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MetroMath

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Newsletter

Metropolitan New York Section of
The Mathematical Association of America

March 2016

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Bronx	**Brooklyn**	**Columbia**	**Dutchess**
Greene	**Manhattan**	**Nassau**	**Orange**
Putnam	**Queens**	**Richmond**	**Rockland**
Suffolk	**Sullivan**	**Ulster**	**Westchester**

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ANNUAL MEETING

Sunday, 1 May 2016
8:30 AM – 5:15 PM

Vaughn College of Aeronautics and Technology
East Elmhurst, NY

(*More Information Contained Within*)

0.68268949213708589717046509126407584495582593345320878197478890048598288397440965900176983681127865505654537517323384300945434414234924089321879626546752479682206254609568685354544015799175873205748337

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Vice-Chair for High Schools (2015 – 2018)	**Rosa Quagliata** Wellington C. Mepham High School	(516) 992-1500 rquagliata@bellmore-merrick.k12.ny.us
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Math Fair Chair – Long Island	**Joseph Quartararo** Northport-East Northport Public Schools	(631) 584-2016 cmleague@optonline.net
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Graph Theory Notes Liaisons	**John W. Kennedy,** Queens College **Louis V. Quintas,** Pace University **Daniel Gagliardi,** SUNY Canton	johnwken@gmail.com lquintas@pace.edu gagliardid@canton.edu
Section Archivist	**Agnes M. Kalemaris** Farmingdale State College (SUNY)	(631) 420-2217 kalemaam@farmingdale.edu

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Section Web Page – sections.maa.org/metrony

National Web Page – www.maa.org (both sites are linked to each other)

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0.693147180559945309417232121458176568075500134360255254120680009493393621969694715605863326996418687542001481020570685733685520235758130557032670751635075961930727570828371435190307038623891673471123 35

Membership Count: 439 as of 17 March 2016

MESSAGE FROM THE SECTION CHAIR

It is a tradition in the Metropolitan New York Section of the MAA that every three years we have a new team of officers. I am delighted to be the organization's new chair for the next three years. I am very excited about the opportunity to collaborate with my talented and energetic team of fellow officers. I hope we can live up to the legacy of the outgoing chair Jerry Ianni and his team.

Our first test is our next meeting. It will take place on Sunday, May 1st, at Vaughn College of Aeronautics and Technology in East Elmhurst. The college is two minutes away from LaGuardia Airport. Details of this meeting (including registration information) are contained in this newsletter. We invited absolutely amazing speakers. Michael Starbird from University of Texas will be talking about *Geometric Gems*. Gilbert Strang from MIT will discuss *Compressing Matrix Images Using Singular Values*. We will also have a panel on teaching with the focus on *Enrichment Strategies in Teaching*, where Michael Starbird will discuss *Inquiry Based Learning: Math and Beyond*, Gilbert Strang will talk about *Mathematics, Technology and Inspiration*, Sheldon Gordon (Farmingdale State College) will inspire us to *Meeting Our Students Halfway*, and Matthew Leingang (NYU) will challenge us with the question whether *Lecturing with Slides* should be considered harmful. In addition, you can fly on *Ride and Play with Air Traffic Control Simulators*. So, mark your calendars with this important date, come, bring your colleagues, and inspire college and high school students to join!

Young faculty, please come and join Section NExT (Metro NExT). This program is active again. It is aimed at supporting young faculty, new and rising Ph.D.'s in mathematics or mathematics education.

Please use our Speakers Bureau. We will be happy to serve local schools and communities by providing interesting speakers on a wide variety of mathematical topics.

Dear Colleagues, it is your Section. Please contact me or Section Officers if you would like to become actively involved, if you seek more information or want to share ideas. Step up to become a section officer. You can start with hosting a meeting. Let us know if your institution would be willing to host a future meeting. Visit the MAA NY Metro website to see what is happening.

I hope to see many of you at the May meeting! Please come, enjoy our speakers, have fun and share your thoughts and ideas.

Elena Goloubeva, Webb Institute

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MESSAGE FROM THE SECTION CHAIR-ELECT

A warm greeting to all the MAA Metro New York Section colleagues!

In a President's Council of Advisors on Science and Technology (2012) report on Science, Technology, Engineering, and Mathematics (STEM) education, it had stated that if the United States wants to retain its preeminence in STEM, the U.S. will need to increase their efforts in raising the proportion of students who receive degrees in STEM. Meeting this need may be challenging because the observed patterns which have emerged over time showed a decline in the proportion of first-year students intending to major in mathematics, statistics, and computer sciences (National Science Board, 2014). Moreover, the proportion of bachelor's degrees in STEM has consistently remained under 20 percent for the last 15 years (National Science Board, 2014). To assist in the efforts to increase more STEM majors, the MAA Metro New York Section is committed to strengthening the community of mathematics educators and researchers so that stimulating discussions, potential collaborations, and high impact practices are exchanged. This year's annual meeting at Vaughn College of Aeronautics and Technology will provide a platform for faculty and students to expand their mathematical knowledge and to learn strategies on how to improve the teaching and learning of mathematics. Our outstanding

panel of speakers will challenge the way you look at mathematical theories and concepts, the way you teach, and the way you motivate your students in mathematics. I look forward to welcoming you to the May 1st meeting.

Janet Liou-Mark, New York City College of Technology (CUNY)

National Science Board. (2014). *Science and Engineering Indicators 2014*. Arlington VA: National Science Foundation (NSB 14-01).

President's Council of Advisors on Science and Technology. (2012). *Report to the president, engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics*. Washington, D.C.: Executive Office of the President, President's Council of Advisors on Science and Technology.

1.732050807568877293527446341505872366942805253810380628055806979451933016908800037081146186757248575675626141415406703029969945094998952478811655512094373648528093231902305582067974820101084674923265

MESSAGE FROM THE SECTION GOVERNOR

Hello Metro NY Section Members,

The following are my reports from the two most recent Board of Governors (BoG) Meetings of the MAA. The first was held at MathFest on 4 August 2015 in Washington, DC; and the second at the JMM on 5 January 2016 in Seattle, WA. A personal emergency prevented me from attending the JMM. Thus, that report is my summary from the official minutes. I include only those items most relevant, or of interest, to MAA members in the Metro NY Section.

BoG at MathFest 2015

In celebration of the MAA's one-hundredth anniversary, an extra day (making it four days rather than the usual three) was added to accommodate additional celebratory activities.

The US team placed first at the 2015 International Mathematical Olympiad. The last time the US team won first place was in 1994.

The proposed 2016 budget shows a deficit of $416,761. However, this figure does not reflect the $250,000 donation from the Simons Foundation nor the accumulated Project NExT funds that will help offset the cost of the Project NExT program in 2016. After adjusting for these positive items, the anticipated deficit for 2016 is $47,771. Membership and publications continue to be areas of concern. Over the last dozen years, revenue from membership and journals has dropped by about $500,000. It is hoped that the new departmental membership will help, as it gives member prices for textbooks as well as unlimited student memberships. Other ideas for increasing revenue were discussed.

