of the twentieth century was stimulated by the metrization question and after 1950, the methods of both general and algebraic topology were utilized jointly and applied to the study of manifold theory. It has been extremely rare for general topology to be applied to fields outside of mathematics, and the uniqueness of such ventures makes them of particular interest. We shall examine Kurt Lewin's book (1936), *Principles of Topological Psychology* and Andre Hermant's (1946) "*Geometry and Architecture of Plants.*"

P. Allaire, City University of New York
The Roots of British Symbolical Algebra in "The Problem of the Negatives"

Even into the nineteenth century, a significant number of mathematicians expressed doubts about the soundness of the foundation of the negatives (and therefore of algebra) because of the way in which negative numbers were defined. Some respected writers of the time, holding that a logically sound algebra is impossible if the negatives are included, proposed algebra with positive real numbers only and were willing to accept such consequences as the loss of much of the theory of equations. Attempts to define negative numbers rigorously and to reconstruct algebra in such a way as to place the subject on a logically secure foundation, led to symbolical algebra and to the notion of formal algebra. In this paper, we shall examine the way in which negative quantities were viewed in the period prior to 1830 when George Peacock published *A Treatise on Algebra*, the first systematic restructuring of the subject. In addition, we shall explore the reasons that the symbolical movement arose at that time and why Cambridge University was its birthplace.

C. Baltus, SUNY Oswego
Lagrange and the Fundamental Theorem of Algebra

"[In 1799] Gauss gave the first wholly satisfactory proof of the fundamental theorem of algebra [FTA]. ... Unsuccessful attempts to prove this theorem had been made by Newton, Euler, d'Alembert, and Lagrange." [Eves 1990, p. 477] This is the standard history of the FTA, to be found in Boyer, Struik, etc. Lagrange didn't accept it. He reissued his own 1772 proof in the 1808 edition of *Traité de la Résolution des Équations Numériques*... . The history is not so simple. S. Smale [Bull. AMS, 1981] outlined problems with Gauss' contribution; C. Gilain [*Archive for History of Exact Sciences*, 1991] reexamined the earlier work. How about Lagrange? Just what did he show?

E. Cohen, Université d'Ottawa
Elisabeth Achelis: Calendar Woman

Elisabeth Achelis found her life's ambition at the age of fifty: to simplify the Gregorian calendar, which had been in use since 1582. She studied many calendars in order to introduce a simplified World Calendar. Although she did not succeed, her idea has not yet disappeared as others are still trying to obtain a more perfect one.

D. A. Cutler, University of Western Ontario
Frege, Metatheory and the "Logocentric Predicament"

A notable difference between Frege's conception of formal logic and our present conception is demonstrated by Frege's failure to consider any of the usual metatheoretical questions (soundness, completeness, consistency, etc.) with regard to his systems, *Begriffschrift* and *Grundgesetze*; by contrast such questions occupy a central role in the study of modern formal theories. Van Heijenoort has tried to explain Frege's failure to investigate metatheoretical questions by arguing that, for Frege, the very notion of metatheory is incoherent. According to van Heijenoort, Frege regarded his logical systems as "universal" in the very strong sense that nothing "can be" or "has to be" said outside of them. Thus Frege finds himself in a "logocentric predicament". Van Heijenoort's proposed explanation has, directly or indirectly, influenced the work of Goldfarb, Hintikka, Wang and many others. I argue that van Heijenoort's view of Frege's philosophy of logic is vaguely formulated and, moreover, on the most natural interpretations, van Heijenoort's view is in poor accord with Frege's explicit statements. There is a much simpler explanation for Frege's failure to consider metatheoretic questions: No such considerations were pertinent to Frege's logicist project. Frege wanted to show that arithmetical knowledge was, in principle, independent of spatio-temporal intuition. He could show this by deriving statements that characterize the natural numbers -- i.e. what we call the Peano Axioms -- from his "basic laws" in such a way that it is clear that spatio-temporal intuition has not been appealed to. Frege's project is an extension of the project of "rigorization" in analysis that had resulted in the elimination of spatio-temporal notions from the foundations of the theory of the real numbers. The point of rigor is to display the independence of arithmetic from geometry, and not to place arithmetic on a firmer epistemic basis. I argue that one of the main sources of van Heijenoort's misinterpretation of Frege is his misconstruction of both the purpose of metatheory and the nature of Frege's project of rigorizing arithmetic: Both are constructed by him as attempts to confer greater epistemic security.

