Contest Director's Article, 14th Annual Contest

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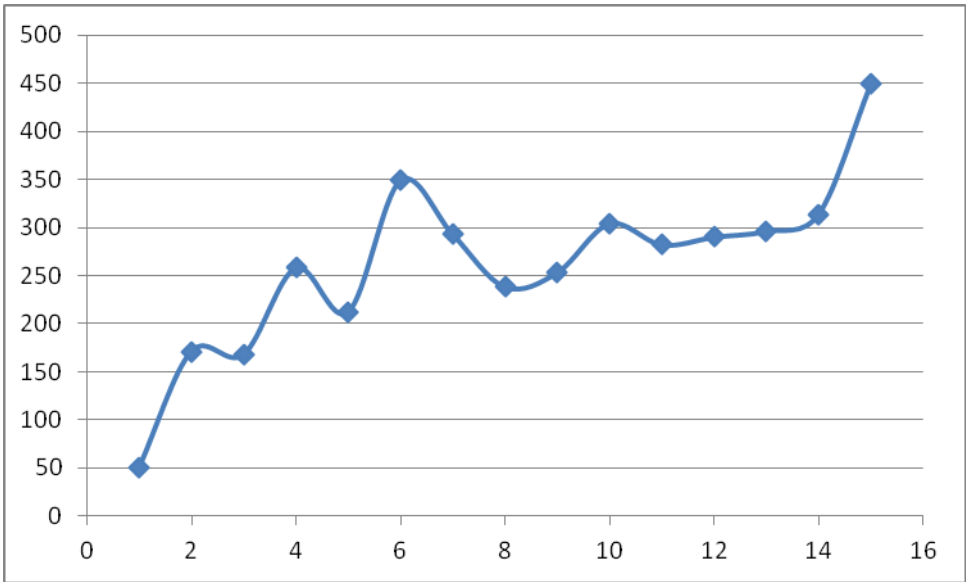
It is hard to believe that the High School Mathematical Contest in Modeling (HiMCM) completed its fourteenth year in excellent fashion. It is and continues to be a fantastic endeavor. The mathematical and modeling ability of students, and faculty advisors, is very evident in the professional submissions and work being done. The contest is still moving ahead slowly, growing with a positive first derivative, and consistent with our positive experiences from previous HiMCM contests. We hope that this contest growth continues. The plot of the growth over time is given below. The current trend is an exponential increase.



This year the contest consisted of 450 teams consisting of 1721 students from 24 states and 4 foreign countries. We had 266 United States teams and 169 foreign teams, representing a 35% and 58% growth in teams. In the United States these teams represented 49 schools across 24 states. These institutions were from twenty-four states and four different countries although China represented about 64% of the foreign entries. Of the 1721 students, almost 35% were female students. The breakdown was 608 female, 1023 male students, and 90 unspecified genders. Since the beginning we have had 12731 total participants and over 36% of been female participants. This year, we again charged a registration fee of $75.

The teams accomplished the vision of our founders by providing *unique* and *creative mathematical* solutions to complex open-ended real-world problems. This year the students had a choice of two problems both of which represent real-world issues.

Problem A: Space Shuttle Problem: No More Space Shuttles

On July 21, 2011, the 135th and final US Space Shuttle landed in Florida after its 13-day mission into orbit complete with a docking at the International Space Station (ISS). NASA will now have to rely on other nations or commercial endeavors to travel into space until a replacement vehicle is developed and constructed. Develop a comprehensive ten-year plan complete with costs, payloads, and flight schedules to maintain the ISS.

Some interesting facts possibly worthy of your consideration:

- The ISS is at full capacity with 6 astronauts, but can surge during shuttle docks to as high as 13.
- The ISS is scheduled to remain in service until at least the year 2020.
- Historically, it has cost between $5000-10,000 per pound to transport to the ISS using the US Shuttles. Shuttle missions have lasted approximately 10-14 days on orbit. Missions onboard the ISS are typically around six months.
- Recently, progress has been made within the private industry to launch unmanned rockets into space.
- Russia is willing to launch US astronauts into space for about $60 million each.