The continuing discussion of possibly restructuring our system of governance, as well as outlining the MAA's priorities, continued at this meeting. After much discussion, it was decided that during the fall more details will be developed as new proposals are received, and by January the Board will vote.

The Member Library is now available through the member profile page.

A few new programs were highlighted that we should promote: PIC Math (Preparation for Industrial Careers in Mathematical Sciences) is designed to help faculty to include industrial research problems in their classes; the Graduate Student Project helps graduate students in teaching and is looking for mentors and mentees; the Common Vision is a project that looks at curricular guidelines put out by five associations (AMATYC, AMS, ASA, MAA, and SIAM).

This was the greatest attended MathFest ever, with total attendance reaching 2501 (which is an anagram of 2015 - coincidence? Hmmm...)!

(continued)

BoG at JMM 2016

President Francis Su called the meeting to order and read the first page of the January 2016 *Monthly* which gives an account of the founding meeting of the MAA on December 30, 1915 at Ohio State University. This summer's MathFest is in Columbus, OH, home of Ohio State. Su also announced that the MAA received a $10,000 donation following MathFest 2015.

The MAA is working on an NSF grant proposal in conjunction with faculty in the American Statistical Association and the American Mathematical Association of Two-Year Colleges.

As discussed at the BoG at MathFest 2015, new governance structures were refined in the fall and narrowed down to two models labeled A and B. Thus, after two years of work, a new governance model (B) was approved with a couple of amendments. The new structure will consist of a 9-member Board of Directors and a 48-51 member Assembly:

Board of Directors
President (serving 4 years, one as president-elect, two as president, and one as past-president)
President-elect or immediate Past-president
Vice President - 2-year term, national election
Chair of the Assembly - 2-year term, elected by the Assembly from its members
Secretary - 4-year term, at most two terms
Associate Secretary - 4-year term, at most two terms
Treasurer - 4-year term, at most two terms
Chair of the Committee on Sections - 3-year term, at most two terms, elected by the Assembly
Director at Large - elected by the Assembly from its members for a 2-year term

Assembly
29 Section Representatives with 3-year terms
7 Council Chairs selected by the Board of Directors for 4-year terms with at most one term
All member of the Board of Directors
3-6 Members-at-Large

I hope to see many of you at both the Metro NY Section Meeting on May 1st at Vaughn College of Aeronautics and Technology, and at MathFest in August in Columbus, OH.

Abe Mantell, Nassau Community College (SUNY)

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TREASURER'S REPORT

(As of 2/17/16)

Business Checking	$ 8,903.75
Business Money Market	$15,073.82
6-Month Business CD	$ 425.00
Total	$24,402.57

All accounts are with J.P. Morgan Chase Bank. Further details will be provided at the annual meeting.

Armen Baderian, Nassau Community College (SUNY)

25 and 50 Year Members

The following members will be recognized during the Awards Ceremony at our May meeting. The 25 year members are offered free registration, the 50 year members free registration *and* lunch (who said there's no such thing as a *free lunch*?!!).

25 Years: Joseph Kirtland (Marist College), Carlos Marques (Farmingdale State College - SUNY).

50 Years: Martin Feuerman, Samuel Greenspan, Keith Harrow, Philip Lehpamer, John Ogle, Ronald Rothenberg (Queens College - CUNY), Thomas Schwarz, William Vojir.

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2016 ANNUAL MEETING PROGRAM
Sunday, May 1
Vaughn College of Aeronautics and Technology
East Elmhurst, NY 11369

8:30 – 9:15 AM	Registration and Refreshments Book Exhibits Open (8:30 AM – 3:30 PM)
9:15 – 9:35 AM	Welcoming Remarks and Introductions
9:35 – 10:35 AM	Invited Speaker: Michael Starbird, University of Texas *Geometric Gems**
10:35 – 10:45 AM	Break
10:45 – 12:20 PM	Panel on Teaching Gilbert Strang - Mathematics, Technology and Inspiration Michael Starbird - Inquiry Based Learning: Math and Beyond Sheldon Gordon - Meeting Our Students Halfway Matthew Leingang - Lecturing with Slides: Considered Harmful?
12:20 – 1:30 PM	Lunch and Vaughn Robotics Team Presentation Section NExT Discussion on Teaching Take a Flight Simulator for a Ride/Play with Air Traffic Control Simulators
1:30 – 1:55 PM	Awards Ceremony and Business Meeting
2:00 – 3:00 PM	Invited Speaker: Gilbert Strang, Massachusetts Institute of Technology *Compressing Matrix Images Using Singular Values**
3:00 – 5:15 PM	Commercial Presentations
3:15 – 5:15 PM	Contributed Paper and Poster Sessions
3:15 – 5:15 PM	Take a Flight Simulator for a Ride/Play with Air Traffic Control Simulators

* See pages 8-10 for Abstracts and brief Speaker Biographies

Presentation Abstracts and Speaker Biographies

Invited speaker: Michael Starbird, University of Texas

Title: *Geometric Gems*

Abstract: Plain plane (and solid) geometry contains some of the most beautiful proofs ever—-some dating from ancient times and some created by living mathematicians. This talk will include some of my favorites from an incredibly clever way to see that a plane intersects a cone in an ellipse to a method for computing areas under challenging curves developed by a living mathematician, Momikan Mnatsakanian; and many more. Geometry provides many treats!

Biography: Michael Starbird is a University Distinguished Teaching Professor of Mathematics at The University of Texas at Austin. He has been at UT his whole career except for leaves, including to the Institute for Advanced Study in Princeton, New Jersey and the Jet Propulsion Laboratory in Pasadena, California. He has received more than fifteen teaching awards including the Mathematical Association of America's 2007 national teaching award, the Minnie Stevens Piper Professor statewide award, the UT Regents' Outstanding Teaching Award, and most of the UT-wide teaching awards. He has given hundreds of lectures and dozens of workshops on effective teaching and effective thinking. He has produced DVD courses for The Teaching Company in the Great Courses Series on calculus, statistics, probability, geometry, and the joy of thinking. He co-authored, with Edward Burger, the textbook "The Heart of Mathematics: An Invitation to Effective Thinking" and has co-authored two Inquiry Based Learning textbooks. He produced an edX MOOC (Massive Open Online Course) titled "Effective Thinking Through Mathematics." His recent book with co-author Edward Burger is "The 5 Elements of Effective Thinking."

Invited speaker: Gilbert Strang, Massachusetts Institute of Technology

Title: *Compressing Matrix Images Using Singular Values*

Abstract: How would you compress an image of a flag with three parallel stripes? (Spanish or French flag, many others too). Each little square in the image has a color and all those little pixels produce a big matrix. For both flags, the rank of that matrix is one!! So the matrix is a column vector times a row vector.

