

U.S. Hosts International Mathematical Olympiad

For the first time in twenty years the United States is serving as host for the International Mathematical Olympiad (IMO), the premier international mathematics competition for young people. In July 2001 about 500 high-school-age students from 83 countries will gather in Washington, DC, for the two-week event, which includes a full schedule of entertainment and cultural activities for the students. The IMO competition itself, consisting of six challenging questions requiring essay-format answers with proofs, will take place over two days, July 8 and 9, at George Mason University.

A Major International Event

First held in Romania in 1959, the IMO was originally a regional competition for countries in Eastern Europe. The United States first took part in 1974 and served as host for the competition in 1981, when the IMO was also held in Washington, DC. For many countries the IMO is the capstone of a series of national mathematics contests. In the U.S. these contests are known as the American Mathematics Competitions (AMC). About 400,000 students participate in the first round of the AMC. Subsequent rounds, including the U.S.A. Mathematical Olympiad (USAMO), yield a group of 24 to 30 students who participate in the four-week Mathematical Olympiad Summer Program, which prepares students for the IMO. Over the course of the summer program, 6 students are chosen for the IMO team. This year the summer program will be held at Georgetown University and will run from June 5 until the start of the IMO on July 3. Titu Andreescu, director of the AMC, will run the summer program and serve as team leader.

Some countries have less extensive preparation of their IMO teams; others have more. China, for example, trains its IMO team year-round. There is a long tradition of mathematics contests in certain countries, such as Romania and Hungary, and their teams tend to do very well in the IMO. About half of the 83 participating countries are in Europe or the former Soviet Union. Participation is also strong in Asia and in South America, but not in Africa and the Middle East, which together have just six teams participating: Iran, Israel, Kuwait, Morocco, South Africa, and Tunisia. Egypt and Zimbabwe are interested in future participation and may send

observers to IMO 2001. In many countries the performance of the IMO teams is closely watched. John Kenelly of Clemson University, who serves as president of IMO 2001, noted that "it's on the front page of the newspapers who is number one."

This year's IMO is under the supervision of a nonprofit corporation called IMO 2001 USA, Inc., formed by twenty-one professional organizations (including the AMS). The host country for the IMO must pay the local expenses of the student contestants, the team leaders, and the deputy team leaders—a total of more than 650 individuals for IMO 2001. The budget for this year's Olympiad comes to around \$3 million. Walter Mientka of the University of Nebraska, director of IMO 2001, noted that in most countries the minister of education covers the tab and sometimes a science funding agency kicks in a portion. For IMO 2001, around half the funding was provided by the U.S. government, and the rest had to be raised through private sources. "We're the richest country in the world, so you'd think it would be easy to raise the \$3 million," Mientka said. But it wasn't. In fact, planning for IMO 2001 reached a crisis last year when fundraising efforts fell short. Kenelly, who has had experience in fundraising, was brought in to help. On a plane trip he happened to be seated next to the wife of Trent Lott, majority leader of the Senate. This chance encounter led to a meeting with Senator Lott, who provided much needed help at a crucial time. Funding for IMO 2001 is now secure, with major corporate sponsorship from Texas Instruments, Wolfram Research, and the Akamai Foundation. The Clay Mathematics Institute is hosting the closing ceremonies and banquet.

A Logistical Nightmare

The IMO is something of a logistical nightmare. One source of complications is the international nature of the event. Some of the teams scheduled to participate in IMO 2001 come from countries, such as Cuba, with which the U.S. has no diplomatic relations, so obtaining visas for the team members and leaders is not an easy task. "It would be very embarrassing if there were countries that deserved to be here and some glitch [concerning visas] turned them back," Mientka noted. IMO 2001 has engaged a visa attorney in Washington, DC, to

handle such matters. To get around language barriers, as well as to ensure the safety and well-being of the teen-age contestants, the IMO has assembled a group of 83 language guides, one for each IMO team. Each guide is fluent in the language of the team to which he or she is assigned. The guides will be housed together with the students in dormitories on the campus of George Mason University.

