# 5th ANNUAL SPUYTEN DUYVIL REGIONAL UNDERGRADUATE MATHEMATICS CONFERENCE

## APRIL 24, 2010
## ST. FRANCIS COLLEGE

## ABSTRACTS

## Abstract of Invited Address

## Dr. Martin Moskowitz

*The Fundamental group and covering groups of topological groups*

This talk will deal with two separate issues, one topological and the other group theoretic. The topological part concerns the fundamental group of a connected space X. The second, group theoretic part, will deal with the universal covering group of a connected topological group. Then we will have the "grand synthesis" bringing the two together to calculate the fundamental group and universal covering of the rotation group SO(3,R), a compact group. If time permits we will also calculate the fundamental group and universal covering of the Lorenz group SO(1,3), a non-compact group which plays an important role in Special Relativity.

# Abstracts of Talks

**Razia Amzad,** Pace University
Faculty Advisor: Dr. Shamita Dutta Gupta
*Unbreakable Codes*

Abstract: A Public Key Cryptosystem uses encoding keys that are the form of modulus m and the exponent k which can be distributed to the public while the decoding method remains secure. Public Key Cryptosystems are also known as RSA coding, which are used often because the internet runs on open networks. Public Key Cryptosystems are used with open systems mainly because there are higher risks than with older forms of e-commerce that run on closed networks such as electronic data interchange (EDI) or electronic fund transfer (EFT). Open networks create a variety of security challenges such as the integrity of the information being transmitted, the confidentiality of private or personal information, the authenticity of the communicating parties, and the assurance that the communicating parties have the authority to enter into the transactions. Public Key Cryptosystems allow secure internet transactions by providing authentication, confidentiality, digital signatures, data integrity, and non- repudiation, which prevents the receiver of a message from denying that the message had been received . Cryptography plays an essential role in protecting the privacy of electronic information against threats from a variety of potential attackers. The purpose of this presentation is to comprehend the evolution of codes and ciphers; along with understanding how to encode and decode a message using RSA coding. In this PowerPoint presentation "Unbreakable Codes" we will highlight the historical advances of communicating secure messages, by illustrating the process of RSA coding with an example.

**Abraham Asfaw,** Manhattan College
Faculty Advisor: Dr. Marvin Bishop
*Properties of Colliding Hyperspheres*

Abstract: Numerical simulations of colliding hyperspheres in two to five dimensions are performed to test theoretical predictions about the moments of the velocity distribution. Good agreement is found.

**Robert Bararwandika,** College of Mount Saint Vincent
*A suggestion of a new notation in group theory*

In group theory, some notations are ambiguous and very confusing.
For instance, when we perform an operation in U (a multiplication operation), we can write b5 = b.b.b.b.b, and when we perform an operation in Z (additional operation) , we can write that r5 = r+r+r+r+r.
I would like to propose a new notation in Z for when we say that 25 = 2x2x2x2x2 = 32, it does not make sense for us to write that 25 = 2+2+2+2+2 = 10 when we are doing an operation in Z.
I would like to propose a new notation:
let us write that b5+ = b+b+b+b+b and r5+= r+r+r+r+r or x-5 = -x-x-x-x-x.

**Daniel Bravo-Vivallo,** Wesleyan University
Faculty Advisor: Dr. Mark Hovey
*Longest subwords and Tableaux*

Let W be a word of finite length over the collection of integers from 1 to n. A subword is a word, with entries and order coming from W. Now we focus on the following simple question: what is the length of the longest subword of W that is weakly increasing? I.e. a word with entries greater or equal than the one before, when read from left to right.
We will introduce Young tableaux and show how the answer to our question is related to some information of a tableaux associated to a word.

