**From the Newsletter Editor.....Frank Ford**

Tommy Ratliff began his tenure as Chair of the Section with the question "What is the purpose of the Northeastern Section of the MAA?" The officers and many others have discussed this on email for some time now. In Tommy's message, he called for comments on the question and I hope you will join the discussion.

## Graduate Student Papers Presented at the NES/MAA Fall 2005 Meeting

**Decoherence in quantum walks on the hypercube**
**Gorjan Alagic, University of Connecticut**

Recent research in quantum computation has led to the development of natural quantum analogues of the classical random walk. This area of research has already met with significant success, in particular by producing a quantum walk algorithm for an oracle problem, which performs exponentially better than is possible classically. In this talk, we will discuss the continuous quantum walk on a graph, as well as recent results (joint work with Alexander Russell) about the effects of decoherence on the quantum walk on the hypercube. Since any real quantum system suffers from decoherence, this is a matter of significant importance for any practical implementation.

**Ill-posed Problems and Regularization Methods**
**Malena Espanol, Tufts University**

Discrete ill-posed problems in the form of linear systems or least squares problems occur in a variety of applications, for example in image deblurring. The difficulty in solving discrete ill-posed problems is the presence of noise on the right hand side of the linear system. The ill-posed nature of the problem ensures that the least squares solution will not approximate its true solution. In this talk we discuss properties of discrete ill-posed problems and give an introduction to numerical techniques for approximating a regularize solution of it. We present a new regularization algorithm, and show promising numerical results.

**Stability of Solutions to the Discrete Nonlinear Schrödinger Equation in Multiple Dimensions**
**Jacob A Gagnon, University of Massachusetts - Amherst**

The Discrete Nonlinear Schrödinger (DNLS) equation has generated much mathematical interest in recent years due to its wide variety of physical applications. Bose Einstein condensates, optical waveguides, and photonic lattices are just a few examples of its applications. In this talk, I will present solutions to the time periodic DNLS using finite differencing in one, two, and three spatial dimensions. The stability of these solutions to small perturbations has been studied and the parameter values yielding stable solutions have been identified. Lastly, I will discuss my current work in determining the time evolution of unstable solutions.

**Generalized Pythagorean Tuples**
**Lisa Henkel, New Hampshire**

A Pythagorean Triple is a triple of integers (x, y, z) such that $x^2 + y^2 = z^2$. Hadwin & Teigen had a method of generating Pythagorean triples that can be generated by a matrix transformation. H. Anders Lonnemo created a matrix L that maps Pythagorean triples to other Pythagorean triples. Starting with the triples (1, 0, 1) and (0, 1, 1), all the Pythagorean triples can be generated by the application of L and the matrices formed by negating a coordinate of (x, y, z). In this talk we extend Lonnemo's result by looking at 4-tuples (w, x, y, z).

**Group Gradings Of Matrix Algebras And Incidence Algebras**
**Lance Miller, University of Connecticut**
Graded rings and algebras are a ubiquitous object in the study of projective algebraic geometry. A slight generalization of this notion is that of a group grading; group gradings of matrix algebras have recently been well-developed. In this talk we will present an accessible introduction to these objects and some highlights of the current research into group gradings of matrix algebras and subalgebras of matrix algebras (specifically incidence algebras or structured matrix algebras).

**A Night at the Operads**
**Rachel Schwell, University of Connecticut**
Mathematical operads are tools that describe an algebraic structure that can be attached to many different sets. We will define operads and algebras over operads, and demonstrate them through accessible examples, namely real-valued functions and trees. We will then introduce a set of polyhedra whose faces are given by the different associations one can insert in an n-letter multiplication, called Stasheff polyhedra or associahedra. We will conclude with a nice theorem that links these polyhedra to based loop spaces. Further applications of operads can be found in algebraic topology, representation theory, algebraic geometry, combinatorics, knot theory, quantum physics, and string theory.

**Uniqueness For The Martingale Problem Associated With Some Partial Differential Operators**
**Huili Tang, University of Connecticut**
The motivation of the martingale problem as well as the relation between martingale problem and Stochastic Differential Equations will be introduced. Some results of uniqueness will be presented.

