Euler 2011 :: Abstracts

<u>The Euler Lecture</u>

Robert E. Bradley, Adelphi University

Evolutes and Involutes from Huygens to Euler

Analyse des infiniment petits, the first differential calculus textbook, was written by the Marquis de l'Hospital and published in 1696. A century later, Joseph Louis Lagrange published *Théorie des fonctions analytiques* (1797). In the intervening period, the conception of the differential calculus had changed from a geometric study of curves with the aid of differentials to a symbolic manipulation of functions, founded on a set of algebraic rules. The pivotal figure in this transition from the geometric to the algebraic was Leonhard Euler.

We examine this evolution of the calculus by considering one particular class of problems, that of finding evolutes and involutes. This subject was pioneered by Christiaan Huygens in his *Pendulum Clock* (1673). Johann Bernoulli elaborated on Huygens' work, applying differential methods; essentially, Bernoulli's contributions to the subject make up the contents of Chapter 5 of de l'Hospital's *Analyse*.

In E129, one of his final papers form the first Petersburg period, Euler answered a question on evolutes posed by G. W. Krafft by extending Bernoulli's methods to an arbitrary degree of generality. By bringing his new methods of differential equations to bear on this subject, Euler essentially tamed it for all time. However, there was one more question to be resolved in E169, where Euler used series expansion to resolve a paradox in the theory of involutes that arose from the conflict between the geometric and algebraic description of curves with a certain kind of singular point.

Sandro Caparrini, Institute for the History and Philosophy of Science and Technology, University of Toronto

A Few Words About Clifford Ambrose Truesdell (1919-2000)

The name of Clifford Truesdell does not need any introduction to Euler scholars. Yet there is schizophrenic attitude toward his work. While he is widely considered the greatest historian of eighteenth-century mathematical physics, his methods and results have often been severely criticized. Thus, for example, he is hardly cited in "Writing the History of Mathematics" (Birkhäuser, 2002), a general history of the history of mathematics. Eleven years after Truesdell's death and about half a century after the publication of his main historical works, it is now high time that an examination of what Truesdell really achieved is undertaken.

Lawrence D'Antonio, Ramapo College

The Mind is Confusedly Omniscient: Euler and the Causality Debates of the Enlightenment

The nature of causality in general, and that of force in particular, formed a central theme in the debates on metaphysics in the Enlightenment. In this era, one finds the conflicting theories of Pre-established Harmony put forth by Leibniz and Wolff, the Occasionalism of Malebranche, Physical Influx found in the work of Kant, and causality as a habit of the mind as articulated by Hume. In this talk we will give the background for these debates and discuss Euler's role in them.

James Harper, Central Washington University

Understanding Euler's Formula for the Sum of Three Cubes

The year following Euler's claim that he had proved Fermat's Last Theorem for the case $n = 3$, Euler derived a formula for all *rational* solutions to the homogeneous Diophantine equation $A^3 + B^3 + C^3 = D^3$. His derivation is an enigma: At one point he has ten parameters to describe the four variables *A, B, C* and *D*. Two of these parameters mysteriously disappear as he solves for four of the initial parameters and then he introduces another parameter in the final solution. (All told he uses up nearly half the alphabet to solve this equation.) The end result is *five* parameters for the original *four* variables. I will present Euler's derivation for this equation (which is not difficult) and then I will parallel that derivation with the simplest solution, namely, $3^3 + 4^3 + 5^3 = 6^3$.

Dominic Klyve, Central Washington University

Euler's Letters to a German Princess: Translation and Betrayal

Euler's book "Letters to a German Princess" is well known within the Euler community, and even enjoys some fame outside of it. Most descriptions of the work include the fact that it was rapidly translated into many of the languages of Europe, and that it stayed in print for over a century. What is not mentioned is that with each edition and translation, the text changed. Editors and translators often had their way with Euler's words, and as often as not, they made no mention of these changes, leaving readers ignorant of the fact that they were not actually reading Euler's sentiments. This talk will examine the people involved in preparing various editions of this work, together with their work and motivation.