**Olivia Brozek,** Marist College
Faculty Advisor: Dr. Matthew Glomski

*Hemorrhagic Fevers: The Inadequacy of Constant-Coeffcient Differential Models*

Ebola and Marburg hemorrhagic fevers are rare, deadly viral diseases first manifested forty years ago. Traditional SIR (Susceptible-Infectious-Removed) models used to study epidemic dynamics have proven inadequate to fully describe the outbreak patterns of hemorrhagic fevers. Any improvement to the model must address age-dependent infection and fatality rates, as well as low levels of hospitalization in each outbreak. In this talk, we attempt to adjust compartmental SIR models to better describe dynamics of these diseases.

**James Buensuceso,** United States Military Academy
Faculty Advisor: Maj. William Smith

*The Application of Game Theory to Determine the Effects of Troop Allocation and Humanitarian Assistance in Counter Insurgency*

The United States military had been conducting counter insurgency operations throughout its history. United States military doctrine prescribes a multi-prong approach in conducting counter insurgency operations. With the advent of communications technology and the increasing importance of information warfare, commanders need to strike the necessary balance of active military and passive civil relations operations to capture or kill insurgents. The purpose of this study is to determine the effectiveness of troop allocation and humanitarian allocations in locating insurgents. We use the value of a two player non-zero sum game as a measure of effectiveness.
We will develop formulae to determine the active and passive probability of capturing insurgents. The formula for finding the probability of capturing an insurgent through active military operations will include three variables: troop allocation, length of troop allocation and terrorist activity in the area. The formula for finding the probability of capturing an insurgent through passive civil relations operations will include two variables: humanitarian allocation and length of occupation.
We will use these formulae to determine the probabilities of capturing insurgents at n areas of operations. We will use game theory to determine the best strategy for the BLUFOR and the OPFOR. The BLUFOR aims to maximize the value of the game while the OPFOR aims to minimize the value of the game. We will conduct sensitivity analysis on troop allocation and humanitarian assistance allocation to determine the effects of these two variables on the value of the game.

**Filomena Califano,** St. Francis College

*Two-dimensional model of phase segregation in liquid binary mixtures*

The hydrodynamic effects on the late stage kinetics of phase separation in liquid mixtures is studied using the model H. Mass and momentum transport are coupled via a nonequilibrium body force, which is proportional to the Peclet number α, i.e., the ratio between convective and diffusive molar fluxes. Numerical simulations based on this theoretical model show that phase separation in low viscosity, liquid binary mixtures is mostly driven by convection, thereby explaining the experimental findings that the process is fast, with thetypical size of single-phase domains increasing linearly with time. However, as soon as sharp interfaces form, the linear growth regime reaches an end, and the process appears to be driven by diffusion, although the condition of local equilibrium is not reached. During this stage, the typical size of the nucleating drops increases like $t^{n}$. As the Peclet number increases, the transition between convection- and diffusion-driven regimes occurs at larger times, and thereforefor larger sizes of the nucleating drops.

**Yafreisy Carrero,** College of Mount Saint Vincent
Faculty Advisor: Dr. Amir Niknejad
*Architecture expressed in forms of Dihedral Groups and Frieze Groups*

In Abstract Algebra, one can observe the formation of Dihedral Groups displayed in art and nature. A Dihedral Group is an algebraic approach for discovering the property of symmetric polygons in respect to reflection and rotation about an arbitrary axis. This can be seen in the patterns used on various windows, buildings, and other symmetrically designed structures.
In this talk we give the basic notion of groups. Then, we specialize in Dihedral Groups and Frieze Groups. Finally we emphasize the relevance of these groups to Architecture and designs.

**Ryan Commet,** Wayne State University
Faculty Advisor: Dr. Sean Stidd
*"General Abstract Nonsense 101": Categories and Topoi in Context*

Since their initial formulation in the middle of the 20th century, the notions of a category and a topos have largely been considered abstruse and out of reach by many within the mathematical community. However, these notions have become increasingly important in modern mathematics, and bear a profound significance in the foundations thereof.
This presentation will include a cursory survey of the basic notions of categories and topoi, ultimately culminating in expositions of advanced applications in such diverse fields as logical type theory and algebraic geometry. Modern research in pure topos theory and categorical logic will be highlighted to provide further context for these notions.