Spanish has rows $\begin{bmatrix} red \\ yellow \\ red \end{bmatrix}$, and French has columns $\begin{bmatrix} blue & white & red \end{bmatrix}$.

The Singular Value Decomposition separates EVERY matrix A into a sum of columns times rows - in order of importance. If the rank is r, we have r easy matrices (all rank one), and we keep the first ones (as many as we need for a good picture). This idea applies all over mathematics:

- r orthonormal column vectors in U and r orthonormal row vectors in V^T
- those are perfect bases for the column space and row space of A
- A times each column of $\boldsymbol{u}$ equals a number σ times the corresponding row $\boldsymbol{v}^T$

I would like to explain where the columns $\boldsymbol{u}$ and rows $\boldsymbol{v}$ and numbers σ come from. In the end, A equals U times a diagonal matrix times V^T. Fantastic!

Biography: Gilbert Strang was an undergraduate at MIT and a Rhodes Scholar at Balliol College, Oxford. His Ph.D. was from UCLA and since then he has taught at MIT. He is a Professor of Mathematics at MIT, an Honorary Fellow of Balliol College, and a member of the National Academy of Sciences. Professor Strang has published eleven books:

- *Differential Equations and Linear Algebra* (2014)
- *Introduction to Linear Algebra* (1993, 1998, 2003, 2009)
- *Linear Algebra and Its Applications* (1976, 1980, 1988, 2005)
- *An Analysis of the Finite Element Method*, with George Fix (1973, 2008)
- *Introduction to Applied Mathematics* (1986)
- *Calculus* (1991)
- *Wavelets and Filter Banks*, with Truong Nguyen (1996)
- *Linear Algebra, Geodesy, and GPS*, with Kai Borre (1997)
- *Computational Science and Engineering* (2007)
- *Essays in Linear Algebra* (2012)
- *Algorithms for Global Positioning*, with Kai Borre (2012)

He was the President of SIAM during 1999 and 2000, and Chair of the Joint Policy Board for Mathematics. He received the von Neumann Medal of the US Association for Computational Mechanics, and the Henrici Prize for applied analysis. The first Su Buchin Prize from the International Congress of Industrial and Applied Mathematics, and the Haimo Prize from the Mathematical Association of America, were awarded for his contributions to teaching around the world. His home page is math.mit.edu/~gs/ and his video lectures on linear algebra and on computational science and engineering are on ocw.mit.edu.

Panel Speakers

Mathematics, Technology and Beyond

Gilbert Strang, MIT (see biography above)

Gilbert Strang will speak about his experience with video lectures on linear algebra on MIT's OpenCourseWare at ocw.mit.edu (and also some short calculus videos, easy to do with a camera and a friend). These have changed his life. But we don't know exactly how to use them with a regular class -- before the class meets, or maybe after the class for review ...? The idea is always to speak to the audience -- somehow make it interesting, and bring them into it. The important part is not the technology!

Inquiry Based Learning: Math and Beyond

Michael Starbird, University of Texas (see biography above)

Methods of instruction called Inquiry Based Learning emphasize what the students are doing. Students prove theorems on their own and present their results to their peers. Expected outcomes for students include their developing theorem-proving skills and the ability to tell whether a proof is correct or flawed. But beyond those mathematical skills, an Inquiry Based Learning experience frequently helps students to learn self-reliance, independent thinking, creativity, and willingness to make mistakes. Those habits can change lives permanently in every area of their experience.

(continued)

Meeting Our Students Halfway

Sheldon Gordon, Farmingdale State College

Today's students do not come to sit at our feet to glean whatever pearls of wisdom we choose to drop into their laps, as Plato and Aristotle did in the Greek marketplace. They are typically required to take some math course or other for reasons they do not usually understand and probably resent. If we are to grab their interest, motivate them, and help them succeed in our courses, we have to reach out and meet them halfway by providing material that is clearly useful to them in an environment that supports their learning of the mathematics.

Biography: Shelly Gordon is a SUNY Distinguished Teaching Professor of Mathematics at Farmingdale State College. He has been deeply involved in efforts to improve the teaching and learning of mathematics at all levels, particularly college algebra, precalculus, calculus, statistics and probability by changing the focus of the courses and the use of technology. He is the author of over 200 articles, a dozen books, and many hundreds of software programs for mathematics education. He has served on many MAA national committees.

Lecturing with Slides: Considered Harmful?

Matthew Leingang, New York University

Perhaps in counterpoint to others on the panel, I would like to offer a defense of the good lecture, and some advice on how to give one. In untrained hands, PowerPoint can create devastatingly bad slide decks. But as mathematicians, we can leverage LaTeX and beamer to create beautiful, illustrative presentations. I will share some of my favorite beamer practices, including overlay specifications and multiple document modes.

Biography: Matthew Leingang is Clinical Professor of Mathematics and Vice Chair for Undergraduate Studies at the Courant Institute of Mathematical Sciences of New York University. He holds a Ph.D. from Harvard and wrote his thesis in symplectic geometry. Over the past fifteen years, he has held positions at Rutgers University and Harvard prior to his current appointment. He is active in MAA MetroNY and the SIGMAA for Web Education. He is the author of an electronic calculus text to be published by John Wiley and Sons**.**

2016 METRO NY SECTION OF THE MAA MEETING REGISTRATION FORM

(* PLEASE PRINT ***)**

First Name: _____ M.I.: _____ Last Name: _____

Badge Name or Nickname: _____ Affiliation: _____

Address: _____

City: _____ State: _____ Zip+4: _____-_____

Phone Number: Day: (___)_____ E–mail: _____

Special diet? (circle one) Yes / No. Please specify: _____

Any other special needs? (wheelchair access, etc. – please specify) _____

The MAA national office requests the following information. Please check the appropriate responses.

Current MAA Member: ☐ Yes ☐ No First Metro NY Section Meeting? ☐ Yes ☐ No

Faculty members at a college or university, please check the highest mathematics degree offered by your current institution: ☐ Associate ☐ Bachelors ☐ Masters ☐ Doctorate ☐ None

Current employment/student status (check all that apply):

☐ High School Student ☐ Undergraduate Student ☐ Graduate Student

☐ High School Teacher ☐ College/University Professor ☐ Business, Industry, Government Employee

☐ Retired (from?) _____ ☐ Other (please specify) _____

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Registration Fee*:	On/Before 15 April	$20.00	_____
(Postmarked)	After 15 April	$25.00	_____
	Student Registration	$ 5.00	_____
Luncheon*? (circle one) Yes / No		$20.00	_____
		TOTAL:	=======

* Registration and lunch fees waived for:
- students presenting papers or posters
- 50-Year Members

* Registration fee waived for:
- 25-Year Members

Important Note: On-site registration will be available (at the higher registration fee), but all members are encouraged to pre-register by mail as early as possible. Registration forms received on or after April 22 will not be processed in advance of the meeting. Luncheons are not guaranteed for attendees registering on-site. If you are not able to mail in the registration form but plan to attend the meeting, please fill in this pre-registration form so we can at least get an accurate head count.