Another reason the IMO is so complex is that the preparation, proctoring, and grading of the examination all take place during the two-week event. The examination is prepared by the IMO jury, which consists of the team leaders from all 83 participating countries. The process began last November, when each team leader was invited to propose up to six problems (the host country is not allowed to propose problems in order to avoid a "home-team advantage"). This initial list contains on the order of one hundred problems. By the time the jury arrives in Washington on June 30, the Problem Selection Committee, chaired by Cecil Rousseau of the University of Memphis, will have produced a "short list" of thirty problems.

Over the next five days in sessions moderated by Ronald Graham of the University of California, San Diego, the jury will narrow the list to six problems to be included on the examination. There will also be break-out sessions organized by language to ensure that all the team leaders understand the problems precisely. With 83 individuals using parliamentary procedure to prepare a six-problem examination, there is a certain amount of chaos. "It's a difficult and awkward process," acknowledged Daniel Ullman of George Washington University, who serves as the Washington, DC, coordinator for the IMO. "But the goal is not just to write a good exam but to make every country feel it is included in the process." The problems must be new and original and must not have been solved by the students, and the team leaders are supposed to speak up when they know their students have seen a problem. The prestige accorded to the winning team, as well as more tangible rewards like college scholarships, can create overwhelming pressure on the leaders to give their team an advantage. At a past IMO a team was disqualified after it was discovered that before the examination the team knew the solution to one of the problems. Balancing the temptation to cheat is the pride the team leaders take in formulating new, original problems. "It would be embarrassing [for a team leader] to admit to copying a problem from somewhere else," Ullman pointed out.

Once the six examination problems are assembled, together with their official solutions, everything is translated into the six official languages of the IMO: Chinese, English, French, German, Russian, and Spanish. Leaders of teams that do not

speak one of these languages then translate the problems into their own languages; altogether, the problems appear in about forty different languages. All of the translations are posted for inspection by jury members. During the problem selection phase and throughout the examination itself, the team leaders are carefully sequestered from the contestants. While the students are housed at George Mason University, the team leaders stay in a Washington, DC, hotel whose location is not disclosed to the students. During the IMO opening ceremonies, which will take place in a performance hall at George Mason on the Fourth of July, the team leaders must remain on a balcony separate from the students. In years past it was possible to isolate the two groups, but today, with the availability of e-mail and cell phones, it's harder to prevent communication between the teams and their leaders.

Mathematics in a Basketball Arena

The examination itself will take place in two $4\frac{1}{2}$ -hour sessions on July 8 and 9 in the Patriot Center, the basketball arena of George Mason University. The entire floor of the arena, as well as the entrance forums, will be taken up with tables where the students will sit and forty volunteer "invigilators" will administer the examination. Each student will be given an envelope containing the problems in up to two languages of the student's choice. During the first half hour students can ask questions about the problems. The invigilators fax the questions to the team leaders, who remain at the hotel and who can fax back replies. Sometimes mistranslations surface during the examination, and corrected translations must be distributed to all students who had requested the problems in that language.

The papers are graded in a two-step process that stretches over two days. First the team leaders and deputy team leaders grade the papers of their own teams. They then defend their scoring before two IMO "coordinators", mathematicians who volunteered for the task and have undergone a two-day orientation on the grading rubric for the examination. There are a total of forty-eight coordinators, eight for each problem: four pairs work in parallel to coordinate the grading of one problem. "Some leaders can be very aggressive" during the coordination, Mientka remarked. "And the students are so bright that their solutions might not be the same as the official solution." Therefore, the coordinators have to be flexible and savvy enough to spot legitimate alternative solutions, as well as firm enough to rebuff efforts to inflate students' grades. A dispute that cannot be resolved in the twenty minutes allotted for each coordination session will be turned over to the chief coordinator, Cecil Rousseau of the University of Memphis, and his assistant, Kiran

Kedlaya of the University of California, Berkeley. The final decisions are made in a meeting of the full IMO jury.