**Edward D'Azzo-Caisser and James Fanning**, St. Joseph's College
*Comparison of Trigonometric Systems Using a Stacking Cylinders Problem*

Utilizing the Cylinder Stacking problem appearing in the November 20th, 2005 Regional Collegiate Programming Contest for the greater New York region, we compared differences in the computational efficiency of traditional and rational trigonometry. We compared the algorithms used to compute traditional trigonometric functions to those required for rational trigonometry (specifically, the square root algorithm). To ensure a practical improvements in computation, we coded the algorithm in several languages. These results showed a significant difference between the two trigonometries.

**Marko Dedovic,** St. Francis College
Faculty Advisor: Dr. Erez Shochat
*An Upper Bound for the Expected Range of a Random Sample*

If we choose independently a fixed number of n points from the interval [0,1] according to some probability distribution what are the expected values of the largest and the smallest numbers chosen? What is the upper bound of the expected range? In this talk I will answer these questions and show which distribution achieves this upper bound.

**Matthew Dempsey,** St. Francis College
Faculty Advisor: Dr. Fotios Paliogiannis
*Calculating Fresnel's integrals using the Gaussian*

Using the properties of integrals, the Fresnel's integrals may be obtained by the Gaussian integral, and calculated by an advanced calculus method.

**Nicholas Drozd,** Hampshire College
Faculty Advisor: Dr. Christoph Cox
*Two Solutions to Russell's Paradox*

Set theories in the style of Zermelo (ZF, GB, etc.) are usually motivated by a diagnosis of size or ill-ordered construction as the cause of Russell's paradox. Occasionally, the paradox is said to be caused by the mismatching of types, and this motivates set theories in the style of Quine (NF, ML, etc.). The two different styles of set theory are almost always portrayed as being completely distinct and unrelated. I will give a different analysis of Russell's paradox, and this analysis will show that Zermelo's and Quine's systems are actually closely-related in concept, differing only in the solutions they offer for avoiding the paradox.

**Yen Duong,** SUNY Potsdam and Yale University
Faculty Advisor: Dr. Joel Foisy
*Minor-minimal intrinsically linked signed projective graphs (Part II)*

We exhibit 46 graphs that form the complete minor-minimal set of graphs that contain a non-split link for every signed embedding. With one trivial exception, these graphs are derived in simple ways from the 7 graphs in the Petersen Family. Accessible to all, we promise!

**Daniel Elmblad and Tyler Seymour,** United States Military Academy
Faculty Advisors: MAJ Benjamin Thirey and MAJ Christopher Marks
*Predicting the Perfect Matchup: The Use of Collaborative Filtering in Baseball*

Abstract: The relationship between a batter and a pitcher in baseball is an integral part of the game and a team's strategy throughout the season. With different leagues and hundreds of different players, matchups between batters and pitchers that have never faced each other are a common occurrence. But what if a manager had the ability to predict how a batter is likely to perform against a pitcher he has never faced? In this paper, we implement collaborative filtering techniques to predict a batter's performance in these situations. We use a sparse matrix consisting of batters' statistical performance measures against pitchers they face throughout an entire season. We establish baseline predictions using Pearson Correlation and Vector Similarity techniques. We then demonstrate a unique way to forecast batter performance through a combination of the Pearson Correlation matrix and Adaptive Resonance Theory clustering. Based upon these techniques, we were able to predict the performance of a batter against every pitcher in baseball. Using the Root Mean Squared Error as an evaluation metric, we compare the predictions from the three different collaborative filtering methods used and discuss the strengths and weaknesses of each approach.