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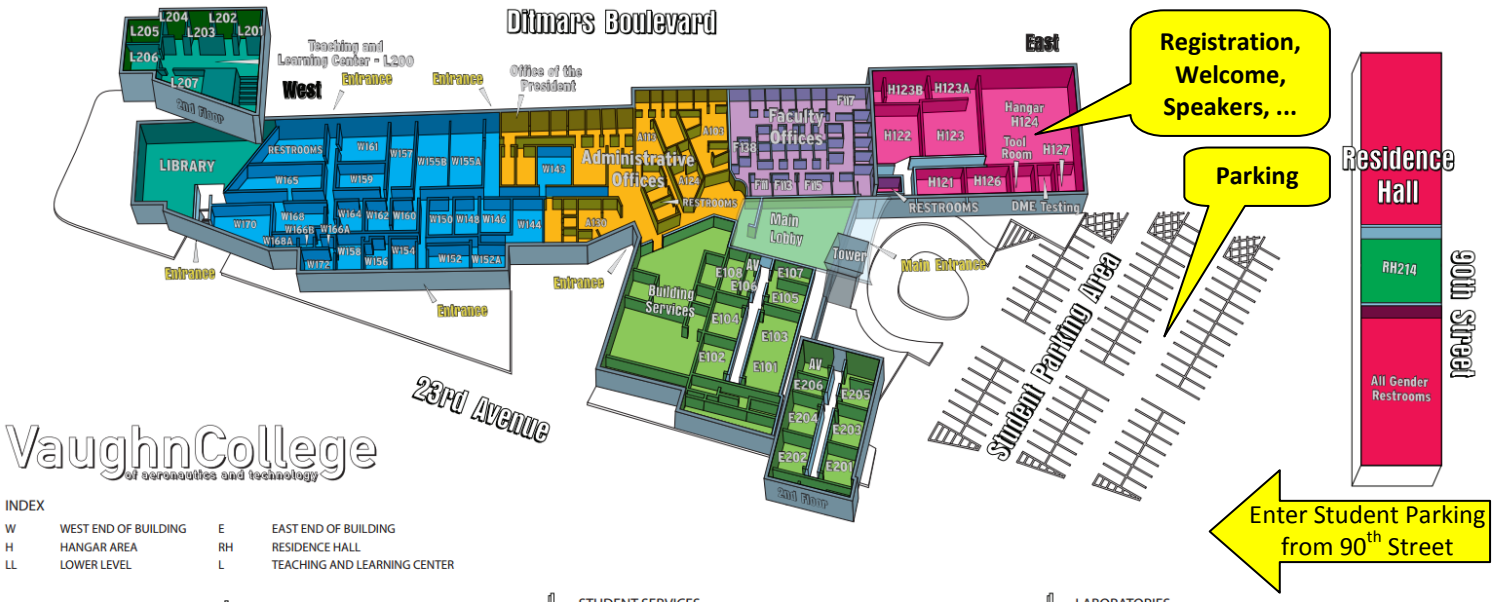
Mail completed form with payment payable to *The Metro NY Section MAA* (do not send cash) to:

Armen Baderian, MetroNY MAA Treasurer
Mathematics, Computer Science, and Information Technology
Nassau Community College
One Education Drive
Garden City, NY 11530-6793

Visit http://sections.maa.org/metrony for the latest news and updates.

Vaughn College of Aeronautics and Technology
8601 23rd Avenue
East Elmhurst, NY 11369



VaughnCollege
of aeronautics and technology

INDEX

W	WEST END OF BUILDING	E	EAST END OF BUILDING
H	HANGAR AREA	RH	RESIDENCE HALL
LL	LOWER LEVEL	L	TEACHING AND LEARNING CENTER

CLASSROOMS

E101	E202	W143
E102	E203	W152
E103	E204	W152A
E104	E205	W155A
E105	E206	W155B
E108	L101	LL11
E201	RH214	

NOTE:
ALL CLASSROOMS LABELED "T" ARE LOCATED IN THE ATI BUILDING AT 43-05 20TH AVENUE, ASTORIA NY 11105.

TEACHING AND LEARNING CENTER

L200	TEACHING AND LEARNING
L201	MATH LAB
L202	TESTING CENTER
L203	STUDENT SUCCESS CENTER
L204	HIGHER EDUCATION OPPORTUNITY PROGRAMS (HEOP)
L205	LANGUAGE LAB
L206	WRITING LAB

ENROLLMENT SERVICES

A103	ADMISSIONS/ENROLLMENT SERVICES
A113	OFFICE OF THE REGISTRAR/ STUDENT ACCOUNTS
A130	FINANCIAL AID

STUDENT SERVICES

A124	CAREER SERVICES
E107	ATHLETICS, FITNESS AND WELLNESS
F111	CONFERENCE ROOM
F113	FLIGHT DISPATCH ROOM
F115	PSI TESTING CENTER
F117	CONFERENCE ROOM
F138	DISTANCE LEARNING
H127	HANGAR MANAGER
W159	ROBOTICS ROOM
W161	UPWARD BOUND/STEP
LL12	FITNESS CENTER
LL13	INFORMATION TECHNOLOGY SERVICES
LL14	BOOKSTORE
LL15	CENTER FOR INSTRUCTIONAL TECHNOLOGY & INNOVATION (CITI)
LL17, LL18, LL19	STUDENT AFFAIRS

THE ENTRANCE TO LOWER LEVEL (LL) IS LOCATED OFF THE NORTHEAST END OF THE MAIN LOBBY.