Problem B: Search and Find

Finding lost objects in not always an easy task, even when you have knowledge of a general location. Consider the following scenario: you have lost a small object, such as a class ring, in a small park, see map 1. It is getting dark and you have your pin light flashlight available. If your light shines on the ring, you assume that you see it. You cannot possibly search 100% of the region. Determine how you will search the park in minimum time. An average person walks approximately 4 mph. You have about 2 hours to search. Determine the chance you find the lost object.
Then assume using map 2, a jogger is lost who was going on a 5 mile run. Determine how you search the region to have a good chance of finding the lost jogger (who might be not conscious). Assume it is night and you still only have your pin light.

Two maps were provided to the participants.

Commendation: All students and advisors are congratulated for their varied and creative mathematical efforts. Of the 450 registered teams, 435 submitted solutions. These were broken down as 222 doing problem A and 213 doing Problem B. The thirty-six

continuous hours to work on the problem provided for quality papers; teams are commended for the overall quality of their work.

Many teams had female members. There were 608 female participants on the 435 teams. There were 1721 total participants, so females made up over 35.3% of the total participation, showing that this competition is for both genders. This percent is almost triple the percent of woman in many other math competitions.
Teams again proved to the judges that they had "fun" with their chosen problems, demonstrating research initiative and creativity in their solutions. This year's effort was a success!

Judging: We ran three regional sites in December 2011. The regional sites were:
Naval Postgraduate School in Monterey, CA
Francis Marion University in Florence, SC
Carroll College in Helena, MN

Each site judged papers for problems A and B. The papers judged at each regional site may or may not have been from their respective region. Papers were judged as Regional Outstanding, Meritorious, Honorable Mention, and Successful Participant. All finalist papers from the Regional competition including all Outstanding awards were sent to the National Judging in Boston. For example, eight papers may be discussed at a Regional Final and only four selected as Regional Outstanding but all eight papers are judged for the National Outstanding. Papers receive the higher of the two awards. The national judging chooses the "*best of the best*" as National Outstanding. The National Judges commended the regional judges for their efforts and found the results were very consistent. We feel that this regional structure provides a good structure for the future as the contest grows.

Judging Results:

Problem	National Outstanding	Outstanding	Meritorious	Honorable Mention	Participant	Total
A	4	25	63	78	52	222
%	2%	11%	28%	35%	24%	
B	4	28	59	67	55	213
%	2%	13%	28%	31%	26%	
Total	8	53	122	145	107	435
%	2%	12%	28%	33%	25%	

National Outstanding Teams
Eastside High School, Gainesville, FL
Winchester Thurston High School, Pittsburg, PA
Maggie L. Walker Governor's School, Richmond, VA
Illinois Mathematics and Science Academy, Aurora, IL
The Charter School of Wilmington, Wilmington, DE
Mills Godwin High School, Richmond, VA
Hong Kong International School, Hong Kong (2 Teams)

Regional Outstanding Teams
The Charter School of Wilmington, Wilmington, DE
Chesterfield County Mathematics and Science High School, Midlothian, VA
China Welfare Institution, Shanghai, China
Eastside High School, Gainesville, FL (2 Teams)
Evanston Township High School, Evanston, IL (3 Teams)
Hangzhou Foreign Languages School, Hangzhou, China
Hanover High School, Hanover, NH (2 Teams)
Hanyoung Foreign Languages High School, Seoul, Korea (2 Teams)
Hong Kong International School, Hong Kong (6 Teams)
Illinois Mathematics and Science Academy, Aurora, IL (2 Teams)
Maggie Walker Governor's School, Richmond, VA (4 Teams)
Mississippi School for Mathematics and Sciences, Columbus, MS
Mills Godwin High School, Henrico, VA (3 Teams)
NO.2 High School of East China Normal University, Shanghai, China
North Springs Charter School, Atlanta, GA
Shanghai Foreign Language School, Shanghai, China (10 Teams)
Shanghai High School, Shanghai, China
Shenzhen High School, Shenzhen, China
Stanford University EPGY Online High School, Stanford, CA
The Ellis School, Pittsburgh, PA (2 Teams)
University High School, Irvine, CA (3 Teams)
Winchester Thurston High School, Pittsburgh, PA
Woodbridge High School, Irvine, CA (2 Teams)

NCTM Standards: The director and the judges asked that we add this paragraph. Many of us have read the NCTM standards and clearly realize the mapping of this contest to the NCTM 9-12 mathematics standards. This contest provides a vehicle for using mathematics to build models to represent and to understand real world behavior in a quantitative way. It enables student teams to look for patterns and think logically about mathematics and its role in our lives. Perhaps in a future Consortium article we will dissect a problem (paper) and map the standards into it.