**Lucas Enloe,** United States Military Academy
Faculty Advisor: Dr. Sheila Miller
*The Process and Consequences of Defining Implication in Symbolic Logic*

Many students with no formal education in logic have some level of ability to tell 'good' arguments from 'bad' ones. Years of real-world experience or natural ability has allowed students to develop various heuristics to judge arguments. However, when presented with complicated, previously unknown types of arguments, those heuristics can potentially lead to confusion. The study of the foundations of mathematics is one subject that can lead to these unknown arguments, specifically proofs involving vacuous truths. In order to better avoid confusion in this subject, a better understanding of logic is required.
We explore the original need for logic, and how a continuing demand for greater precision in evaluating arguments led to the development of symbolic logic. We then look at the process through which logical arguments are represented with symbols, focusing specifically on implication. We explore how implication can have various interpretations, and how certain interpretations of implication can lead to paradoxes that might easily confuse a student. Furthermore, we study some of the more notable attempts to resolve these issues. Finally, we present our own ideas on the interpretation of implication, and offer suggestions to better educate students of both logic and mathematics.

**Ioannis Farmakis,** St. Francis College
*What is Super rigidity?*

The rigidity of a linkage in geometry has an analogous notion of rigidity in Group Theory. We will prove that if H is a discrete subgroup of a connected group G, a homomorphism defined on H can be (almost ) extended to a homomorphism defined on G.

**Bailey Fay,** Manhattan College
Faculty Advisor: Dr. Kathryn Weld
*Depicting the course of infectious diseases with the SIRS model*

How can we use mathematics to model the course of an epidemic? How does modeling help us understand how epidemics behave? The SIRS model is used in biology to illustrate a population's relationships between susceptible, infective and removed classes during an epidemic. In this talk I will explain both the mathematics behind this model and how to understand what these models depict. I will also discuss how the model changes when immunity or birth and death are taken into account. The talk will be accessible to students with a background in calculus. Some familiarity with linear algebra will also be useful.

**Nicole Fjotland,** Manhattan College
Faculty Advisor: Dr. Richard Goldstone
*Dancing With The Stars: Advanced Mathematics for Elementary School*

The stars we are dancing with are circulant graphs for the integers modulo m. We believe they can be used to provide a comprehensive series of investigations in which children try to uncover, on their own, the principles determining when an m-pointed star can be created by a sequence of "jumps" of fixed size.
We believe that the proposed activities, which emphasize process over content, provide a much-needed mathematical experience for students at the elementary level, one which has significant mathematical content and the potential for pursuing ideas and concepts through many grade levels.
Our talk will address the underlying mathematical ideas as well as pedagogical approaches to the material.

**Ross Gingrich,** Southern Connecticut State University
*Hey, Pythagoras! We Have A Problem!*

In the 6th Century BCE, Greek mathematicians, probably Pythagoreans, made a discovery that was very disturbing to them. They realized that not all quantitative comparisons could be expressed as the ratio of two positive integers, or equivalently that not all quantities are commensurable. In modern terminology, we would say that they had discovered an irrational number, the square root of 2. We will discuss the problem of incommensurables and its effect on Greek mathematics and on mathematics for the following two millennia.

**Steven Goliber,** Western Connecticut State Univesity
Faculty Advisor: Dr. Samuel Lightwood
*Algebraic properties of sequences of polynomials*

The fundamental theorem of Galois theory is the abstract connection between polynomials and the automorphisms of its splitting field. We give a concrete yet powerful example of how to apply these theorems and generate polynomials with a predictable Galois group. Using a recursion formula and two initial polynomials in integral coefficients we generate a family of polynomials whose roots are proven to be cosines of rational angles. This provides a simple proof of the fact that the cosine of any rational angle is algebraic and allows us to exploit a loophole via the roots of unity to write an explicit formula for the Galois group of any one of our polynomials. Our future goal is to be able to create polynomials on demand with any desired Galois group.

