Department of Mathematics February 16, 2007

UNDERGRADUATE MATHEMATICS SEMINAR

It's Math Movie Monday! In the next meeting of the seminar, there will be a screening of the NOVA documentary "The Proof". This will be this coming **Monday February 19,** at 5:00pm in Bailey 201, preceded by refreshments in the Math Commons Room, Bailey 204 at 4:45.

TITLE: The Proof

ABSTRACT: This documentary show produced by Nova uses the search for a proof of Fermat's famous theorem to provide a better understanding of the quest for knowledge. It is this quest that apparently motivates mathematicians to attempt to solve what many feel is the unsolvable. For those of you unfamiliar with Fermat's Last Theorem, it states that for all natural numbers n greater than 2, $x^n + y^n = z^n$ has no roots among natural numbers x, y, and z. Over 300 years ago, Fermat stated that he had a proof of this result, but the margin of the paper was to small to include it. Because this problem had an obvious link with the Pythagorean Theorem (and because Fermat stated that he had a proof) mathematicians felt the argument would be found immediately. But for centuries people struggled to uncover the proof, and it was not until the mid 1990s that Andrew Wiles of Princeton University finally succeeded. For further information on the documentary, see http://www.pbs.org/wgbh/nova/proof/.

The Mathematical Contest in Modeling 2007: An Overview

This past week, from Thursday night to Monday night, Union College fielded a team of three students in the annual Mathematical Contest in Modeling (MCM): Richie Bonventre '08, a math and physics major, Brian Feldman, '07, a mechanical engineer, and Tom Mazur, '07, a math and physics major. In the MCM, undergraduate teams from colleges and universities around the world are given two "real world" problems, select one, and then spend an extended weekend developing a solution and writing a paper justifying their solution. After submitting their paper, a panel of math professors (including our very own Professor Black) judges and rates the solutions.

The problems in this year's contest were:

Problem A: Gerrymandering. The United States Constitution provides that the House of Representatives shall be composed of some number (currently 435) of individuals who are elected from each state in proportion to the state's population relative to that of the country as a whole. While this provides a way of determining how many representatives each state will have, it says nothing about how the district represented by a particular representative shall be determined geographically. This oversight has led to egregious (at least some people think so, usually not the incumbent) district shapes that look "unnatural" by some standards.

Hence the following question: Suppose you were given the opportunity to draw congressional districts for a state. How would you do so as a purely "baseline" exercise to create the "simplest" shapes for all the districts in a state? The rules include only that each district in the state must contain the same population. The definition of "simple" is up to you; but you need to make a convincing argument to voters in the state that your solution is fair. As an application of your method, draw geographically simple congressional districts for the state of New York.

Problem B: Airplane Seating. Airlines are free to seat passengers waiting to board an aircraft in any order whatsoever. It has become customary to seat passengers with special needs first, followed by first-class passengers (who sit at the front of the plane). Then coach and business-class passengers are seated by groups of rows, beginning with the row at the back of the plane and proceeding forward. Apart from consideration of the passengers' wait time, from the airline's point of view, time is money, and boarding time is best minimized. The plane makes money for the airline only when it is in motion, and long boarding times limit the number of trips that a plane can make in a day. The development of larger planes, such as the Airbus A380 (800 passengers), accentuates the problem of minimizing boarding (and deboarding) time.

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Devise and compare procedures for boarding and deboarding planes with varying numbers of passengers: small (85–210), midsize (210–330), and large (450–800). Prepare an executive summary, not to exceed two single-spaced pages, in which you set out your conclusions to an audience of airline executives, gate agents, and flight crews.

Which would you choose? How would you devise your solution?

MCM 2007: **The Aftermath**, by Brian Feldman '07

As a mechanical engineer, I was not sure what to expect going into MCM, but I was hoping it would be fun. I felt as if I were a guest in the world of Math that Tom and Richie both experience. Tom, Richie, & I met for the first time on Thursday night. Tom and I read both problem descriptions as soon as they became available and discussed them together. My initial gut feeling was that the airplane passenger-boarding problem would be better, because it made more sense to me and was something I could understand. The voting district partitioning seemed foreign and undefined. We all spent the next several hours researching the topics. I only researched voting district partitioning so that I could obtain a better understanding of that particular problem. After further discussion, I went to sleep leaning towards this problem.

On Friday, we spent more time discussing the problems, but I had a change of heart. Eventually, we all agreed that the passenger-boarding problem would be easier and more interesting.

On Saturday we began working at 9:00 AM. We got ourselves hot chocolate and donuts and spent the rest of the day writing code in MatLab to move passengers through the airplane. Richie took the lead in writing the overall code, while Tom researched an interesting alternative method involving Lorentzian space, a completely incomprehensible topic in my eyes. I spent a great deal of time writing code that described the various passenger-boarding strategies and creating images of the passenger seating assignments. That night we left at midnight, but not before running the MatLab code simultaneously on 39 computers in the engineering department.

On Sunday, again beginning at 9:00 AM, we collected data obtained from the various passenger boarding strategies being input to the passenger movement and interference code. With this data, I performed a statistical analysis on the data to verify if the various passenger-boarding strategies were faster than a purely random boarding strategy. We proceeded to outline each section of the paper and determine who would write each individual section. We finished around 1 AM, but not before a good 3 hours of writing.

Monday was a hectic day. A large portion of writing had yet to be done, as well as many small things, such as citations, images, references, etc. In the mid afternoon, we were distracted by other students in our vicinity, but we stepped it up and finished about a half an hour before the 8:00 PM deadline. After frantically reading through the paper looking for errors, we printed the final 38 page version and sprinted down to deliver it to the math department. Starving, we rewarded ourselves with the exquisite food of Dutch.

Overall, I enjoyed the time I spent doing the contest. I now know more about loading passengers onto commercial aircraft than most flight attendants. Although Tom has been one of my closest friends for my four years here at Union, I had never had the opportunity to work with him before, as our courses specialized from each other fairly quickly, so it was fun to finally work with him. As an engineer, I have become accustomed to thinking and working in a way altogether different from the way that both Tom and Richie do, who are both Math/Physics majors. I tried to learn the best I could from both of them, as they are both very intelligent and hard-working individuals. Now if I could only convince them to switch majors…

Do these problems interest and excite you? Consider taking some courses in Applied Mathematics!

This spring, Math 138, **Methods of Applied Mathematics I,** is being offered. It has a differential equations (Math 130 or Math 234) prerequisite.

Problem of the Newsletter: February 16, 2007

Unfortunately, no winning solutions were submitted to last week's problem…

Here is this week's problem: In keeping with the theme of the undergraduate seminar, find all integer-sided right triangles whose area is equal to its perimeter. (Hint: First show $x^2+y^2=z^2$ and $xy/2=x+y+z$ imply $(x-4)(y-4)=8$.)

Professor Friedman will accept solutions to this problem until 12:00 noon Thursday, February 22.