R. DiSalle, University of Western Ontario

Reconsidering Conventionalism

The conventionalist view of geometry originated as an attempt to understand how axiomatic geometry comes to acquire a physical interpretation. The controversial outcome of this attempt was the idea that physical geometry is radically underdetermined, and therefore subject to (more or less arbitrary) conventional choice. Over the past few decades, this consequence of conventionalism has led to its downfall: philosophers have argued persuasively that allegedly equivalent "conventional alternatives" are not at all equivalent on decisive mathematical, empirical, and methodological grounds. In this paper, I suggest that, while these arguments are important and unexceptionable as far as they go, they fail to address the essential core of conventionalism. This core is not an account of what makes geometrical claims reliable or how one might be judged to be superior to another, but an account of how geometrical claims -- claims that "the world has a given geometrical structure" -- become meaningful in the first place. While the conventionalists' own exaggerations may have invited such a critical response, at the same time their analysis of what geometry can say about the physical world has been neither appreciated nor substantially improved upon.

C. Fraser, University of Toronto

Theories of Quantity in Euclid's Elements

There are at least three theories of quantity in the *Elements*, namely: the arithmetic proportion theory of Book VII; the "geometric algebra" of Books I and II; and the Eudoxian proportion theory of Book V. The paper examines these theories and considers the conceptual, mathematical and historical connections which may be said to link them. The problem of incommensurability and homogeneity as well as issues of existence and methodology in Euclidean geometry will be explored in the paper.

I. Garro, Aleppo, Syria

The Paradoxes of Yahya Ibn Adi and Bertrand Russell

Yahya Ibn Adi, a Christian Arab logician of the 10th century, formulated what I called the paradox of the empty relation in his epistle defending the doctrine of the Ones, which appeared in several publications, e.g. (1).

There he analyzes several ways in which two objects could be different. What interests us here is the formulation based on the definition of difference as a disagreement on all properties. In that case the conclusion is that there is agreement (a new property) on being different in all properties. I compare this formulation of a paradox of self-reference with that of the Liar and of B. Russell and pinpoint their structural similarities.

Yahya also discusses a rudimentary theory of relations based on the duality property-object (fulfilling that property). I discuss his theory in detail. In another article I develop a theory of relations based on this duality in a mathematical model of polytopes which leads me to an incompleteness result of human knowledge. My results were summarized by Stachowiak in (2).

In another paper I resolve the three paradoxes of Yahya, Russell and the Liar using a set theoretic model which is a solution to an infinite general flat system in the theory of non-well-founded sets (cf. Barwise (3)). The similarity of the three paradoxes is reflected by using the same model to resolve them.

1) Khalifat, Sahban; Yahya Ibn Adi, *The Philosophical Treatises*; Amman, 1988.
2) Stachowiak, Herbert; *Handbook of Pragmatics*, Vol. V, Meiner Verlag Hamburg, 1995.
3) Barwise, Jon; *Vicious Circles*, CUP 1996.

I. Garro, Aleppo, Syria

Space, Time and Motion -- Bridging the Gap Between Aristotle, the Arabs, and Einstein

The bridging concept between the ancient philosophy of space and time (Greek and Arabian) and the modern Einsteinian views is based on the role of motion in determining space and time. This is completely absent from the Newtonian thought where motion is accidental to the space-time diagram.