LABORATORIES

H121	STRUCTURES/MACHINE SHOP	W150	COMPUTER AIDED DESIGN
H122	COMPOSITE	W154	AVIONICS LAB 1
H123	ENGINE	W156	AVIONICS LAB 2
H124	HANGAR	W158	ELECTRONICS
H126	FLUIDS MECHANICS/ POWER ELECTRONICS	W160	MECHATRONICS SUBSYSTEM
H127	SPECIAL PROJECTS	W162	MECHATRONICS SYSTEMS
LL10	AIRCRAFT STRUCTURES	W164	CATIA
W170	FLIGHT SIMULATORS	W165	FLIGHT SIM. II
W144	PHYSICS	W168	AIR TRAFFIC CONTROL
W148	GRAPHICS		

SHUTTLE HOURS:*
7:30 A.M. — 11:15 P.M. MONDAY AND TUESDAY 7:30 A.M. — 9:15 P.M. WEDNESDAY AND THURSDAY 7:30 A.M. — 5:15 P.M. FRIDAY 8 A.M. — 5:15 P.M. SATURDAY
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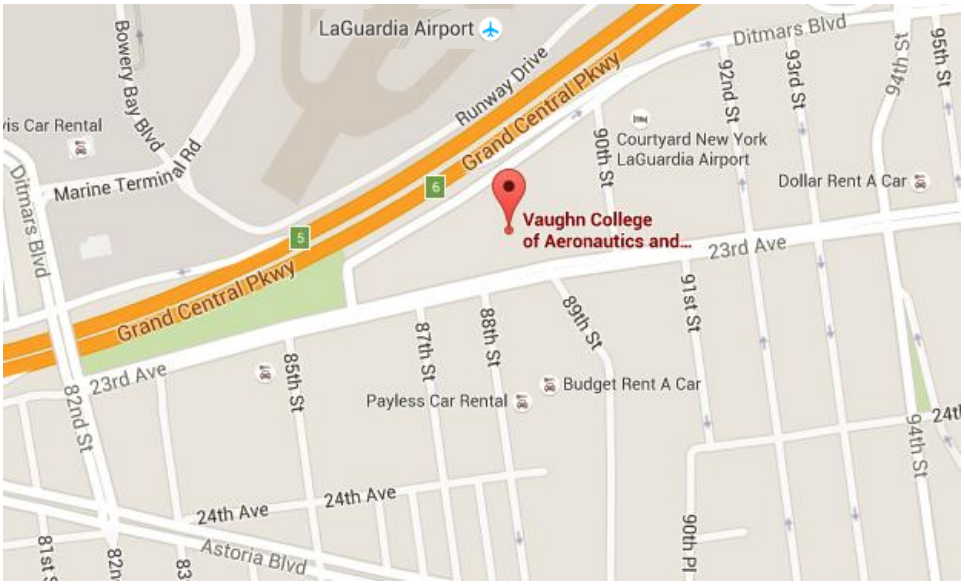

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FEATURED ARTICLES

The 1981 CUPM Mathematical Sciences Major Report Revisited

Alan Tucker, Stony Brook University

This January is the 35th anniversary of the influential 1981 CUPM report titled, Recommendations for a General Mathematical Sciences Major. The context in which this report occurred was dramatic. During the 1970's, the number of mathematics majors declined by 60% with even larger declines in enrollments in core math major courses such as Abstract Algebra and Introduction to Analysis. The end of the race to put a man on the moon and the emergence of a major in computer science were the obvious causes for reduced employment prospects for mathematics majors. To make matters worse, while employers became more selective in their reduced hiring in all STEM disciplines, the curriculum in the mathematics major was becoming more theoretical with a focus on preparing math graduates for graduate study in mathematics. (The rationale was projections of a demand for over 3,000 math PhD's a year by the mid-1970's to teach the ever growing demand to train the engineers—a bust in STEM demand was never dreamt of). Employers found too many of the mathematics grads trained for graduate study to be of little value to them. Collectively, these factors led students to abandon the mathematics major unless they wanted to be teachers.

The CUPM Panel on a General Mathematical Science was established in 1977 to give guidance and encouragement to efforts to broaden the mathematics curriculum. The objectives were to (i) attract students to study the growing diversity of the mathematical sciences; and (ii) better prepare math graduates for employment outside of teaching. This writer was the chair of the Panel. The Panel held a number of sessions at mathematics meetings that revealed that some faculty were strongly opposed to the Panel's draft proposal to allow versions of a math major that did not require upper-division courses in algebra and analysis. These faculty knew that most of their majors did not like these courses, and they hoped that the new CUPM recommendations would give them the justification to continue requiring them for even an applied track in a math major.

Instead of recommending specific theory-oriented courses, the Panel's final recommendations were more general, calling for "a sequence of two upper-division courses leading to the study of some subject(s) in depth", adding, "Rigorous, proof-like arguments are used throughout the mathematical sciences, and so all students should have some proof-oriented coursework." The primary theme organizing the Panel's recommendations was: "The curriculum should have a primary goal of developing attitudes of mind and analytical skills required for efficient use and understanding of mathematics. The development of rigorous mathematical reasoning and abstraction from the particular to the general are two themes that should unify the curriculum." Note the critical shift from the then-current curriculum that started with theory. This writer remembers being told by his professors in the 1960's that once one learns the theory, the applications are easy and can be learned on one's own. That attitude needed to change.

By the time the Recommendations for a General Mathematical Sciences Program finally appeared in 1981, there was already growing experimentation with more flexible math majors, or alternative tracks in the mathematics major. Some departments renamed themselves the Department of Mathematical Sciences. That vision of breadth in the mathematics major has grown in subsequent years and is now taken for granted. Today, it is a rarity to find a math major with a single track. And it is a rarity to find a math major requiring students in all tracks to take proof-oriented algebra and analysis courses.

However, the emergence of different tracks in the mathematics major is something that the Math Sci Panel did not envision. The Panel looked at the major as still an education in mathematics. It recommended broadening in the context of a renewed focus on core mathematical values that could also be developed in courses in probability/statistics, discrete mathematics, differential equations, and

(continued)

operations research. For all subjects, the strategy was to start with specific problems and, as they got more difficult, be forced to develop theory that organized and generalized classes of problems. This theory also typically led to problem-solving tools yielding simpler solution techniques than the ad hoc approaches students would use on their own. The goal was to have classrooms where students learned to look forward to theory to give them ways of thinking and formulas for solving problems, whether in number theory or linear programming. Further, students would see connections between different classes of problems and even more between different subjects, so that they would view mathematics as a more connected body of knowledge and reasoning and would appreciate the usefulness of multiple ways of approaching problems. In short, students would think like mathematicians, though they might be aiming for graduate study outside of mathematics or for immediate employment in industry. The education summarized above would also be of great value to future mathematics teachers.

There is a problem with tracks. A mathematics major track in, say, mathematical biology runs the danger of putting the subject matter, and more generally the connections between mathematics and modern biology, ahead of the unifying mathematical goals listed above. A course in mathematical biology (with the second reading course) is more in the spirit of the mathematical sciences major described in the 1981 CUPM Panel report. Most students interested in the mathematical sciences are not ready to think about specialization until late in their studies. An example of this fact is the small number of statistics majors, about 1000 a year, despite many statistics programs.

The sort of general breadth in the mathematical sciences the CUPM Panel envisioned is exemplified by the major in the Stony Brook Department of Applied Mathematics and Statistics; it has no tracks. This writer developed the major, whose success in the 1970's was a leading reason why he was invited to head the CUPM Math. Sci. Panel. The major is focused on decision-science mathematics, primarily statistics and operations research (physical-science oriented majors have to compete with physical science and engineering majors that are full of interesting applied mathematics of this type). This focus is possible because Stony Brook does not have separate Statistics and Operations Research Departments. Currently, there are only two departments at Stony Brook graduating more majors a year, biology and psychology. Only about 20 freshmen declare an interest in majoring in Applied Math annually, less than $1/10^{th}$ of the number of eventual graduates.