**Anna Gribovskaya and Adisa Hamataj,** St. Francis College
Faculty Advisor: Dr. Kathleen Nolan
*The Use of the Hardy-Weinberg formula to predict change in a population*

The Hardy-Weinberg formula (p2 + 2pq + q2 = 1) is used in population genetics to assess and/or predict change in proportion of alleles (forms of genes) in a population in the next or subsequent generations. Genetic drift, mutation, migration and various types of selection can all cause change in allele frequencies, but at different magnitudes. Biological examples from the literature of each of the parameters noted above will be demonstrated.

**Anna Haensch,** Wesleyan University
Faculty Advisor: Dr. Wai Kiu Chan
*Sphere Packing and Codes*

What is the best way to fill a box full of oranges? This is the fundamental question of sphere packing. How do we most efficiently fill an n dimensional space with n spheres. This geometric question can be approached from an algebraic angle by considering lattices, which we will then extend to codes. I will present classical results of sphere packing with a brief introduction to some recent results in coding theory.

**Richard Hargrove,** Manhattan College
Faculty Advisor: Dr. Kathryn Weld
*"Proving To Be Graceful"*

In graph theory, for a graph with v vertices and e edges to be considered graceful, first it must be labeled such that its vertices are distinct integers between 0 and e inclusive, while the edges between any two vertices be labeled as exactly 1 to e inclusive. Edges are labeled as the absolute value of the difference between the two vertices it connects. A bipartite graph is one that contains 2 disjoint, non-empty sets A and B such that no two vertices in A are connected and no two vertices in B are connected. I will provide examples, lead into, and prove when and how an arbitrary bipartite graph will be a graceful graph.

**Harvey Hindin,** Emerging Technologies Group, Inc.
*Triangles Within Triangles: From Feynman to Fibonacci and More*

Famous theoretical physicist Richard Feynman spent most of one evening at dinner trying to show that for a triangle in the plane, if each vertex is joined to the point one-third along the opposite side (measured say anti-clockwise) the area of the constructed inner triangle formed by the joining lines is one-seventh the area of the outer triangle. There are numerous proofs that this is the case and much interesting mathematics is involved. We extend the theory to include the new cases wherein the position of the opposite point joined to is the reciprocal of a golden ratio power and the triangle area ratios are then expressed as a function of Fibonacci numbers. We also set the ratio of the triangle areas to the reciprocal of powers of the golden ratio and get surprising new results for the opposite side intersection points that involve (at first hidden) standard trigonometric functions. The same concepts are applied to the extension of the problem to a parallelogram within a parallelogram. Complete references are supplied and the talk's content is accessible to student, professor and researcher alike.

**Jennifer Kile,** Marist College
Faculty Advisor: Dr. Scott Frank
*Application of Separation of Variables to Underwater Acoustic Examples*

Abstract: Separation of variables is used to solve many types of partial differential equations including those involving waves and heat. We will apply this technique to two specific examples from underwater acoustics. First, we will solve the problem regarding two rigid boundaries where acoustic waves reflect from the top to the bottom of a waveguide. This example yields sinusoidal solutions with discrete spacial frequencies and also reveals a minimum or "cut-off" frequency. Our second example involves an absorbing bottom in which there will be a lower cut-off frequency but becomes more similar to the rigid waveguide with increasing frequency.

**Steven Thomas Kinney,** United States Military Academy
Faculty Advisor: Dr. Elisha Peterson
*Exploration of Diffusion and Infection Models: Sensitivity to Topology and Initial Conditions*

This paper investigates the sensitivity of current models that describe diffusion or the spread of infection to changes in topology and/or initial conditions. We construct a computer simulation based on cellular automata that allows for customization of network and infection scenarios. Using the simulation we run several batch runs with varied circumstances to assess the impact of small changes in topology and initial conditions upon diffusion through a network. We also build mathematical models to predict long term infection and spread rates, based upon insights from the computer-based cellular automata simulation. The goal is to highlight weaknesses in current models and present alternative models that are more realistic. Using network science and computer science techniques, we present another option for modelers to use when forming their own spread and diffusion models.