We discuss this phenomenon in detail in the works of Aristotle, al-Kindi and Ibn-l-Haytham. The latter's work could be considered as a mathematization of the Aristotelean views.

In a recent articles, "Limits, Asymptotes, and Infinities Old and New", we looked at Haytham's work from the point of view of classical differential geometry. Here, we give a philosophical motivation for this analysis and discuss how this approach could be undertaken in formalizing relativistic motion in line with the ancient tradition of philosophy of nature.

R. Godard, Royal Military College of Canada
An Historical Analysis of Time Series

Let us give an example of Time Series, not by a mathematician, but rather by an Historian, E. Leroy Ladurie: "Climate is a function of time. It varies: it is subject to fluctuations; it has a history." We present a few classical examples of Time Series: rainfalls and precipitations, sunspot numbers, tree rings, wine harvests, geomagnetic pulsations, motions of the earth; and also the variations of the lynx population in Canada. The mathematical modelling of Time Series in extremely complex, because it is linked to random functions, and the concept of filtering. The XVIIIth century has glorified the concept of the "mean value", and mathematicians like Condorcet were very sensitive to the variations of different phenomena: "C'est alors que, connaissant toutes les causes qui influent sur la formation des prix, tous les élémens qui doivent y entrer, il deviendra possible d'analyser les phenomenes que répresentent leurs variations, d'en reconnaitre les lois, et de tirer de ces observations, des conséquences vraiement utiles." Bienayme (1874-1875) presented a nonparametric, simple test which involves the counting of the number of local maxima and minima, i.e. turning points, in the series. We shall call these tests as descriptive statistics. The time series analysis is mainly a contribution of the XXth century. One can distinguish two types of approach:

1) A temporal approach: the research of trends, the concept of moving averages. In this chapter, we follow the presentation given by E. Borel, R. Risser, and C. E. Traynard.
2) A frequency approach with the works of Kolmogorov, and N. Wiener during the 1940's, and the concept of optimal filtering.

Finally, numerical methods have emphasized the concept of sampling, and windowing. We emphasize the importance, and the contribution of W. Gibbs in 1899, and H. Nyquist in 1924, and the history of the fast Fourier transform.

H. Grant, York University
Edouard Lucas and the History of Primality Testing

Edouard Lucas (1842-91) was in some (mathematical) respects a French counterpart of C.L. Dodgson -- a solid professional with a gift for expository writing and a particular interest in the "recreational" side of the subject. I shall offer a necessarily hasty overview of Lucas's career and then concentrate on his role in the history of what remains the classic method for discovering ever larger prime numbers.

P. Griffiths, London, U.K.

The Velocity of Celestial Bodies is Determined by Kepler's Distance Law Rather than by Newton's Principia

Four out of Kepler's five laws are still accurate in determining the orbit velocity and shape of celestial orbits. Velocity is determined by the relationship between at least two celestial bodies, and is inversely related to the square root of the distance between the bodies.

Kepler's distance law applies as much to Mercury as to Jupiter, planets of very different mass. This could mean that planets of high mass position themselves further away from the sun focus than planets of low mass.

Kepler did not need to identify gravitation, although gravitation is tacitly taken into account in the power in Kepler's distance laws. These laws effectively operate without Newton's additional concepts of gravitation, mass and the application of forces.

A. Jones, University of Toronto
The frame of reference in Greek astronomical papyri

A large part of the data contained in the astronomical papyri and horoscopes from Roman Egypt consists of calculated longitudes of the heavenly bodies. These are usually expressed by a zodiacal sign and a number of degrees, from zero to thirty. What was the "zero point" of this frame of reference? In Ptolemy's *Almagest* longitudes are tropical, i.e. reckoned from the vernal equinoctial point (one of the intersections of the celestial equator and the ecliptic) as ostensibly determined from observations of dates of equinoxes and solstices by Ptolemy and his predecessors. On the other hand, Neugebauer showed in 1959 that the known examples of Greek horoscopes exhibited deviations in longitude relative to tropical longitudes computed by modern theory, the trend of which implied that the frame of reference was sidereal. We now have a much larger corpus of documents to work with, including many tables and almanacs that give precise longitudes over extended intervals of time. These allow us to reexamine the question of whether the preferred system was tropical or sidereal, and whether the gradual adoption of Ptolemy's tables influenced this preference. The results of this investigation incidentally cast light on the origins of the concept of the "trepidation of the equinoxes" in medieval astronomy.