Stacy Langton, University of San Diego

What did Johann Bernoulli mean by the "eddy"?

Clifford Truesdell has suggested that Euler got the idea which became, eventually, the foundation of his work in fluid mechanics from reading Johann Bernoulli's *Hydraulica*. In that book, Bernoulli claims to have discovered a new concept, which had been overlooked by all previous writers on fluid mechanics—including his son, Daniel. Johann Bernoulli designates this concept by the Latin word "gurges", which Truesdell translates as "eddy", using one of its classical meanings. But Truesdell finds Bernoulli's explanation of the "gurges" to be obscure.

Recently, Olivier Darrigol ("Worlds of Flow", Oxford, 2005, p. 10) has proposed that Johann Bernoulli's "gurges" is, in modern terms, the "convective component of the material derivative". In my talk, I will explain what this means, and give my own interpretation of what Bernoulli meant by the "gurges". Part of the talk will be based on an important letter that Euler wrote to Johann Bernoulli in May 1739.

Chukwugozie Maduka, University of Benin (Nigeria)

Comparability of Use of Euler and Venn Diagrams for Proof of Validity in Classical Logic

One of the celebrated methods for verifying the validity or otherwise of an argument in classical (Aristotelian) logic is the use of diagrams. The more common diagrammatic approaches derive from the works of Euler and Venn. Since propositions and arguments in classical logic are built essentially on class membership of subject and predicate terms, the foundation, then, of the formulations of Euler and Venn in this regard must be the algebra of classes.

At the present moment, the use of Venn diagrams has met with so much considerable success that almost all classical logic textbooks present it as if it were the sole available diagrammatic approach. Little or no attention is paid to Eulerian diagrams, yet all of the four typical Aristotelian logic categorical propositions (A, E, I, O) can be succinctly represented in the Euler model. The actual problem seems to lie in the use of Eulerian diagrams to represent arguments wherein, as usual, we are confronted with major, minor and middle terms. Validity or invalidity cannot be meaningfully established in this approach unless adequate yet distinctive diagrammatic representations can be procured.

This study is an attempt to pinpoint where exactly the problem lies in the use of Euler's diagrams and thereafter to propose a solution.

In order to achieve this end, there will be need to go back to the original formulations of Euler in order to ensure that all suggestions being proposed are in line with his thinking. The comparison with the Venn diagram approach, on the other hand, will not only throw more light on the strengths and weaknesses of either method but will in addition provide a basis for deciding on which method to engage and for which type of problems. It may well be the case that while one approach may be preferable when dealing with affirmative and particular propositions, another method will provide better facility in cases involving universal and negative propositions. Such situations abound, for instance, in sentence and predicate logic with respect to the use of truth trees and truth tables. Of course, it is common knowledge that such features as simplicity of presentation, rigour, scope of application, ease of application, amenability to semantic rendering usually play a role in the decision on which approach to use and for what. Some of these entailments will be considered in this study.

Joseph McAlhany, Carthage College

Mind Over Matter: Euler's Enodatio

Euler's brief work, "Enodatio questionis utrum materiae facultas cogitandi tribui possit necne" (1746) purports to offer incontrovertible proof, based on principles from the field of mechanics, that material bodies cannot possess the capacity for thought. While Euler does reduce the question to a clear and logical syllogism, his ultimate goal is a proof of the non-corporeality of the mind—an early salvo in the philosophical dispute over the nature of the mind, with important theological ramifications. This paper will give a brief overview of the work, which has been fully translated, and situate Euler's argument in the broader context of contemporary philosophical and theological concerns.

Michael Saclolo, St. Edward's University

Equilibrium According to Euler

In his "Essay concerning a metaphysical experiment on the general principle of equilibrium" (E200), Euler discusses how forces act on a body in equilibrium. He begins by defining the notions of magnitude and direction of a force. He then describes the action of a force as consisting of the contraction of "fibers" that make up the force. Finally he conceives of a body in equilibrium as a moment where all opposing forces acting on the body are at their greatest effects, translating to the greatest contraction of the corresponding fibers, rendering a minimum of their lengths.