**Rajko Kisdobranski,** St. Francis College
Faculty Advisor: Dr. Fotios Paliogiannis
*A Complex Analysis Proof of the Fundamental Theorem of Algebra*

Assuming that the polynomial has no zeros, we use the Cauchy's integral formula to derive a contradiction. This proof is due to Anton R. Schep. (American Mathematical Monthly, January 2009)

**Bono Lee,** St. Francis College
Faculty Advisor: Dr. Fotios Paliogiannis
*Some minimization problems using Calculus of variations*

We present the basic problem of the Calculus of variations and we apply it to find the minimal curve joining two distinct points on the Euclidean plane. As a second application, we find the minimal surface of revolution.

**Matthew Linkus,** St. Francis College
Faculty Advisor: Dr. Fotios Paliogiannis
*An Advanced Calculus Proof of the Fundamental Theorem of Algebra*

We present an Advanced Calculus proof of the Fundamental Theorem of Algebra based on a proof given by Anton R. Schep in American Mathematical Monthly. (January 2009)

**Joseph Lombardi,** Marist College
Faculty Advisor: Dr. Matthew Glomski
*Uncertainty In Mathematical Epidemiology: Modeling Bacterial Dynamics*

The Susceptible – Infected – Susceptible (SIS) model in mathematical epidemiology has proven to be an important and effective predictive tool in describing the dynamics of bacterial diseases in all but the most rudimentary models, some degree of uncertainty in parameters must be expected as inescapable. In this talk, we will focus specifically on the dynamics of endemic cholera. It will be our attempt to quantify the uncertainty introduced into the SIS model, and analyze the degree to which this uncertainty ultimately propagates throughout the model.

**Kyle MacDonald,** Fox Lane HS
Faculty Advisor: Mr. Jonathan Swart
*The Secrets of Wythoff's Nim*

Game theorist Willem Wythoff created a game called "Wythoff's Nim" in which two players take turns taking away from two piles of an arbitrary amount with the goal of being the player to take away the last of the piles. A graphical representation of this game helps identify a strategy to ensure that a player will be the last to move and therefore win the game. The graphical solution to Wythoff's Nim is shown by the use of "safe spots" or points on the graph in which if moved to successively will result in a player winning. The coordinates of these points can be found by using two sequences generated from a recursive pattern. Additionally, the sequences can be altered to show the coordinates of "safe spots" for any Wythoff's Nim board with the addition of "barriers", or points on the game board in which you cannot pass through nor move to, that lie along the line y=x. The integration of new safe spots resulting from these barriers into the original recursive sequences lets us find an infinite number of new safe spots for a select board.

**Aleksandra Milanova,** St. Francis College
Faculty Advisor: Dr. Ioannis Farmakis
*Galios Groups*

While the quadratic formula was known to the Greeks, the cubic and quartic (degree 4) formulas were not found until the 16th century. The formulas for quadratic, cubic and quartic all arise by applying a sequence of arithmetic operations. The next step is polynomials of degree 5. Several hundred years passed without anyone finding a radical formula for the roots of the general quintic polynomial. There is a good reason for that – there is no such a formula.

**Dusan Milanovic,** St. Francis College
Faculty Advisor: Dr. Ioannis Farmakis
*Dehn's dissection theorem*

In 1900 David Hilbert presented 23 problems in mathematics. His third problem was first to be solved by his student, Max Dehn. Can one take a cube, cut it in finite number of pieces and then assemble tetrahedron of the same volume?

**Raymond Mugno,** Southern Connecticut State University
*The Fisher Exact Test for Tables Bigger than 2 by 2*

Determining if two variables are associated is a common task in many social sciences. If these variables are categorical, a Chi-squared test for independence is most commonly used. As this is a parametric test, there are requirements on the sample size. When these requirements are not met, the Fisher-Exact Test (or Fisher-Irwin Exact Test) is a common non-parametric alternative. Most computer packages will only let you use the Fisher-Exact Test for 2 by 2 tables, because significant computing power may be needed when the rows or columns are bigger than 2. This presentation will explain the Fisher-Exact Test for both 2 by 2 cases and n by m cases when n or m is bigger than 2. We will then explain how the Fisher-Exact Test was used to analyze a data set and the results were published in a Public Health journal article.