I. Kleiner, York University
Highlights in the Evolution of Field Theory

I will discuss aspects of the evolution of field theory, including its sources dating back to the early 19th century, and its founding as an abstract, axiomatic theory in the early 20th century.

E. Kreyszig, Carleton University
Tendencies of Functional Analytic and Topological Developments During the Last Quarter of the 19th Century

Functional analysis and topology are primarily creations of the twentieth century, characterized by extraordinary efforts near the turn of the century and shortly thereafter; here we are thinking of famous works on integral equations by Fredholm, Lebesgue's theory, Frechet's metric space, F. Riesz's attempt on topological space, and Hilbert's work on integral equations and spectral theory, to name just a few landmarks.

However, in this talk we shall outline how that spectacular period around 1900 had its classical roots in the last quarter of the nineteenth century, connected to several only weakly related tendencies of development. This includes Riemann's work on topology, Cantor's point set theory, Cantor's, Dedekind's and Meray's rigorous introduction of the real number system, Weierstrass's general influence on rigor as well as his creation of a modern calculus of variations, Dini's and Volterra's work on derivatives and functionals, Peano's infinite-dimensional vector spaces and his work on logic, Arzela's and Ascoli's theorem, perhaps the earliest substantial result in functional analysis, Borel's work on complex analysis, which led him to the circle of ideas related to the Heine-Borel theorem, Hilbert's general influence on axiomatics, and, last but not least, the investigations on potential theory, spectral theory, and integral equations by C. Neumann, Poincare, H.A. Schwarz, Le Roux, and Volterra. We shall attempt to systematize these various developments and some of their interrelations.

S. Kunoff, Long Island University
A Brief Look at the Hilbert Problems and Hilbert's Contributions to 19th Century Mathematics

In 1900 David Hilbert delivered a lecture to the International Congress of Mathematicians defining 23 open questions in mathematics the answers to which he felt would be crucial to the advancement of mathematics in the 20th century. Hilbert was known for seeing "the big picture," a definite asset when foretelling the future. History has proven his insight correct. This paper will focus on some of the advances in mathematics made in the 19th century which led Hilbert to his choices. It will also provide an overview of Hilbert's important contributions to the mathematics of that century.

E. Landry, McGill University
Category Theory as a Framework for Mathematical Structuralism

In this paper I argue that if we distinguish between ontological realism (the claim that mathematical objects exist independently of their linguistic expression) and semantic realism (the claim that mathematical statements which talk about mathematical objects are meaningful), then we no longer have to choose between the standard platonist and nominalist interpretations of mathematical structuralism. If we take category theory as the language of mathematics, then a linguistic analysis of the content and structure of what we say in, and about, mathematical structures allows us to justify the inclusion of mathematical concepts and theories as legitimate objects of philosophical study. It is in this sense that category theory provides a framework for a semantic realist interpretation of mathematical structuralism -it allows us to organize what we say about mathematical objects (as positions in structures) and mathematical structures, without our having to take structures themselves as independently existing objects.

