Ability, Training, Preparation

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Introduction

Since 1997, Bengt Fornberg and I have been advisors for Modeling Contest teams at the University of Colorado at Boulder. Through 2005, we have worked with 23 teams and have had consistent success: 6 Outstanding, 9 Meritorious, 7 Honorable Mention, and 1 Successful Participant designations.

Over the past few years, I have given considerable thought to the ingredients that make an Outstanding team. *I believe that success in the MCM comes down to equal parts student ability, training, and team preparation.* Take bright and talented students, give them challenging coursework that includes mathematical and computational work, prepare them in teams of three for the MCM, and then let them go. The results are exciting.

Students

The University of Colorado at Boulder has some of the most talented undergraduates anywhere. After graduating from high school, these students are looking for additional challenges—although they don't always know what that means. They are bright and articulate, and our goal is to encourage each of them to develop fully. These students have different majors in science, engineering and applied mathematics; but as they pass through our calculus and differential equations courses, we encourage them to "take more math courses." Some will become applied math majors, double majors, or minors; but all will benefit from additional mathematical and computational training.

Training

The mantra of the Department of Applied Mathematics is "mathematics, computation, and communication." Each of these skills is infused throughout our curriculum. As early as Calculus 3, our students are required to work on computer projects using Mathematica or Matlab. Each major, and most of our minors, takes a minimum of one programming course and one course in

numerical analysis. Computer software is used extensively throughout our upper-division courses.

Our best undergraduates, many of whom are MCM participants, are also encouraged to work on research projects with CU faculty. Students have worked in physics labs, on significant programming projects, and on research projects with applied math faculty. While working on these projects, students don't have the time pressure of the MCM. Nonetheless, they do work on open-ended research problems, grappling with some of the same issues as those posed in the contest problems. Through coursework and research projects, our students receive extensive mentoring and training in skills that will serve them well in both the MCM and in future graduate work or careers.

Team Recruitment and Preparation

The primary role of the advisor in the MCM is team recruitment and preparation. Students are recruited from throughout the science, engineering, math, and applied math disciplines. The best teams are those where each student brings skills that complement those of their teammates. We recruit students from our classes, via email, and by word of mouth spread through students. We always stress that students must want to do the contest—they need to feel excited and challenged. As soon as possible, even as early as the fall semester, we encourage students to form their teams. Thus, the individual excitement that they feel is transferred to team enthusiasm.

The MCM is a unique event that students must be prepared for. You can have students with enormous amounts of ability and good training; but if they are not prepared for the nature of the contest, they may not do as well as possible. To prepare students, we have one or two meetings before the winter break and then three meetings afterwards. After going over the contest rules, we discuss division of labor, timing, and the nature of the final paper.

It is important that each team understand that a division of labor is critical. While the character of each team is slightly different (and depends on the problem), there are usually three roles: *the writer, the programmer, and the researcher*. After some initial brainstorming and research by all team members in the first few hours of the contest, the team should have some ideas for their first, and most simplistic, model. At this point, the writer can begin writing the introduction, the programmer begins the numerical work for the first model, and the third member continues the mathematical development and library (or Internet) research.

Beginning the writing on Friday cannot be overstressed. One of my first teams was exceptionally talented, but they did not understand (and I had not stressed) the importance of this timing. Each person worked on the research, model development, and programming. They actually developed several models, from the simple to the very sophisticated. Unfortunately, only the simple model made it into their paper. They didn't start writing until Sunday night—

and then all three wrote furiously. The resulting paper was an unedited jumble of ideas, a real disappointment. I now stress, multiple times during our preparations, how important it is for one person to be responsible for the paper—and that he/she needs to start writing early.

During our practice sessions, we also discuss the format of the paper. The problem restatement, the assumptions, the models, and the conclusion are all examined. We also talk about the word-processing itself. Some teams prefer to work in LaTeX; others prefer Word. I tell students that they should use whichever they feel most comfortable as long as they can easily incorporate equations, graphs, and tables. I do encourage students to set up a template before the contest begins and to make sure that they can import graphs and figures.

The last topic that we discuss is where each team will work. Each team needs its own separate workspace. Some teams prefer to work at a team member's home or apartment. Others prefer to work in one of the computer labs. We also provide weekend access for one team to the departmental conference room.

Aftermath

After the contest results are announced, we make sure to publicize them throughout the university. In April, we host the Modeling Contest presentations. Each team is given 15–20 minutes to present their solution. All undergraduates and faculty are invited to attend. It is great for each team to be able to share their solution with everyone else. Students who did not participate in the contest are inspired to do it the following year. It is always amazing to me how much these students can accomplish in just 96 hours. Their energy and enthusiasm motivate me. I believe that these students, who have accepted the MCM challenge and given it their best, will remember this event for the rest of their lives.

About the Authors

In 1994, Anne Dougherty received her Ph.D. in probability from the the University of Wisconsin–Madison. She then joined the Dept. of Applied Mathematics at the University of Colorado at Boulder as an instructor. She is currently a senior instructor and Associate Chair of the department. Her research interests include applied probability and statistics and image analysis. She has been working with and advising MCM teams since 1997.

Bengt Fornberg received his Ph.D. in numerical analysis from Uppsala University in Sweden in 1972. He held several university positions from 1972 until 1984. He then worked for Exxon for 11 years before joining the Dept. of Applied Mathematics at the University of Colorado at Boulder in 1995. His research interests include computational fluid dynamics, pseudospectral methods, and industrial applied mathematics. He has been working with MCM teams since 1997.