**Edward Ohanian,** Marist College
Faculty Advisor: Dr. Matthew Glomski
*Uncertainty in Mathematical Epidemiology: Modeling Viral Dynamics*

Eighteenth century Mathematician Daniel Bernoulli introduced the notion of compartmental models in Mathematical Epidemiology in his work on the dreaded smallpox virus. Some 200 years later, smallpox was declared dead in a spectacular scientific triumph which would lengthen and improve the lives of millions worldwide. Despite advances in all aspects of the science, this success has proven unique in the fight against global viral epidemics. In this talk, we will consider Mathematical models in viral epidemiology. Specifically, we will address and attempt to quantify the effect of Mathematical uncertainty in model parameters which have stymied subsequent viral eradications.

**Fotios Paliogiannis,** St. Francis College
*Brouwer's fixed point theorem in 3-space and generalizations*

A proof of Brouwer's fixed point theorem will be given for the 3 dimensional ball using the Divergence theorem. Some generalizations of the theorem to balls in normed linear spaces and topological vector spaces .

**Robert Perez-Alemany,** United States Military Academy
Faculty Advisor: Dr. V. Frederick Rickey
*Finding the shape of the Earth*

For two millennia, the shape of the earth has been a subject of great debate. Famous people from Aristotle to Isaac Newton have tried to prove through reason and mathematics how to accurately find the shape of the earth. A sphere? A spheroid? Pear shaped? These were questions that many astronomers asked. We will discuss the theories of different astronomers and mathematicians, how they reasoned mathematically, and how their theories affected history, all the way to the final conclusion of this debate.

**Jean Nicolas Pestieau,** Suffolk County Community College
*The Five Platonic Solids: An Existence Proof Through Graphs*

The five platonic solids have been extensively studied since the early days of Pythagoras. In the thirteenth and final book of The Elements, Euclid culminates his opus constructing the tetrahedron, the cube, the octahedron, the dodecahedron, and the icosahedron inside a sphere. Moreover, he shows that no other such regular constructions exist. In this talk we also turn to the question of the existence and uniqueness of the five platonic solids, but from a graph theoretical perspective. This approach has the advantage of being both short and elegant without straying too far from the Euclidian framework. In essence, the problem is reduced to enumerating only five "non-trivial" platonic graphs. A platonic graph is defined as any planar, regular graph that has all of its faces bounded by the same number of edges, where that number is strictly greater than one. Here a "trivial" platonic graph is defined as one whose number of faces is strictly greater than 2. The reason for excluding such "trivial" cases in the graph-theoretical argument will become clear in light of the underlying geometrical constraints of the problem.

**Erez Shochat,** St. Francis College
*Non-Standard Models of the Natural Numbers*

A non-standard model of the natural numbers is a mathematical structure which satisfies the same first order sentences as the natural numbers do (for example: there are infinitely many primes), yet this structure has additional elements, greater that all natural numbers.
After a brief introduction to first-order logic, I will use a theorem known as the Compactness Theorem to prove the existence of such models. Then, I will briefly discuss the order type of countable non-standard models of arithmetic.

**Lynea Snyder,** SUNY Potsdam
Faculty Advisor: Dr. Joel Foisy
*Minor-minimal intrinsically linked signed projective graphs (Part I)*

We exhibit 46 graphs that form the complete minor-minimal set of graphs that contain a non-split link for every signed embedding. With one trivial exception, these graphs are derived in simple ways from the 7 graphs in the Petersen Family. Accessible to all, we promise!

