How to Help Your Students Get the Most Out the MCM and ICM

By Holly Zullo, Mark Parker, and Kelly Cline

Each February the Consortium for Mathematics and Its Applications (COMAP) coordinates the Mathematical Contest in Modeling (MCM) and the Interdisciplinary Contest in Modeling (ICM). Students from around the world compete at their home institutions in teams of three, working on an open-ended applied mathematics problem. The problems are big, messy, and not at all like a homework problem; instead, they resemble an applied research problem. Past problems have included estimating the global effects of a large meteor impacting Antarctica, studying dinosaur hunting strategies, and developing methods for detecting submarines in the ocean. In other words, the students spend 96 hours working on a problem that is unlike anything they have ever seen before.

Steffan Francischetti, Kyle Nixon, and Ben Dunham: Carroll College's 2006 Outstanding MCM Team at Work.

Most students have great fun with the contest and learn a lot of math. Best of all, it can be a really inspiring experience. The contest gives them a chance to test themselves against a genuinely difficult problem with no faculty training wheels to help when they get stuck, giving them a taste of what it is like to use mathematics in a real-world situation. The modeling contest has become one of the high points of the year for our department, luring more students to pursue majors and minors in mathematics.

However, if you want this to happen, you can't just sign up a few bright students and throw them in the deep end, hoping that things will turn out well 96 hours later. Your students will be much more successful if you can provide support by helping them form teams, running practice sessions prior to the contest, and then making sure they have what they need during the contest. We provide each team with a room of their own on campus (an NP-hard task considering that the contest runs through both a Friday and a Monday). We make sure that they have computers and internet access. We even provide food, munchies, and caffeine to help fuel them through those late nights.

The pre-contest practice sessions are particularly helpful in arming our students with the skills they need in order to make sure that this contest is a fabulous learning experience instead of an overwhelming disaster. Teams need to be formed early and meet regularly for practice. We try to form our teams in early November and get practice sessions going immediately. We generally have five meetings, each one lasting about two hours. But what should we do with our ten hours of practice time? First we need to recognize what skills are needed for this contest. We break these skills into three categories: communication, problem solving, and writing.

Communication

Although students may have experience working on group projects, it is likely that there is nothing in their backgrounds that has come close to preparing them to work with two other people on one project for 96 straight hours. They need to learn how to be sure that everyone's ideas receive proper consideration, how to keep everyone busy with a valuable task, and how to resolve the conflicts that will inevitably arise. Last year we invited a faculty member from Communications to meet with our students and work with them on small group communication skills. We found that during the contest weekend students were much more aware of the need for communication, and they were actively practicing the skills they had been taught.

One dangerous pitfall that many teams face is that when a disagreement comes up, they vote, two students on one side, one student on the other, the majority rules and the thoughts of the third student are ignored. Several times we have seen a team member frozen out who then feels disenfranchised and left out. Instead, students need to be told right from the beginning that voting is off the table, and that all decisions need to be made by consensus or not at all. If there's a 2–1 split then they need to sit down and talk things through, and the two need to listen very carefully to the thoughts of their teammate, to understand where he or she is coming from, and to figure out what they are not seeing.

It's also important to remind the students to spend time listening very carefully to all of their teammates. The most talkative person usually ends up being the team leader, and more quiet students are ignored. However, being talkative has little to do with intelligence, and some very smart people are quiet and perhaps shy. Students need to listen, to make sure that everyone is participating, and if someone on their team isn't speaking up, they should specifically ask for their teammate's opinion.

Problem Solving

MCM problems are big, and the students need help managing problems of this magnitude. They need to learn a modeling process where they take a large problem, make simplifying assumptions to develop an initial model, and then relax assumptions to develop more realistic models as time permits.

We use about half of each practice session to have our teams carefully look at past problems. Our standard exercise has been to hand out a problem from a previous year and have each team read the problem statement carefully, brainstorm ideas, and then outline their solution strategy. This can be very useful, because it gives the students a sense of what to expect, as well as a little practice in how to get started. However, these sessions often result in a laundry list of minutiae that could be important to the problem, without settling on any particular starting point.

To avoid this trap, we now send students off with a problem and a goal of finding a very simple model for the situation. Rather than wandering around all the possible complications of a problem, we want them to focus on the bare minimum details and simplifying assumptions. Once they have a very simple model, they can decide what complicating factor would be added next.

Last year, we gave students the Coal Tipple Problem (MCM Problem B, 1993). In this problem, students are asked to analyze the operation of a coal tipple which is used to load coal trains. Three trains arrive stochastically throughout each day, with a high capacity train arriving on Thursdays, and the students

are given the details about how much coal the tipple can hold, how much time it takes to the load the tipple, how much the trains can hold, and the relevant costs involved.

The students must determine the number of crews to have on duty to load the tipple and the average monthly costs. Last year, after 30 minutes of brainstorming and work, our students developed initial models that assumed all days were equivalent and that the three train arrivals were deterministic and evenly spaced throughout the work day. Next, the teams planned to incorporate some form of probability distribution into their models and account for the non-homogeneity of the work days. This exercise of creating a minimal model seemed to help the students quickly get started during the contest.

Writing

The end result of this contest is a written paper that is submitted for judging. Students tend to greatly underestimate the time necessary to prepare this paper, and they sometimes flounder when it comes to writing as a group. Often a team will do some really good mathematics, but not put nearly enough time into writing the paper, resulting in something barely coherent. Also, the writing should be as collaborative as possible, and every team member should read and try to improve every word in the paper. A team that divides up the sections of the paper and then blindly combines them together at the end will rarely turn in a lucid document.

It is not easy to convince the students to set aside enough time for the writing part of the contest. We can talk at them all we want about writing, but in the end they have to experience it first-hand to get the point. To provide them this experience, we give the students a simple optimization problem from first-semester calculus, and we ask them to solve the problem and write a paragraph or two describing their solution process. Although they are able to solve the problem in about five minutes, most have trouble completing the writing in the allotted 30 minutes. They learn a lot about how to write as a team, but even more importantly, they learn how long it takes to write about even a small amount of work. We always encourage students to begin writing almost immediately during the contest, and to cease all work shortly after the halfway point and devote all their energy to writing up their results.

The MCM provides a great opportunity for students to challenge their skills in mathematics, teamwork, and mathematical writing. They will get the most out of this opportunity if they have some preparation and advance practice with their teams. In the end, whatever their rankings are, we want the students to feel satisfied with the work they did during the weekend, and to come away more excited about the power of mathematics.

For more information on the MCM/ICM, see http://www.comap.org. For more information about the MCM/ICM at Carroll College and our preparation, see http://www.carroll.edu/~mparker/mcm.html.

Holly Zullo, Mark Parker, and Kelly Cline teach at Carroll College in Helena, Montana and have been involved in the Modeling Contest for the past eleven years.

The COMAP Undergraduate Modeling Contests

The Mathematical Contest in Modeling (MCM) challenges teams of students to clarify, analyze, and propose solutions to open-ended problems. The contest attracts diverse students and faculty advisors from over 500 institutions around the world.

The Interdisciplinary Contest in Modeling (ICM) is an extension of the Mathematical Contest in Modeling (MCM) designed to develop and advance interdisciplinary problem-solving skills as well as competence in written communication