Math Circles and Olympiads: Historical, Conceptual, and Structural
Chair: Hugo Rossi
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Speakers: Dmitri Fomin, Bob Megginson, Steve Olson, Mark Saul, Alexander Soifer

Bob Megginson: (has power point slides)
Why does MSRI have interest in math circles and Olympiads?
--MSRI administers Bay Area Math Circles and Olympiad (begs the question)
--We need to develop mathematical talent, students who have an aptitude and love for mathematics are the source for professional mathematicians
--The US needs to foster mathematical talent:
in 1966 3.8% of US bachelors degrees were in mathematics
in 1970, 3.5%
in 2001, .9%
--Are we doing better with women
in 1966, 33.3% of math bachelors to women
in 1970, 37.4%
in 2001, 48.0%
but only because the number of men has dropped so drastically
--other mathematically based science fields are still falling in relative numbers
--Fraction of US college freshmen intending to major in mathematics based field that actually want to do math/stats: in 1975 11.4%, in 2001 4.4%
--Some questions to explore in the conference: What is exceptional talent and how do we identify it? What are the models for math circles, can they be improved, and do they address the needs of students from diverse backgrounds?
--The best reason for encouraging math circles and Olympiads is the students who get excited about mathematics.

Mark Saul: (has power point slides)
--Mark is a retired high school teacher and his talk is very much from the classroom.
--There are 2^2=4 subsets of the set {a,b}/ Arrange these in a sequence so that each subset differs from the previous subset by exactly one element. Then ask about {a,b,c}. You can ask how many ways are there to do this. You can then teach about characteristic functions, binary counting, and binary gray codes. The point: this starts with almost nothing and leads to significant issues in computer science. They can learn subsets, counting, geometry, dimension, coordinates, graph theory, Hamiltonian circuits, symmetry, induction, recursion, etc.
--Question: Is this the embroidery on the fabric of mathematics, or is this mathematics?
--NSF and Funding: you can relate mathematical circles to the interests of the NSF by seeing how they are a part of a wider effort to encourage mathematics. The NSF is also interested in research, the accrual of knowledge. The idea is to not just do problem sets, but do problem sets that students learn from, that tie into other things, that make math accessible to different kinds of students. Get connected with a math education researcher to study how the students are learning. Get involved with math teachers so they can integrate problems solving into their classrooms.
-Funding: Check out NSF 04-600, EMSW21, and MCTP or email jconway@nsf.gov,

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Dmitri Fomin:
Models for math circles

1. Metropolis math circle
   e.g. St. Petersburg, where they had a network of 30-50 math circles
   large city, strong traditions of out of school scientific education
   the result was that "no child was left behind"—parents and teachers all knew about the math circles and how to get invovled
2. Metropolis-Schools-Seminars
   e.g. last 20-30 years in Moscow
   mostly run by university students, graduate students, post-docs
   combine regular teaching and extra-curricular math, which has the advantages of being more integrated with what students are learning in school, but also a disadvantage, as many students not ready for advanced math

The above two models' success is very much depending of the circles being networked with the universities and colleges.

3. City-University
4. City-Teacher
   Main problem in above two cases in insufficiency in pool of local educators. They need to be supported by some larger network, or centralized educationc enter.
5. Net-Teacher (correspondence school)
   This could be the most important model right now.

The relevance of this for the United States:
--The systems will only work if they are well-known. It needs to be known to everyone so that any parent even remotely interested for their kids will know where to go.
--The system needs to attract and motivate kids. Extra-curricular math needs to be made more "sexy," exciting for kids.
--It needs to be made simpler, but with a strong main message. Fifteen or sixteen year-olds shouldn't be given brainteasers (e.g., draw three lines that go through these nine points). That is for ten year olds. The main message should be real mathematical proof and rigorous logic.

Alexander Soifer: (has overheads)
--As a boy, he went to music school and was expected to go into music. Mathematics was not his favorite subject; he thought it was boring to have a formula for everything. He then encountered an Olympiad when he was 12 years old. Then he saw something else in mathematics, for those problems you didn't need to know much, but they were fun to solve. As an 8th grader he got involved in a math circle. Over the summer, he got some problems to work on, and it took him a month to solve a geometry problem and his teacher was very happy that he stuck with it for a month.
--in 1984, he started Colorado Mathematical Olympiad for middle and high school students. It is very much in the style of Russian Olympiads, except the problems are the same for all students—5 problems, 4 hours. It is not bad that all grades have the same

problems, because it requires that no senior mathematics topics are involved in the problems. In 2000, the first prize went to an 8th grader, who was also involved in art, came from a poor family without a computer, and a regular school.
--Goal: show mathematics studies beauty. See overhead pictures of the statues—mathematics uses different means.
--Overhead: problems of 2004 Colorado Mathematical Olympiad. Problems about national security and coastline, related to national news (overhead of Kerry vowing to protect coastline, overhead of Bush as cowboy).
--Publications: Main goal of his publications is "affirmative action." He fights discrimination against the young. He thinks young students should get access to real mathematics. Mathematics cannot be taught. Teachers can just provide an environment and guidance for students to learn mathematics by doing it.
--He publishes journal "Geombinatorics" dedicated to open problems in combinatorics and discrete geometry. They publish problem posing essays with information about history of problem, and why problems are interesting.
--He published books, where goal is to show reader life piece of mathematics and how problems are interrelated. They include lots of open problems.
Books:
How does one cut a triangle?
(took him 20 years to write)
Geometric etudes in combinatorial Mathematics.
Colorado Mathematical Olympiad: the first ten years and further explorations. (presents history of creating an Olympiad where one didn't exist. The further explorations part shows how the Olympiad problems lead to further mathematics and open research problems.)
He is writing four more books in progress: *Mathematics of coloring and the colorful life of its creators* (book on Ramsey theory, and about the mathematicians who did Ramsey theory), *Open problems of PGOM, Paul Erdos;* A book about the next 10 years of the Colorado Math Olympiad, and then a book about art in west equatorial Africa.

Steve Olson:
--Interested in broadening conversation to talk about math education in general
--Two good reason to talk about math education: broader context will have effects on math circles and Olympiads, and math circles and Olympiads can have effect on broader context of mathematics education
--His experience: working with math clubs while his two students were in elementary, middle, and high school. In Bethesda, MD, no university nearby but good schools, but in neither elementary or middle schools was there any math club or math team. Even though 1400 kids in middle school, it is tough to get 20 kids to come to math activity. There is a factor of attitude in middle schools: no one in the math club wanted to pose for yearbook photos of math club. They were worried about other students' opinions and ridicule. The movie *Mean Girls* shows these attitudes. In high school, there is a strong math program run by Susan Wildstrom, but when she retires, it is unclear if anyone will continue it.
--Steve thinks math club activities need to be integrated more into standard curriculum. He sells math club to students by telling them that the math they do there is nothing like what they do in math class—why is that? The NCTM standards really do emphasize

problem solving skills compatible with math clubs and teams, but the implantation of the standards have lagged.
--The people here at this workshop are a great resource for mathematics teachers.
--We need popularizing of mathematics. ESPN has started broadcasting MathCounts.
--We need math clubs at every school. Steve asked MathCounts director what it would take to get MathCounts in every school, but that is ridiculous. Maybe we can start small though. All DC middle schools are doing mathcounts.
--We need to make our media available through lots of different means: internet, magazines, etc.