P. Laverty, University of Western Ontario
Predicativism in Weyl's Das Kontinuum

In his *Das Kontinuum*, Herman Weyl attempts to provide a foundation.for analysis which avoids both the antinomies of set theory and the *circulus vitiosus* of impredicative definitions. The antinomies of set theory are avoided in Weyl's system by subjecting Î to type restrictions. The *circulus vitiosus* of impredicative definitions are avoided by restricting the existential quantifier in his comprehension scheme. Beginning from the natural numbers, which he treats as *sui generis*, Weyl employs his 'mathematical process', the process by which one derives sets from pre-existing objects within the domain, to construct the fractions and the rationals from which the real numbers are subsequently constructed. Given the above mentioned restrictions, however, Weyl disallows the construction of a set of real numbers, and as such, Dedekind's cut principle, as well as the least upper bound theorem for every set of real numbers, fail to hold. The result, however, is an arithmetical construction of the continuum which is free any impredicative definition. However, throughout the work, Weyl also discusses various philosophical problems surrounding our notion of the continuum and any attempt to construct it arithmetically. Specifically, Weyl claims that any attempted foundation which divides the continuum into discrete points "lacks the required support in intuition." As a result, Weyl is forced to admit that his own construction, in the end, while an advancement in the foundation of the arithmetical continuum, remains unsatisfactory in capturing the continuum presented to us in intuition. Jairo Jose Da Silva, however, in his *Husserl's Phenomenology and Weyl's Predictivism*, argues that in *Das Kontinuum,* as a result of a Husserlian phenomenological influence, Weyl's aim is to give us "a 'symbolic reconstruction' of the continuum of intuition." In addition, Da Silva argues that Weyl aims to go beyond translating the intuitive continuum into the arithmetic continuum to provide, again, due to Husserlian influences, a "constitution of the arithmetic continuum itself out of its intuitive basis, the intuition of the discrete sequence of the whole positive numbers." The aim of this paper is twofold. Firstly, I will argue that Weyl's treatment of the natural numbers as sui generis does not come from Husserl, as suggested by Da Silva, but rather, it is derived from Poincare. In addition, I will illustrate that while Weyl undoubtedly was persuaded by Husserl and other phenomenologists, the motivation behind *Das Kontinuum* is merely to provide a predicative account of the arithmetical continuum. Weyl's attempt to translate the intuitive continuum into the arithmetic continuum begins a year later with his conversion to L. E. J. Brouwer's intuitionism.

J. Lefebvre, Université du Quebec à Montréal
Mathematics in the 17th Century: Essays on Human Thinking by Descartes,Pascal,Arnauld and Nicole, and Spinoza

Mathematics is highly regarded by the named authors. It is used by them sometimes as a global model, sometimes as a source for fruitful examples, in the task of establishing sound rules for the formation of the mind. We shall try to scrutinize judgments made concerning the value of mathematics as an intellectual practice and present some caveats by these authors. We shall illustrate a number of major or minor uses of mathematics, and find a few retroactive thoughts of some of these authors on the possible improvement of mathematics. On the whole, mathematics stands out as the best discipline or science from which to draw a model for clarity and solidity of thought. Thus mathematics seems to be of the utmost necessity for training for training the mind. But is it sufficient? The talk will be focused on papers on human thinking, with auxiliary recourse to a few excerpts from other works by these great seventeenth century figures, but without looking at their mathematical work per se.

D. Lehoux, University of Toronto
Ancient Egyptian Astrometeorology

When Neugebauer and Parker published their monumental *Egyptian Astronomical Texts* in 1969, they included a translation of a difficult little Egyptian text, the 'Autobiography of Harkhebi'. Certain parts of the text were particularly difficult to understand, since they used extremely unusual (indeed, unique) writings for certain technical terms of Egyptian astrology. In this paper I argue that the difficult parts of this text are not primarily concerned with planetary astrology, as Neugebauer and Parker thought, but with astro-meteorology, that is, the application of astrology to weather prediction, which was being practiced in Greece at the time of Harkhebi (3rd c. B.C.). Not only does this approach solve the textual problems encountered by Neugebauer and Parker by avoiding their unusual readings of the hieroglyphic signs, but it also accords splendidly with recent discoveries by Christian Leitz in the wider field of Egyptian Astronomy, in particular his publication of the Saft-el-Henna decan-list. I conclude that the Egyptains were practicing astrological weather-prediction along the lines of what the Greeks were up to at the same time, and that this activity may well be the hitherto unknown source for the later Greek and Latin reports of Egyptian "parapegma" or weather-calendars.