There is an important reason for this mismatch. Most career-oriented students with good math skills are advised in high school to major in computer science or engineering unless they want to be a secondary school mathematics teachers (such preparation is a track in the regular Mathematics math). The success of the Applied Math major comes from attracting many of those students back from computer science and engineering, along with attracting quantitative students in economics and other Arts and Science disciplines to double major in Applied Math. The vehicle for bringing students in is the following three courses: the sophomore Applied Linear Algebra course and junior-level Intro to Prob/Stat and Applied Combinatorics courses, which each enroll around 800 students a year; these numbers are twice the number of students required to take this course for the Applied Math and other majors (note that Stony Brook Engineering majors offer their own prob/stat courses). These courses are taught by the best faculty and advanced TA's. The courses start topics with practical problems that lead to a rigorous analysis of a class of problems and unexpected mathematical structure; this is the approach in all upper-division Applied Math courses. Then this structure is used to simplify the original problem solving. Instructors enrich their presentations with an array of real-world uses of the topics. Theory is almost always presented in a context where it is a helpful tool for solving problems. Formal proofs of more complicated results, such as Polya's enumeration formula, are skipped and rather, after several examples, the statement of a theorem becomes "obvious" (this is how Polya himself presented his theory in Stanford classes).

Some of the components that make this major successful have been found to be applicable elsewhere; this writer has been a consultant to dozens of colleges.

MAA Student Chapters and Departmental Membership

David Seppala-Holtzman, St. Joseph's College

We professional mathematicians understand the benefits of "citizenship" in the mathematical community. Here we keep abreast of mathematical news, receive intellectual stimulation and find like-minded colleagues with whom to interact. For the most part, the entire concept of a mathematical community is foreign to our students. In order to make students aware of the existence of such a community and to help them come to appreciate its value, the MAA established the Student Chapter Program. Unfortunately, this required students to pay for membership out of their own pockets, albeit at highly discounted rates. Students who had not yet come to see membership as having any value at all would be disinclined to join. This inhibited the growth of the program.

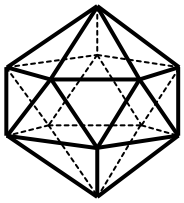
Now, with the restructuring of the entire benefits fee structure, a solution may be at hand. The MAA has created Departmental Membership with the following benefits: One faculty member (the Departmental Membership Administrator) gets full membership privileges:

- Membership in the local MAA Section
- Online subscriptions to:
  - *The American Mathematical Monthly* (10 issues per year)
  - *The College Mathematics Journal* (5 issues per year)
  - *Mathematics Magazine* (5 issues per year)
  - *Math Horizons* (4 issues per year)
  - *MAA FOCUS* (6 issues per year)
- The Membership Administrator will receive a print subscription to *MAA FOCUS*, MAA's newsmagazine (published 6 times per year).
- All faculty members in the department receive $100 off every hosted WeBWorK course.
- Administrator and Student Nominees will also receive *MAA Math Alert*, the MAA's monthly e-newsletter, filled with the latest news and happenings from across our mathematical community.
- Student and Administrator Members receive discounts on MAA books (typically 20% off list price), and discounted registration for MAA MathFest and the Joint Mathematics Meetings (JMM).
- Student and Administrator Members may join any of MAA's *Special Interest Groups* (SIGMAA's).

The Departmental Membership Administrator may nominate ***any number*** of mathematics students (undergraduate and graduate) for MAA membership at no additional cost. The students you nominate become MAA members with these benefits:

- Online access to all MAA journals: The American Mathematical Monthly, Mathematics Magazine, and the College Mathematics Journal
- Online access to Math Horizons
- Online access to MAA FOCUS
- Online access to archives for all MAA journals.
- Access to the online Member Library, featuring a selection of MAA's outstanding books
- Discounts on meeting registration fees at both MAA MathFest and the Joint Mathematics Meetings
- Discounts on purchases of MAA books

The fee to become a Departmental Member is based upon the size of the academic institution in question as well as whether or not it is a Ph.D. granting institution. For more information and how to apply, visit www.maa.org. With this new procedure in place, it is now quite inexpensive and easy to bring large numbers of your students into the mathematical community. Once they become members, they are quite likely to see the benefits of having joined. There are, of course, the tangible benefits, listed above, that include access to journals, archived materials and discounts. But, just as importantly, they will come to feel a part of something larger, a community of like-minded people. Once they come to appreciate that, your students are apt to remain members for the rest of their lives.



The 4-Color Problem: Central Role of the Icosahedron

James A. Tilley, Ph.D.
jimtilley@optonline.net

The 4-color conjecture was first posited in 1852 by Francis Guthrie. Several proofs have been claimed since, the most famous by Alfred Kempe. The flaw in his proof was not found for 11 years. The coloring problem relates to a (simply connected) map in which various regions (countries or states or provinces or counties) must be assigned different colors if they share a border, leading to a so-called "proper coloring." The conjecture is often stated in terms of chromatic numbers. The "chromatic number" of a particular map is the minimum number of colors needed to give it a proper coloring. The 4-color conjecture is that any map having specified properties has chromatic number at most 4.

A valid, but initially controversial, proof was finally given in 1976 by Appel and Haken. They showed that a least one of 1,936 different configurations of countries must occur in any map. Part of their proof involved demonstrating that if one of those configurations is present in the map, then the entire map can be 4-colored. What made the proof controversial at the time is that it relied heavily on the use of a computer. There are few mathematicians today who question whether the Appel-Haken analysis constitutes a valid proof. However, virtually all would prefer to see a non-computer-assisted proof.

Few mathematicians are willing to devote time to finding a traditional proof of the 4-color problem because it appears virtually intractable to known methods. Those who continue to study it do not work directly with maps. Instead, they consider mathematical objects called graphs. A "graph" is nothing more than a collection of points (referred to as "vertices") and lines (referred to as "edges") connecting various pairs of the points. Any map has an associated "dual graph" obtained by replacing every country by a vertex, let's say its capital city, and joining two vertices by an edge if the countries they represent share a border. The dual graph is planar, meaning that it is possible to draw it so that there are no crossings (intersections) of edges.

In the world of planar graphs, the 4-color conjecture is most often stated for triangulations. A "triangulation" is any graph in which every "face" (a region delineated by edges) is a triangle. The statement of the coloring conjecture becomes: *Any planar triangulation has chromatic number at most 4.* What I have found is that it is useful to study instead a "near-triangulation" obtained by taking a triangulation and deleting one of its edges so that the resulting graph has one face of "size 4" (that is, delineated by 4 edges). I call such a graph an "a-graph" because it is "almost" triangulated.