Emil Sargsyan, Indiana University

Proofs & Priorities in Euler's Manifold Demonstrations of the Basel Problem

Euler's numerous solutions to the Basel problem have come under scrutiny both in his time as well as in the twentieth-century. Mathematicians have praised and criticized Euler's bold handling of the sum of the powers of reciprocals of natural numbers; historians of mathematics have offered modern reconstructions, exposing and proving hidden lemmas; while philosophers have cited one of his earliest solutions as an instance of empirical methods employed in mathematics. Paul Stäckel's early pioneering study of Euler's multiple publications and letters revealed a third forgotten French addition to his proofs and that these endeavors were fruitful in producing mathematics far beyond the narrowly construed question first posed by Jacob Bernoulli. But what drove Euler to produce what some people have counted as at least five different demonstrations, not counting the earliest discovery, which was based on a numerical approximation? I believe a careful study of Euler's multiple derivations and comments he received from Johann, Daniel, and Nicolaus Bernoulli could reveal contemporary priorities concerning what is an acceptable mathematical proof. As many historians of mathematics have pointed out, proof-standards have dramatically changed since the eighteenth-century. My paper tries to highlight shifts in these standards and priorities by reconstructing the motivating factors behind Euler's manifold demonstrations of the Basel problem.

Justin Z. Schroeder, Vanderbilt University

Euler's Orthogonal Latin Square Conjecture

In 1782, Euler famously conjectured that no pair of orthogonal Latin squares of order $n = 4t + 2$ exist for any integer t. In 1960, Bose, Shrikhande, and Parker proved the conjecture false for all $t \geq 2$. This talk begins with a brief history of the mistaken conjecture and some of the methods used to refute it.

A Hamiltonian embedding of a graph G is a drawing of G on a surface such that no edges cross and every vertex appears exactly once on the boundary of each face. In the second part of this talk, we develop a connection between orthogonal Latin squares and Hamiltonian embeddings of the complete tripartite graph $K_{n,n,n}$. In particular, we show how Euler's m-step construction can be modified to yield orthogonal Latin squares with some desired properties. This gives a potential new approach to constructing pairs of orthogonal Latin squares of order $4t + 2$. This is joint work with Mark Ellingham.

Brian Schwartz, Carthage College

A precision test of the inverse square law of gravity: Euler's Lunar calculations (and mis-calculations) for the eclipses of 1748

Observations of lunar and, even more so, solar eclipses offer a rigorous test of the quality of astronomical tables and observations as well as the computational skills of the astronomer. In this talk we will demonstrate Euler's process for calculating the details of the 1748 solar eclipse visible in Berlin. We also discuss the relevance of the accuracy of these predictions with respect to precision tests of the inverse square law of gravity. In addition, we will show how planetarium software can be used in a classroom or some other setting to reproduce measurements made by Euler and his contemporaries. This allows us today to—almost literally—see the universe as Euler saw it.

Mark Snavely, Carthage College

Proof of Fermat's Theorem That Every Prime Number of the Form 4*n*+1 is the Sum of Two Squares

We will examine Euler's paper, "Proof of Fermat's Theorem That Every Prime Number of the Form 4*n*+1 is the Sum of Two Squares" [E241]. We will describe Euler's proof in detail, and include recent proofs of some parts of the work.

Emma Sorrell, Carthage College

Fluid mechanics in Euler's "Recherches sur le mouvement des rivieres"

While Euler is well-known for his two three-part series on fluid mechanics—E225/226/227 and E258/396/409—they were not his only writings on the subject. In addition to these series, Euler wrote the present paper [E332], which predates his other works on the subject.

He begins this paper with the bold statement that all the research done in fluid mechanics up to this point, while helpful to very specific applications, is incomplete because it cannot be applied generally. To find this general rule, Euler constructs a model which he says "will serve as a basis for all others." We will examine this model, placing it in historical context, and contrasting it with the work of Bernoulli and d'Alembert.