D. Melville, St. Lawrence University
Weighing Stones in Ancient Mesopotamia

An Old Babylonian mathematical tablet states a series of problems ostensibly to do with finding the original weight of a stone given its weight after it has undergone assorted additions, subtractions, multiplications and fragmentations. The solution to each exercise is given, but no hint as to how that solution was obtained. We propose a procedure the students could have followed in solving these problems and indicate how analyzing Mesopotamian mathematics from an algorithmic point of view helps to improve our understanding of the boundaries and depth of the subject.

G. Moore, McMaster University
From Euclid to Veronese: The Evolution of "Magnitude"

Until sometime in the 20th century, mathematics was defined as the science of quantity or magnitude. Yet it was exceedingly difficult to define "magnitude". Euclid did not include any definition of it in his *Elements*, but stated several properties of magnitude in his common notions. His apparently reluctant treatment of horn angles as magnitudes began a discussion that continued over two millenia as to whether such angles were actually magnitudes.

Aristotle stated that the characteristic of quantity or magnitude is that is can be equal or unequal. But by the 17th century, the typical definition of magnitude had ceased to be so Aristotelian, and instead stated: "what can be increased or decreased". That definition was found in Euler's *Algebra* in the 18th century and continued to appear in textbooks until at least the early 20th.

This talk will concentrate on the changing concept of magnitude, its axiomatization in the late 19th and early 20 century, and the debates over whether there exists an infinite magnitude, particularly non-Archimedean ones.

C. Panjvani, University of Western Ontario
On Wittgenstein and Identity: Why Identity is not a relation

According to Wittgenstein, despite appearances which may be to the contrary, identity does not involve a relation, be it between names or objects named. This paper investigates Wittgenstein's case. Informative identities involving names are seen to not be relations when the sense of the name is specified with a definite description. Identities between objects reduce to the self-identity of an object, the expression of which, according to Wittgenstein, is nonsense. This has consequences for, *inter alia*, Russell's Axiom of Infinity and Frege's derivation of the natural numbers.

V. Peckhaus, Institut f✦r Philosophie der Universit•t Erlangen-Nurnberg
***Keynote Address**: 19th Century Logic: Between Philosophy and Mathematics*

The history of modern logic is usually written as the history of mathematical or, more generally, symbolic logic. As such, logic was created by mathematicians. Not regarding its anticipations in Scholastic logic and in the rationalistic era its continuous development began with George Boole's *The Mathematical Analysis of Logic* in 1847 and it became a mathematical subdiscipline in the early 20th century.

Recalling some standard 19th century definitions of logic as, e.g., the art and science of reasoning (Whately) or as the doctrine giving the normative rules of correct reasoning (Herbart), we should, however, not forget that mathematical logic was not but up from nothing. It arose from the old philosophical omnibus discipline logic. The standard presentation ignores the relation between philosophical and mathematical logic, it sometimes even denies that there was any development in philosophical logic at all. It therefore fails to give the reasons for the final divorce of philosophical and mathematical logic.

In the paper the relationship between the philosophical and the mathematical development of logic will be discussed. Answers to the following questions will be provided:

(1) What were the reasons for the philosophers' lack of interest in formal logic?
(2) What were the reasons for the mathematicians' interest in logic?
(3) What does "logic reform" mean in the 19th century? Were the systems of mathematical logic initially regarded as contributions to a reform of logic?
(4) Was mathematical logic regarded as art or as science or as both?

