How to Succeed in the COMAP MCM

Introduction:
The COMAP Mathematical Contest in Modeling is an annual competition that challenges students to tackle difficult interdisciplinary problems through the use of mathematical tools. I was fortunate enough to be one of the Outstanding winners of the competition in both 2008 and 2009 as well as the INFORMS prize recipient for the continuous problem in 2008\(^1\). I developed a strategy for approaching the MCM that worked for both the teams I competed with, and through my experiences I have gained some insight that may be helpful in your own pursuits. In the following pages I will outline my teams’ winning approach as well as provide some practical tips for success.

General Guidelines for Creating a Competitive MCM Team

Creating a competitive MCM team is not always as simple as just putting together the best mathematics students. This competition challenges students in a number of areas and requires a great diversity of skills. Some of those skills include mathematics, physics, engineering, programming, research, data processing, and graphic design. However, one of the most important skills is often the most overlooked: the ability to write. Every team needs to have a good writer – someone who can quickly and effectively summarize the processes and results of mathematical modeling. It is not enough to have a great model; it must also be presented and explained well.

Aside from creating a balance of these different skill sets, one of the other most important aspects of creating a team is simply making sure these three people can work well together. It’s very likely that at some point over the four-day competition your team will be confined to a small room for upwards of 24 hours straight. Bottom line: make sure you actually like your teammates because you will be spending a large proportion of the weekend together.

The Judging Process

The MCM has four different designations: Successful Participant (\(\approx 63\%\)), Honorable Mention (18%), Meritorious (18%), and Outstanding (1%)\(^2\). The papers that fall into these categories are often very distinct, and there are several simple things that teams can do to improve their chances of receiving a higher designation by simply understanding the judging process.

Like most judging processes, papers are judged in a series of rounds, and in each round more and more papers are removed from consideration. Perhaps the most important piece of information I can relay is that in the first round of judging, the summary statement is the only thing that is considered! What this means is that over 60% of papers are never actually read! Don’t blow off the summary statement – it is the most important thing you will do in the entire weekend.

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1 I competed on two different teams while at the College of Idaho. In 2008 I was paired with Megan Longo and Tyler Gross, and in 2009 my teammates were Zachary Kopplin and Nate Landis. Dr. Michael Hitchman (now a professor at Linfield College) was the advisor for both of these teams. Without these people, my success in the competition would not have been possible.

2 Based on 2009 MCM Statistics
Honestly, making it through the first round of judging is the most difficult part. Aside from a quality summary statement, there are a few things teams can do to improve their chances. There are a lot of submissions, and logistically there is simply not enough time for judges to read all the papers completely though. So make it easy for the judges to understand your models by clearly outlining your assumptions, strategies, and results, and providing graphs, charts, and diagrams that visually explain your paper. The bottom line is that the paper needs to be written logically, in an ordered fashion that clearly identifies the most important parts (i.e., make bold section headings like: “Assumptions” or “Results”).

The second round of judging determines the honorable mention papers. In this round, the judges still can’t read the entire paper, so it is of the utmost importance to create a solid summary statement, clear and interesting graphics, and a logical layout. Make the paper interesting – the entire goal is to get the judges to want to read your paper.

If your paper makes it past the second round, you’re in great shape because your paper will actually be read. This lines the team up to receive either Meritorious or Outstanding (barring any major errors that may arise through a closer examination of the paper). There are several things that set these papers apart from the rest:

- Great summary statements
- Interesting and explanatory graphs, charts, and diagrams
- Multiple or iterative models
- Solid research on the subject
- A complete analysis of the problem

This last point is often the determining factor between Meritorious and Outstanding papers. The Outstanding papers address every aspect of the problem, and even when certain things cannot be accounted for mathematically, these teams talk their way through the issues and explain their ramifications. So, even if you have no idea how to model a particular aspect of the problem, talk about it in the paper to show that it has not been overlooked. The judges are often looking for several specific things, and the oversight of any one of them can cost a team a chance at the Outstanding designation.

A Workable Timetable

The following breakdown is the timetable both of my teams used. This is by no means the exact way to approach the competition, but it worked for us. Whether your teams uses a strategy close to this or not, it is extremely important to develop a timetable and stick to it.

Thursday Night:

Take a good look at both problems. A lot of teams go into the competition set on one problem type or the other (continuous or discrete), but I think it’s important to go into it with an open mind. Even if you have a good idea which problem your team is going to tackle, take an hour or so to brainstorm solutions to each problem – maybe even start working on a basic model. After you have decided which problem to work on, start your research and be diligent about keeping track of your sources! Start thinking about a basic model, and get some sleep, because opportunities for that will be scarce in the coming days.
Friday:

At this point, your team should have already picked a problem and done some preliminary research. Friday is all about researching the topic and building a basic model. **Keep track of your sources.** When a team has three people doing research on a broad topic it is easy to lose track of the exact location of everything they have found. Be diligent about keeping a comprehensive list of everything that *might* come in handy during the write-up process. My first team had a problem with this particular aspect of the competition and we had to scramble on Sunday and Monday to rediscover some of our previous sources. It is not uncommon to have 30 or more citations, so be careful. **Keep a separate document with not only URL’s but also a brief description of what information it contains and how it is useful to your project.** It is also useful to cite your sources along the way using something like easybib.com or BibTeX.