At the IMO in Sigtuna, Sweden, in 1991, one of the members of the U.S. team, Lenhard Ng, wrote a two-page solution that could not be coordinated in the allotted time. A team of coordinators spent several hours scrutinizing Ng's solution, trying to determine its correctness. All of the solutions of all the other students in the competition had been scored and recorded, except Ng's solution to this one problem. "The whole place was waiting for the verdict," recalled Ullman, who was serving as deputy team leader. He and team leader Rousseau had asked for a perfect score of 7 points for this solution, but in the end the coordinators gave Ng only 3 points. Ng ended up with a silver medal in the competition and, like many former members of U.S. teams for the IMO, has gone on to distinction in mathematics. Ng received his Ph.D. from the Massachusetts Institute of Technology this year and was recently given the prestigious AIM Five-Year Fellowship from the American Institute of Mathematics.

By Wednesday evening, July 11, the jury will have decided which students will receive IMO medals. The medals are distributed in such a way that about one-twelfth of the students will receive gold medals; about one-sixth, silver medals; and about one-fourth, bronze medals. Altogether, around half the students will receive medals. Officially, there are only individual scores on the IMO, no team scores. However, in news reports about the Olympiad it is common practice to rank the countries' performance by totaling the team scores for each country. The U.S. is usually among the top contenders and has placed among the top five countries in all but four of the competitions in which it has participated.

A Cultural Exchange

While the examination is being prepared and graded, the 500 teen-age contestants keep busy with a variety of activities planned especially for them. "The IMO is much more than a mathematics contest," remarked Ullman, who has been closely involved in planning local activities for the students. "It's a cultural exchange among the top talented mathematics students internationally." IMO activities have traditionally showcased the culture of the host country but have involved little mathematics. "I have always felt the IMO needed more of a mathematics component," Ullman noted, "and we are doing some of that." Students will have the opportunity to see the BBC television program about Fermat's Last Theorem, the film showing the sphere being turned inside out, and the film *Not Knot*, which features a ride through the world of hyperbolic geometry. The day before the first part of the examination, a selection of

mathematically based games, toys, and puzzles will be available for the students, and the calculating wizard Arthur Benjamin of Harvey Mudd College will give a performance.

One of the aims of the IMO 2001 organizers is to display the multiculturalism of the U.S. The opening ceremonies on the Fourth of July will feature a number of cultural performances, such as clogging, Native American hoop dancing, and gospel singing. Later that day the group will take a boat ride on the Potomac River and watch the fireworks display on Constitution Mall. During the rest of the IMO there will be a visit to the Air and Space Museum, trips to the National Zoo and to a large amusement park, and an all-day excursion to Baltimore to visit the National Aquarium and the Maryland Science Center. Just how much entertainment to schedule, especially close to the examination, is a difficult call. "The kids do get nervous," Ullman noted. "There's a lot of pressure, especially with a team that has a chance to do well. If you don't do well, you disappoint a whole country. So it's tough."

After the examination students will pay visits to their individual countries' embassies. Last year when the IMO was held in South Korea, President Kim Dae Jung had the entire IMO contingent as guests at his residence. Ullman said that the idea of having the IMO 2001 group visit the White House was dropped because it seemed so complicated and uncertain. There is still hope, though, that some high officials from the U.S. government will turn out for the opening or closing ceremonies.

The Clay Mathematics Institute (CMI) is organizing the IMO closing ceremonies and banquet, which according to CMI president Arthur Jaffe will provide an "elegant and uplifting" finale. Students will receive their medals at the closing ceremonies on July 13, to be held in the concert hall of the John F. Kennedy Center for the Performing Arts. One of the highlights will be inspirational talks by CMI advisory board members Andrew Wiles and Edward Witten. (CMI is also holding its own annual meeting in conjunction with this event and will present its annual research award.) That evening the closing banquet for the Olympiad will take place at the National Building Museum, one of the most spectacular dining halls in Washington and the site of many presidential dinners. About one thousand people will attend the banquet.

All of the IMO organizers have been working hard to make IMO 2001 an event that shows off the best of the United States. As Kenelly put it, "We will be able to stand up, stick our chests out, and be proud of being U.S. mathematicians."

—Allyn Jackson

For further information on IMO2001, consult the Web site <http://imo2001.usa.unl.edu/>.