My research, documented in the article http://arxiv.org/abs/1511.06872, strongly suggests that there is a unique a-graph that lacks a coloring property relevant to solving the 4-color problem easily. The particular a-graph arises from the triangulation known as the "icosahedron," one of the five Platonic solids, an object with 12 vertices, 20 faces, and 30 edges that should be familiar to readers of the newsletter as the logo of the MAA. The icosahedron is "5-regular," meaning that there are exactly five edges incident to every vertex. The number of edges emanating from a vertex is known as the "degree" of the vertex. For the icosahedron, every vertex has degree 5 and every face is a triangle. *Deleting any edge* gives rise to the a-graph depicted in figure 1. The 4-face is the infinite region exterior to the graph. In this drawing, all the 3-faces are finite. Each vertex in the left-right opposite boundary pair has degree 5; each vertex in the top-bottom opposite boundary pair has degree 4.

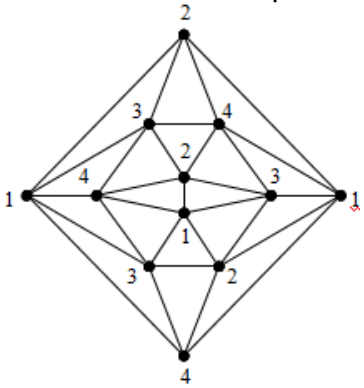


Figure 1. One of the 18 distinct proper 4-colorings of the a-graph obtained by deleting an edge in the icosahedron. There is no 2-color interior path between the top-bottom pair of opposite boundary vertices.

I have found it useful to consider paths between a given pair of opposite boundary vertices. A “path” is a sequence of adjacent vertices in which no vertex is repeated. An “interior path” between a pair of opposite boundary vertices in an a-graph is one that involves no edges along the boundary. A path is “2-colored” if its successive vertices alternate in color. It is conventional to use the numbers 1, 2, 3, and 4 to represent the four different colors for coloring vertices in a planar graph. One pair of those numbers is said to be “complementary” to the other pair. For example, the color-pair (1,3) is complementary to the color-pair (2,4). A result not difficult to prove is that in any 4-coloring of an a-graph, there is either a 2-color interior path between one pair of opposite boundary vertices or a complementary 2-color interior path between the other pair of boundary vertices.

In the *arXiv* article, I show that the 4-color problem for planar triangulations is equivalent to the following coloring problem for a-graphs.

The a-graph coloring problem. Given a 4-coloring of any a-graph in which two opposite boundary vertices are colored the same, find a different 4-coloring in which those two vertices are not colored the same.

Let *G* be an arbitrary 4-colorable a-graph and let *u* and *v* be one pair of opposite boundary vertices and *x* and *y* the other pair. Suppose there is a 2-color interior path *P* between *u* and *v* using colors 1 and 2. Then the color of *x* can be 3 or 4 and the same for *y*, and there cannot be a 2-color interior path *Q* between *x* and *y* using the colors 3 and 4. Without loss of generality, suppose the color of *x* is 3 and consider all the (3,4) paths emanating from *x* (there might be only one, and if *x* is not adjacent to any vertex colored 4, the “path” is taken to consist solely of vertex *x*). Interchanging the colors 3 and 4 on all the vertices involved in those paths maintains a proper coloring of *G* and changes the color of *x* without changing the color of *y*. Thus, the coloring of *G* can be arranged so that the colors of *x* and *y* are either the same or different, and for the pair *x* and *y*, the a-graph coloring problem can be solved.

This technique, known in the literature as an interchange of colors along a “Kempe chain” (Kempe being the first to introduce the idea of utilizing 2-color chains to recolor graphs), fails for the pair of opposite boundary vertices of degree 5 in figure 1. Why? Because it can easily be verified that in none of the 18 distinct 4-colorings of figure 1 (two colorings are not distinct if they become the same under a permutation of colors) is there a 2-color interior path between the pair of degree-4 boundary vertices using colors different from the color(s) of the degree-5 pair of boundary vertices. Does this mean that the a-graph coloring problem cannot be solved for the degree-5 pair of opposite boundary vertices? No, it does not. Among the 18 distinct 4-colorings of the icosahedral a-graph, there are 12 that solve the a-graph coloring problem for the degree-5 pair, but none can be obtained merely by Kempe interchanges starting from a coloring in which both vertices in the degree-5 pair are colored the same.

There are indeed other a-graphs for which the Kempe interchange technique fails to solve the a-graph coloring problem. But I claim that there are no other a-graphs derived from “sufficiently connected” planar triangulations for which the technique fails. The precise term is “internally 6-connected.” In a seminal 1913 paper, G. D. Birkhoff proved that any “minimal counterexample” to the 4-color conjecture must be internally 6-connected (he did not use that term; it was coined later). So those are the only triangulations worth scrutinizing. On the strength of the investigations and arguments presented in the *arXiv* article, I contend that the icosahedron occupies a special, perhaps unique, place in the 4-color problem, a feature likely unknown to the creator of the MAA’s logo.

REFERENCE

A useful overall reference for the material in this article can be found in *Four Colors Suffice: How the map problem was solved* by R. Wilson (Princeton University Press, Princeton, NJ, 2002).

CALL FOR PARTICIPANTS AND INVOLVEMENT

Go Back to School, Join *The Mathematics Speakers Bureau!!!*

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The primary goals of the MSB are to stimulate the interests of local youth in mathematics, to provide opportunities for students to meet active and enthusiastic mathematicians, to motivate students towards careers in the mathematical sciences, and to encourage cooperation between corporate and academic institutions in the mathematical education of area youth. Volunteers provide information about talks they are willing to give and the Bureau, in turn, advertises these talks to the faculty of local area schools. Schools contact speaker volunteers directly to make specific arrangements for a visit. Volunteers determine the number of presentations they give in any given academic year and always maintain the right to decline any invitation to speak. The Bureau web-page (sections.maa.org/metrony/speakers.html) contains an up-to-date listing of available speakers and their proposed talks. Additional information regarding the goals, history and operation of the Bureau can also be found at this site. If you wish to volunteer with the MSB, please contact Bureau Chair Dan King at dking@sarahlawrence.edu.

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MATH IN THE NEWS FROM THE MAA

(much more can be found at: http://www.maa.org/news and http://mathdl.maa.org)

U.S. Wins Romanian Master of Mathematics Competition

A team of U.S. high school students won first place in the 2016 Romanian Master of Mathematics (RMM), one of the most challenging international high school mathematics competitions in the world. Sixteen countries were invited to compete in the RMM, held from February 24 to 29 in Bucharest, Romania. In addition to the team victory, U.S. student Eshaan Nichani achieved the highest individual score in the contest, winning a gold medal.