As the day progresses, your team needs to develop a basic “hasty model” that simplifies the problem down to the most essential elements. This first model is one of the most important things you will do because it shows the judges that you understand the problem and that you’ve done your research on previously implemented techniques. Furthermore, sometimes one of the best ways to mathematically model a problem is through an iterative process that starts with a solid base model and slowly adds variables during each iteration until the model fully encompasses all the necessary elements.

**Sleep!**

Saturday:

Today is all about modeling! At this point, your basic model should be completely done and now it’s time to build either a complex model of the system or a second, more complete iteration of the basic model. Depending on the problem, programming may be involved to create simulations or to show that an algorithm works. Saturday should be almost entirely devoted to these two things. Ideally, the programming aspects should be complete by Saturday night so that lengthy simulations and calculations can run through the night (if necessary).

In my experience, Saturday night has been the all-nighter. As things start to come together with your model and whatever programs you may have running on the side, it is important to **start writing.** At the very least, make an outline either in Word or LaTeX so that you know exactly what you have to do over the final two days. There is nothing worse than having a great model with an extremely poor write-up.

Sunday:

**It’s time to write!** Don’t worry too much if your model is not entirely finished. Sunday is all about writing the paper, tying up loose ends, and pulling everything together. Ideally, your team will be very close to having all of the research done as well as **two or three models** working models of varying complexity. There is still a lot of time left to work out the bugs, but do not try to make any significant changes to your models after about 4:00 pm on Sunday.

It’s okay if your model is not perfect. The judges do not expect a perfect solution – often there is not one – however, they do expect a coherent, polished, and easily readable
analysis of what you have done. Make it easy for the judges to understand your work. Don’t forget to make graphs, charts, and diagrams because the judges are more likely to look at those than the text itself.

**Monday:**

Revisions, Summary Statement, and any loose ends. When Monday morning comes, there needs to be a workable draft. It doesn’t have to be perfect, but Monday should be about revising and polishing, not writing.

Sometime around 1:00 pm ET, the Summary Statement needs to be written. I cannot stress enough how important this statement is. It speaks for your entire paper and it is the only thing the judges look at during the initial phases of the judging process! Leave a large bulk of time for the sole purpose of writing this statement. I developed my own strategy for successfully writing a summary statement. In the early afternoon (or morning, if your team is ready) separate for about an hour. Go to different places and have each team member write his or her own summary statement. This is important because each member may have different ideas about what is most important or how to word it, and it is absolutely essential to the success of the COMAP team to be able to explicitly state the problem as you see it, your main assumptions and methods, and the results of your paper. After each member has written a summary statement, regroup, discuss, and either choose one to move forward with or rewrite one as a team. In total, even though the summary statement is under a page I highly recommend that each team spends at least 3 or 4 hours getting that summary statement as polished and complete as it can be.

Lastly, once the summary statement is done, all the revisions have been made, and all the finishing touches have been put on the paper, leave yourself 2 hours to print your paper, burn it onto a CD, email the solution in, and gather all the proper documentation. Things inevitably go wrong. I encountered major issues both years and I know several other people who experienced the same thing. Just don’t forget Murphy’s Law…

**Ten Keys to Success**

1. **Summary Statement:** Create an exceptional Summary Statement that includes your own restatement of the problem; your methods, assumptions, and techniques; and a brief statement of the most important results.
2. **Workable Timetable:** Develop a timetable that fits your style of research and the nature of the problem. Sticking to this plan as closely as possible and only deviating when necessary will give your team the best chance of completing all the requirements and delivering a quality paper.
3. **Charts, Graphs, and Diagrams** are of the utmost importance in explaining your models. It is easier for the judges to literally see what you’ve done as opposed to having to search through lengthy passages to find information. Just remember the basics: number and label your figures and always label the axes on your graphs.
4. **Make it Clear and Concise:** Often times it is easy to overcomplicate things and create a convoluted mess of a paper. Be conscious of your readers and make it easy for them to understand what you’re doing and how you’re doing it on a quick flip-through of the paper.
5. **Make an Impressive Basic Model:** This is important because it shows the judges that you’ve done your research and also that you understand the most basic
aspects of the problem. It’s okay if it is really simple – successful models often are. This model also acts as a springboard for launching into more intricate and complex models. If you create iterative models, that’s self-explanatory, but even if you go in a completely different direction, this model will give you something to compare your results with.

6. **Leave Ample Time for Writing**: Too many teams focus on the model alone and leave the writing to the very last minute. Both of my submissions were over 20 pages long single-spaced; that’s not something that can be done in just a couple of hours.

7. **Be complete, realistic, and honest.** If the prompt asks for five specific things, *it is absolutely essential that you address each of them*. Don’t try to hide anything in your model or magically generate results. The people looking at these papers are very knowledgeable and they will see through it. State very clearly both the *strengths and weaknesses of your models* and be explicit about your assumptions.

8. **Cite your sources** and keep track of everything that might be even remotely helpful. As you’re working through, keep a log of all the sites your team is visiting, as well as a basic description of what each of them contains.

9. **Follow the instructions** to make sure that everything is being submitted *exactly as* the people at COMAP want it. Take a few minutes to read through the instructions before the contest begins or early on in the contest when you need a break from the modeling itself.

10. **Be creative** and have fun with it. Most teams are going to come up with the same introductory sources and perhaps even the same basic model. Your team can stand out from the rest by doing something innovative and taking advantage of any interesting aspect of the problem.