A. Reynolds, University of Western Ontario
Peirce and an Early Statistical Model of Darwinian Evolution

The physicist-philosopher Charles S. Peirce (1839-1914) was among the first to recognize the statistical reasoning inherent in Darwin's theory of evolution by natural selection. In the late 1880's Peirce, who was interested in generalizing Darwin's achievement into a Spencer-like theory of cosmic evolution, experimented with a stochastic model which he felt captured the essential features of Darwin's theory. His example consists of a gambling scenario wherein a large population of players bet on a fair game of rouge et noir (roulette). This (Monte Carlo) model is rather seriously flawed insofar as it is meant to include an analogue of the non-random effects of natural selection. For it really constitutes a random-walk with one absorbing barrier, the property which he calls "fitness" is a conserved quantity, there is no non-circular means of identifying the "fittest" individuals, and the model completely lacks any analogue of inheritance. Yet despite its serious deficiencies as a model of biological evolution, it is of some real interest for the way in which it anticipates the theory of stochastic systems developed early in the twentieth century. For instance, it is easily shown to generate a Markov chain of weakly-dependent events with a suggestion of convergent behaviour. Peirce himself believed that the example illustrated something quite novel and undocumented by any other statistical researchers (he explicitly mentions Poisson). For Peirce it counted as further evidence for his metaphysical thesis of tychism, that objective chance provides a better explanation of the irreversible evolution of structure and order in the universe than does the assumption of strict mechanical and reversible causation. In considering the details of this model and how he came to arrive at it, I will discuss the possibility that Peirce was influenced by Francis Galton's research on inheritance.

J. Seldin, Concordia University
Euclidean Geometry Before Non-Euclidean Geometry

In my paper "Two Remarks on Ancient Greek Geometry", which I presented to the CSHPM two years ago, I argued that a culture that takes up the systematic study of geometry is likely to arrive at Euclidean geometry first because it is natural for humans to think in terms of rigid motions (i.e., that rigid bodies do not change shape when they move) and scale models. Marcia Ascher (in private correspondence) has suggested that these arguments were ethnocentric. In this paper, I will examine some geometric ideas from other cultures to provide an alternative indication of why a culture that starts to study geometry using an approach compatible with that of the ancient Greeks is likely to arrive at Euclidean geometry before any of the standard non-Euclidean geometries.

Sylvia M. Svitak, Queensborough Community College, CUNY
The "Chicago Connection" in the Mathematical History of Factor Analysis, 1930-1948

Factorial indeterminacies and invariances were major dilemmas faced by American researchers in the mathematical formulation of factor analysis during the 1930s and 1940s. In 1988, W. W. Rozeboom entitled an article, "Factor indeterminacy: The Saga continues" and a search of works since then has shown that there are still no definitive answers to the dilemmas. Researchers at the University of Chicago in the 1930s and 1940s, were major contributors to the early mathematical theory of factor analysis in the United States and their work is the focus of this paper. The engineer turned psychologist, L. L. Thurstone, is recognized as the American pioneer in the development of factor analysis as a method of scientific investigation. The physicists, C. Eckart, G. Young, and A. S. Householder were among the primary explicators of the basic mathematics underlying matrix approximation techniques employed in factor analysis. A. A. Albert, a well-known algebraist, contributed a solution for obtaining unique communalities in a correlation matrix.

J. Tattersall, Providence College
Greek Arithmetic According to Nicomachus and Theon

We discuss several interesting number theoric results found in the second century texts *On Mathematical Matters Useful for Reading Plato* by Theon of Smyrna and the *Introduction to Arithmetic* by Nicomachus of Gerasa.

G. Van Brummelen, The King's University College, Simon Fraser University
Geometry in the 10th Century: Three Persian Miniatures by Ab⅄ Sahl al-K⅄h✚

Ab⅄ Sahl al-K⅄h✚ flourished at a time of renewed growth, exploration and redefinition of ancient modes of thought. We explore three examples of al-K⅄h✚'s geometrical research. Through it we shall attempt to reach some insights about Muslim reception of Greek geometrical methods.