**Undergraduate Student Papers Presented at the NES/MAA Spring 2005 Meeting**
**Paul Hughes, Isabelle Meira, Framingham State College**
**The foremost works of Sir Isaac Newton**
Abstract: My partner and I will be presenting on the foremost works of Sir Isaac Newton. Of particular interest is his major contribution to the development of Calculus, as well as some of his involved geometric proofs. We also explore major points in Newton's life and career, and the contributions to physics made by this luminary scientist. Newton's laws of motion and universal gravitation, and the impact of each, are of particular interest.

**Ruth Hibbard, Framingham State College**
**The History of 3-Space**
As students of mathematics, we find ourselves studying vectors and 3-space as part of our Calculus III or Multivariable Calculus courses. Who were some of the mathematicians who helped to explore, to develop, and to reveal connections between the mathematics and the 3-dimensional world? In this presentation, I will discuss some of the contributions of Hamilton, Cayley, and Peano as well as some contributions that go as far back as 1000 B.C.

**Pamela Soggu, Merrimack College**
**The Calculation of Rainbows**
Many students take math courses, such as calculus, and do not know how to apply the knowledge gained from their classes in the real world. My presentation will be on calculating the formation of rainbows using calculus. The presentation will concentrate around describing the path of light traveling through a single raindrop to create the illusion of a rainbow using the Law of Refraction, also known as Snell’s Law, and calculating the different colors of the rainbows.

**Russell Yang Gao, Worcester Polytechnic Institute**
**Modeling Survival of U.S. Business Firms**
This project examines various factors affecting the survival of U. S. business firms. Life tables for firm survival were constructed for three different firm-size classifications using data from the Small Business Administration and U.S. Census Bureau. The impact of firm size on survival was analyzed. Lastly the impact of various macroeconomic factors was investigated in order to build a multiple regression model for firm survival rate.

**Christine Franey, Simmons College**
**The Mathematics of Cryptography**
The topic of this presentation is the Mathematics of Cryptography. The history will be highlighted - from the time of the Roman Empire through to some present-day applications. Cryptography evolved most quickly when the need arose, such as during times of war.

**Sarah Lupa, Simmons College**
**Mathematics Education: The Rally for Change and the Aftermath**
In the United States, mathematical pedagogy is not only changing, but it is also of the utmost importance. The mathematics that teachers teach in primary and secondary schools today is drastically different from the mathematics that students learned for the last century. Since the 1970s, the United States has been compared to China and Japan concerning mathematics education and the quality of its graduates. Sadly, U.S graduates are unable to compete globally. This presentation, based on research gathered for an independent study, will explore mathematical pedagogy, lesson plan study, curriculum, and other factors that caused the National Council of Teachers of Mathematics in 1989 to give a report that rallied for change in mathematics curriculum. Moreover, I will answer the question: Sixteen years after the call for change how does mathematics education fare, and where do we go from here?

**Scott R. McCarthy, Worcester State College**
**Primes, Algorithms, and Applications**
In this presentation we define second order primes and third order primes. The goal is to study difference of primes. We give our findings bases on the study of a large number of primes. We developed algorithms based on existing algorithms for determining large primes and hence the difference of primes. We assert a conjecture about primes, difference of primes and twin primes. We will present pseudocodes, algorithms, test cases, logarithms, and graphs indicating the behavior of certain types of primes.

**Anh Le, New England College**
**The Dihedral Group of Order 8**
The dihedral group of order 8 can be used to encode the social structure of the kin system of family relationships among the Warlpiri – an Australian tribe. The kin relationships discussed in this paper includes the tribe's marriage and child birth rules used to determine the inheritance rights and responsibilities for land and religious rituals. Illustrated by a Cayley table, the Warlpiri relationships is an example of a group, satisfying all properties of the dihedral group of order 8.