**Richard Starks,** United States Military Academy
Faculty Advisor: Father Gabe Costa
*Solutions of the Generalized Airy's Equation*

A great deal of study has gone into the Airy equation. I will generalize this classic equation by introducing a parameter, a, and seek solutions to this new equation which will clearly depend on the parameter, investigate properties of such solutions and perhaps even determine whether such solutions have real-world applications. The equation is given by y^"-x^a y=0, where a is any real number.

**Ana Nicolle Strat,** Manhattan College
Faculty Advisor: Dr. Richard Goldstone
*Field of Dreams: Hamilton's Doomed Quest*

Hamilton spent 8 years attempting to define a multiplication of vectors in R^3 that would turn R^3 into a field. He eventually turned his attention to R^4, and invented the quaternions. We shall prove that his quest for field status for R^3 was doomed to failure from the outset.

**Yasser Toruno,** The City College of New York
Faculty Advisor: Dr. Sean Cleary
*Tree Rotations and Reductions*

Abstract: Binary trees are widely used for efficient searching of many types of data. Rotations can be used to balance trees for quicker searching. There are no known polynomial-time algorithms for computing rotation distance between binary trees.
We describe operations of reduction on randomly-generated pairs of binary trees and experiments to measure average case behavior.
Joint work with John Passaro.

**Vitaly Zaderman,** St. Francis College
*CONVEX SETS*

The definitions and examples of convex sets and convex hulls. Theorems of Minkowski and Caratheodory of representation of convex sets as a convex hulls of its extremal points in Rn. Theorem of Strashewitch of density of an exposed points at the set of extremal points of convex sets in Rn. Representation of convex sets as an intersection of half planes, which contains it. Separation of pairs of convex sets by hyperplanes in Rn. Ideas for generalization above theorems for infinite dimensional spaces.

# Abstract of Posters

**Cristina Liberta, Catherine Nelson, and Enzamaria Scandariato,** St. Francis College
Faculty Advisor: Dr. Arthur DiClementi
*Tips,Tricks and Secrets for Making Math More Fun*

This poster deals with strategies and techniques to reduce math anxiety as children progress from elementary to advanced topics in mathematics.

**Sebastian McDaniel, Richard Poach, and Daniel Radil,** Southern Connecticut
*"Sweet Spot of a Baseball Bat"*

Question A from the 2010 Mathematical Contest in Modeling asked about the "sweet spot" of a baseball bat. This is the spot on the bat where the most power is transferred to ball when hit. We were able to observe the variables involved in the "sweet spot" of baseball bats. We investigated a technique used to find the "sweet spot" and confirmed its validity in multiple types of bats. We explored the effects of corking a bat and reasons why it is banned in Major League Baseball. Furthermore, we explained reasons why aluminum bats are prohibited from Major League Baseball. Our study showed that the "sweet spot" is dependent on many variables, including the bat's vibrational frequency when hit, the position that the batter swings, and any opposing force acting on the bat. We constructed formulas to generate approximate regions where the "sweet spot" should be in various bats and developed reasoning for its being the most effective area of the bat.

**Grigoriu Rus, Jonathan Yeo, and Cleark Yuan,** United States Military Academy
*"Sweet spot" phenomenon on a baseball bat"*

This report explains the "sweet spot" phenomenon on a baseball bat, examines whether or not corking augments the sweet spot or overall bat performance, and evaluates the materials used in bats. An increase in bat performance results from a change in the moment of inertia, a lighter bat weight, and the advantages derived from human factors. Our model reveals that the loss in mass due to corking is offset by increased bat speeds. As a result, the ball will travel slightly faster and farther when hit by a corked bat.

**Patricia Terepka,** St. Francis College
Faculty Advisor: Dr. Erez Shochat
*The many proofs of the Pythagorean Theorem*

This poster presentation on the Pythagorean Theorem will include variations of proofs of the theorem. The presentation will include a brief history of Pythagoras and the theorem itself, and will consist of about 10 to 12 different proofs ranging from elementary levels to intermediate and some advanced levels of mathematics.