General Judging Comments: The judge's commentaries provide specific comments on the solutions to each problem. As contest director and head judge, I would like to speak generally about solutions from a judge's point of view. Papers need to be coherent, concise, clear, and well-written. Use both spell and grammar checker before submitting your paper. Papers should be written using at least 12 font. Students need to restate the problem in their own words so that the judges can determine the focus of the paper. Papers that explain the development of the model, assumptions with justifications, and its solutions and then support the findings mathematically generally do quite well. Modeling assumptions need to be listed and justified, but only those that come to bear on the solution (that can be part of simplifying the model). Laundry lists of assumptions that are never referred to in the context of the model development are not considered relevant and deter from the paper's quality. The mathematical model needs to be clearly developed,

and all variables that are used need to be well defined. Thinking outside of the "box" is also considered important by judges. This varies from problem to problem but usually includes model extensions or sensitivity analysis of the solution to the team's inputs. Students need to attempt to validate their model even if by numerical example or intuition if applicable. A clear conclusion and answers to specific scenario questions are all key components. The strengths and weakness section is where the team can reflect on their solution and comment on the model's strengths and weaknesses. Attention to detail and proofreading the paper prior to final submission are also important since the judges look for clarity and style. Citations are also very important within the paper as well as either a reference or bibliography page at the end. We encourage citations within the paper in sections that deal directly with data and figures, graphs, or tables. We have noticed an increase in use of Wikipedia. Teams need to realize that although useful, the information might not be accurate. Teams need to acknowledge this.

Facts from the 14th Annual Contest:

- Wide range of schools/teams competed including teams from Finland, Hong Kong, Korea, and China.
- The 435 teams representing US and International institutions representing a 47.4%% increase in participation.
- There were 1721 student participants, 1023 (62.7%) male and 608 (37.3%) female. There were 90 team members whose gender was not specified.
- Schools from only twenty-four states participated in this year's contest.

The Future:

The contest, which attempts to give the under-representative an opportunity to compete and achieve success in mathematics, appears well on its way in meeting this important goal.

We continue to strive to improve the contest, and we want the contest to grow. Any school/team can enter, as there are no restrictions on the number of schools or the numbers of teams from a school. A regional judging structure is established based on the number of teams.

These are exciting times for our high school students. Mathematics continues to be more than learning skills and operations. Mathematics is a language that involves our daily lives. Applying the mathematical principles that one learns is a key to future success. The abilities to recognize problems, formulate a mathematical model, use technology, and communicate and reflect on one's work are keys to success. Students gain confidence by tackling ill-defined problems and working together to generate a solution. Applying mathematics is a team sport!

Advisors need only be motivators and facilitators. They should encourage students to be creative and imaginative. It is not the technique used but the process that discovers how assumptions drive the techniques that is fundamental. Let students practice to be problem

solvers. Let me encourage all high school mathematics' faculty to get involved, encourage your students, make mathematics relevant, and open the doors to success.

Mathematical modeling is an art and a science. Teach your students through modeling to think critically, communicate effectively, and be confident, competent problem solvers for this new century.

International flavor of the contest:
Next year's award format will differ as the contest continues to grow internationally.
Current Designations proposed change to New Designation
Successful Participant still will be Successful Participant.
Honorable Mention still will be Honorable Mention.
Meritorious still will be Meritorious.
Regional Outstanding Winner will be designated a Finalist.
National Outstanding Winner will be designated as Outstanding Winner.

Contest Dates: Mark your calendars early: the next HiMCM will be held in November 2012. Registrations are due in October 2012. Teams will have a consecutive 36-hour block within the contest window to complete the problem. Teams can register via the Internet at www.comap.com.

Math Models.ORG

It is highly recommended that participants in this contest as well as prospective participants take a look at the new modeling web site, www.mathmodels.org, which has a wealth of information and resources.