**Kevin Hamer, University of New Hampshire**
**Wikis**
Wikis, a popular format for websites, offer new means of developing mathematics. The ease of interconnecting pages and typesetting allows for material to be expressed quickly in detail. Relevant connections are easily traced, while the simplicity of editing allows memberships to ensure the accuracy of articles and proofs. Large wikis provide comprehensive references, while involving a class in the development of their own wiki provides the class with notes and a means to identify one another's strengths outside of class.

**Kirsten Hutchinson and Derek Pouliot, University of New Hampshire**
**A Counterexample to Kaplansky's Conjecture**
Kaplansky's conjecture has been a highly anticipated tool in the study of based rings. Many algebraists have spent much time trying to validate the conjecture in order to simplify their study. Thirty-two years have passed and no progress had been made. Noticing that a direct proof of the conjecture would be very difficult, we set out to explore the possibility of a counter example. We were hoping to find an existing based ring that would contradict the conjecture; what we ended up doing was discovering a new based ring, which has dimension fifteen, that can be used to disprove the conjecture for based rings. This based ring is unique in that it can not be created by any transformation on a group.

**New Colleagues Papers Presented at the NES/MAA Spring 2005 Meeting**
Dr. Esha Chatterjee, Bryant University
**On the Boundedness Character of Rational Difference Equations**
We will explore the role of bounded solutions in various difference equation applications. We will then characterize rational difference equations in terms of its boundedness.

Victoria Sapko, Framingham State College
Numerical semigroups and ring theory
Numerical semigroups (subsemigroups of the natural numbers) are very simple to understand yet have a rich theory of their own as well as connections to rings.

**Stephanie Costa, Rhode Island College**
**Ordered Whist Tournaments - Existence Results**
An Ordered Whist Tournament is a relatively new specialization of whist tournament design. It will be shown that Ordered Whist tournaments exist for 4n+1 players.

**Dr. Kathleen Rondinone**, Southern Connecticut State University
**2 Approaches to Teaching College-Level Math: Group Work-focus versus Direct Instruction-focus**
This talk examines two teaching styles (group- and direct instruction-based) for introductory math courses. I conclude that a more balanced approach yields more favorable results.

**Contributed Paper Presentations at the NES/MAA Spring 2005 Meeting**
**Improper Use of Linear Reasoning: Not Just a Careless Mistake.**
**Gertrud Kraut, University of New Hampshire**
Recent studies reveal a deep rooted and almost irresistible tendency among 12 – 16-year old students to improperly apply the linear model to word problems involving lengths, areas, and volumes. In this paper we address four important issues related to the improper use of the concept of linearity: (1) students consider their misunderstanding and incorrect application of the linear model as careless mistakes (2) students have not addressed and corrected these misconceptions by the time they arrive at college, (3) the incorrect use of linear reasoning extends to several topics in algebra, algebraic equations, and functions, and, (4) the incorrect application of linear reasoning causes difficulty in precalculus and calculus courses. Our studies show that these misconceptions are difficult to overcome when students have been permitted to maintain the incorrect understanding and habits until they arrive at college, and these difficulties are often the reason they leave an engineering or physical science major.

**Numerical Analysis of Spectral Properties of Operators Generated by an Aircraft Wing Model**
**Steve Wineberg, University of New Hampshire**

This talk concerns numerical approximation of the eigenvalues of a non-selfadjoint fourth-order matrix differential operator arising from a much-studied model of aircraft wings subject to subsonic air flow.
We discretize the fourth-order matrix differential operator, defined on a domain with nine boundary conditions, using Chebyshev polynomials. Depending on how the boundary conditions are imposed and how the fourth derivatives are handled, this leads to several different, but mathematically equivalent, matrix systems.
Despite their mathematical equivalence, calculating the eigenvalues of these systems gives dramatically different results, even using 17 digits of accuracy for the numerical computations. This discrepancy is explained by the fact that all but one of the systems is extremely ill-conditioned.

The one sufficiently well-conditioned system is generated by a method of imposing the boundary conditions as the kernel of a well-conditioned matrix. This yields a matrix whose distribution of eigenvalues agrees very closely with the qualitative distribution of eigenvalues for the continuous problem, which has been derived by A. V. Balakrishnan and Marianna A. Shubov, using theoretical considerations.