The U.S. team won first place at the Romanian Master of Mathematics. Pictured here with coaches Razvan Gelca and Po-Shen Loh.

All the American students placed high in the competition: Nichani and Junyao Peng won individual gold medals; Alec Sun, Michael Ma, and Calvin Lee were awarded silver; and Celine Liang received honorable mention.

It shows that we have a great depth of talent in the United States," said Po-shen Loh, deputy coach for the team and professor of mathematics at Carnegie Mellon University. This year's top score was 29 out of 42 possible points (Nichani). "This may have been the most difficult RMM ever," he said after the

February 28 awards ceremony. Each year the test is rewritten, and last year's top score was 39 points. Loh said, "It's worth noting that the top RMM student, Nichani, pulled ahead of the pack by observing a link between one of the hardest problems on this exam and elliptic curves, number theory, and group theory--all of which are topics of mainstream mathematics, and outside the typical high school Olympiad spectrum."

The team score is based on the combined highest three individual scores: the United States placed first with a score of 73, followed by the United Kingdom (72) and Poland (69). The United States also won first place at the 2015 International Mathematical Olympiad (IMO), which U.K. coach Geoff Smith labeled the "hardest ever" IMO.

Loh attributes the victories to the Mathematical Association of America's (MAA) robust training program, the Mathematical Olympiad Summer Program. "We've been running the national Olympiad training program with a focus on the long-term development of our country's talent, and it's great to see students using the Olympiad as a bridge to advanced topics, more than just an end in itself," he said.

The MAA's American Mathematics Competitions (AMC) recently launched a campaign to raise awareness of mathematical competitions, "Wanted: Brilliant Young Minds." The goal of the campaign is to recruit more of America's youth to mathematics. "Of course, we're thrilled to score a national victory in this competition along the way, but our eyes are still focused on the goals which remain far in the future," said Loh.

"Wanted: Brilliant Young Minds" Campaign Kicks Off

Many Americans first heard about the International Mathematical Olympiad last summer when the U.S. team made national headlines for winning first place in what is known as the world championship mathematics competition for high school students. Six months later, more than 250 math enthusiasts filled a movie theater in Seattle, Washington to watch math competitions come alive on the silver screen.

The MAA, with support from Sony Home Entertainment, hosted an exclusive pre-screening of *A Brilliant Young Mind* on January 7, 2016. The event kicked off a new MAA campaign called "Wanted: Brilliant Young Minds," to raise awareness of MAA sponsored math competitions.

The film tells a coming-of-age story of a gifted high school student named Nathan (played by Asa Butterfield, *Ender's Game*) as he goes through the challenging process leading up to competing at the IMO. While he works his way up to the contest Nathan must navigate personal tragedy, an autism diagnosis, and complicated relationships with his family, teammates, and love interests.

"I especially loved the portrayal of humanness in the context of exploring and living mathematics," said James Tanton, Mathematician-at-Large for the MAA, about the film. "I don't think many people truly understand that mathematics is an intensely human experience--both in its doing and thinking, but also in its historical development, and also how it operates in living and experiencing life," he said.

Characters and plot points in the film are adapted from the original BBC documentary (similarly named *Beautiful Young Minds*, directed by Morgan Matthews) which adds authenticity to the story. The mathematics are legitimate too, pointed out Tanton. "Every question portrayed was a deep, playful, and organic question. This is joyous, hard, but intensely satisfying mathematics."

"Wanted: Brilliant Young Minds" seeks to boost middle school and high school math competitions distributed by the MAA American Mathematics Competitions (AMC). More than 350,000 students participate each year in contests designed to engage and inspire young people nationwide.

"Math competitions provide an alternate context for students to work on significantly more challenging math than is available in the standard classroom curriculum." said Po-Shen Loh, who is an associate professor at Carnegie Mellon University and directs the Mathematical Olympiad Summer Program.

(continued)

Participating in these contests may lead students down the road to the USA Mathematical Olympiad, and on to compete with their mathematical peers from around the globe at the IMO.

“For math enthusiasts, competitions provide a host of significantly more challenging and far-reaching mathematical questions which tickle the mind and encourage development of analytical creativity,” said Loh, who is also the lead coach for the USA IMO team.

Students, parents, and teachers can find out more about the MAA’s math competitions on the campaign website: www.maa.org/brilliantyoungminds.

The film *A Brilliant Young Mind* will be available on DVD & Digital on January 26, 2016.

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49th New York City Math Fair 2016
April 3, Sunday, Brooklyn Technical HS, Brooklyn, NY
For more information, visit: nycmathfair.com

NYSMATYC Annual Conference • April 8-10, 2016, Kingston, NY • Visit: www.nysmatyc.org/conf.php

NCTM 2016 Annual Meeting and Exposition • April 13-16, 2016, San Francisco, CA
For more information visit: www.nctm.org/conferences/

Innovative Practices in Developmental Mathematics Conference • April 15, 2016
LaGuardia Community College (CUNY), Long Island City, NY
For more information visit: www.laguardia.edu/mathconference/

Al Kalfus Long Island Math Fair 2016
April 15, Friday, (Final Round) Hofstra University. All rounds begin at 3:00 PM.
For more information, visit: www.ncams.org/math-fair.html

MAA Seaway Section Spring Meeting • April 15-16, 2016, SUNY Geneseo, NY
For more information visit: www.maa.org/Seaway

MAA New Jersey Section Spring Meeting • April 16, 2016
William Paterson University, Wayne, NJ
For more information visit: sections.maa.org/newjersey/Main/index.html

Metropolitan New York Section Meeting • May 1, 2016
Vaughn College of Aeronautics and Technology, East Elmhurst, NY
For more information see this newsletter, or visit: sections.maa.org/metrony/

Graph Theory Day Seventy-One • May 7, 2016, Nassau Community College (SUNY), Garden City, NY
For more information, visit: sections.maa.org/metrony/GTD71Notice.pdf

The 2016 Euler Society Conference • July 25-26, Adelphi University, Garden City, NY
For more information, visit: www.eulersociety.org

MathFest • August 3-6, 2016, Columbus, OH • For more information visit: www.maa.org/meetings/mathfest

NCTM Regional Conference and Exposition • October 31 - November 2, 2016, Philadelphia, PA
For more information visit:
www.nctm.org/Conferences-and-Professional-Development/Regional-Conferences-and-Expositions/

AMATYC 42nd Annual Conference • November 17-20, 2016, Denver, CO
For more information visit: amatyc.site-ym.com/?2016ConfHome

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Mathematical Finance students will take 25 credits in mathematics and 21 credits in finance. They will also receive a strong foundation in programming as well as economics and accounting. For more information, please contact the department chair, Dr. Sylvia Silberger, at sylvia.silberger@hofstra.edu.

Hofstra University, located just 25 miles east of New York City in Hempstead, NY, is the largest private university on Long Island.

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