The CAMCOS Handbook

Center for Applied Mathematics, Computation, and Statistics (CAMCOS)

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(based on the Harvey Mudd College Math Clinic Handbook)

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1. Introduction

CAMCOS (the organization behind Math 203) is an academic program within the SJSU math department that offers a different kind of learning experience. The main goal of CAMCOS is to find interesting problems in the applied mathematical sciences from outside sponsors, and to form small teams of students to work on them. A team consists of:

- A faculty supervisor;
- A team leader or leaders (often a graduate student or students); and
- Several undergraduate or graduate students (usually 3-8).

For the purposes of academic credit, a team's work counts as a regular course (Math 203). (See Section 5 for rules on 200-level credit towards the master's degree.) However, the content of the "course" and the team experience are not like a regular course, as team members learn how to apply theory to solve real-life problems, and also learn how to work effectively in a group.

The CAMCOS program benefits those involved in several ways. Students in the program get valuable experience with the world of industry and with doing independent work, as well as contact with potential employers. Sponsors get useful research done on their problems, and they also get the opportunity to see the work of some good students and potential employees first-hand. CAMCOS projects also enrich the academic program of the Mathematics Department and help keep our program up-to-date and relevant to the needs of the outside world.

Projects run for an entire academic year when possible, as this is usually the most effective time frame for a project. However, one-semester projects are possible as well.

A note about the director: The director of CAMCOS is an SJSU faculty member who is responsible for locating sponsors and faculty supervisors, preparing proposals, budgets, work statements and agreements, publicizing the Clinic projects to students, helping faculty supervisors set up teams, organizing Report Days, and assisting teams as needed throughout the year. Dr. Jane M. Day was the first director of CAMCOS, and she served from 1983 to 1988. The current director, Dr. Tim Hsu, has served since Fall 2001.

2. Team organization

As mentioned earlier, the people most directly involved with a CAMCOS project include:

- A faculty supervisor;
- A team leader or leaders (often a graduate student or students);
- Several undergraduate or graduate student team members (usually 3-8); and
- One or two liaisons from the sponsor.

At the beginning of a project, the entire team meets at a regular class time 2-3 times per week. Parts of the team may also meet regularly. As the project progresses and the team's work becomes more independent, there often tends to be less work done in the in-class meetings, and more work done outside of class. The team will also meet somewhat less frequently (maybe once every 2 or 3 weeks) with a liaison or liaisons.

The roles of the various people involved in a CAMCOS project can be described as follows:

Faculty supervisor

The faculty supervisor bears major responsibility for overseeing the project.

First, the faculty supervisor is responsible for selecting the team members and the team leader before the project starts, and for evaluating their work at the end of each semester.

Second, the faculty supervisor is responsible for teaching the team members the background knowledge they need for the project, as projects often require techniques and theory that are unfamiliar to the students in the team. This teaching responsibility may be shared by the team leader(s) and other team members, as appropriate.

Third, the faculty supervisor and the team leader(s) are responsible for communication between the team and the sponsor, and between the team and the CAMCOS director. The supervisor is ultimately responsible for ensuring that copies of all reports are given both to the sponsor and the director.

Finally, the faculty supervisor and the team leader(s) are responsible for managing and planning the progress of the project. It is important for the faculty supervisor to help team leaders improve their skills as managers and supervisors.

Team leader

A team leader position in a CAMCOS project is meant to offer genuine management responsibility, as well as requiring mathematical skill. Under the direction of the faculty supervisor, the team leader is responsible for:

1. Day-to-day project management, including organization of team meetings and distribution of tasks to team members;
2. Liaison work with the sponsor, including supervision of written and oral reports; and
3. Project continuity between semesters, especially when new members join the team.

The team leader may also be involved in teaching background material to other team members, especially when new members join the team between semesters.

In the end, the point of having a team leader is both to ensure that the work of the team is properly focused, and also to ensure that the results of that work are properly communicated to the faculty supervisor and the sponsor. A team leader must therefore monitor the work of the team closely, respond to problems as they arise, and distribute tasks to team members appropriately, taking into account their talents and limitations. All of this requires a fairly intense time commitment to the project, and regular consultation with the faculty supervisor.

Team members

Responsibilities of other team members are similar to those of any college course. Assignments given by a faculty supervisor or team leader must be completed on time, and oral and written progress reports must be done while required. In particular, to pass the course, each team member must participate in both the final oral presentation and the final written report.

In addition, each team member must remember that he or she is part of a team, and not just working in a vacuum. His or her work and attitude must make a positive contribution to the team's efforts in reaching its goals.

Sponsor liaisons

The sponsor will identify one or two employees who will serve as technical liaisons to the CAMCOS team. Liaisons keep in close touch with the team, meeting with them occasionally (say, once every 2 or 3 weeks), and providing additional information as needed. It is also often helpful if the liaison can give one or more classroom presentations on the context of the problem, to help the team understand how its work fits in with the sponsor's business or research. Finally, as the semester progresses and the team learns more about the problem it is investigating, the liaison will often need to clarify or modify the problem in response to the team's work.

3. Oral reports

At the end of each semester, CAMCOS/Math 203 holds a Report Day. The teams meet together to give and observe 20 minute presentations of the work done by each project. In addition to the sponsors of the current teams, all interested students, faculty, administrators, and potential sponsors are invited.

Each Report Day is run like a professional meeting. Several or all team members should participate in the team's report, and the report should be of professional quality and style (see Appendix C). The report should be aimed at a general non-technical audience.

Report Days are one of the most important parts of the CAMCOS program, for several reasons. For one thing, they provide excellent publicity for the program. More importantly, Report Day is a focal point of the educational experience of Math 203. By participating in Report Day, students receive first-hand evidence of the value of their work in the "real world" of business and industry. In fact, since sponsors and visitors to Report Day are often potential employers, Report Day is an excellent opportunity for students to show off their employable skills. Finally, working on the oral report itself develops an essential skill: the ability to present very technical results in understandable non-technical terms.

4. Written reports

By the end of each semester, each team must complete a final written report. This report must be well-written and attractively presented. It should be addressed to the sponsor, and copies should also be given to the faculty supervisor, liaisons, and the director of CAMCOS. The faculty supervisor should give prior approval to all reports, and the team leader(s) should take an active role in the planning and writing of the final report. The team should start its report early, as it will need several weeks to plan and write the report.

One technical note: Every report must begin with an abstract or introduction (preferably both) that can be read and understood by a general scientific audience. This is both useful to the program, and is also just good practice in writing scientific and technical papers. The abstract and introduction should be written under the (realistic) assumption that the reader will not look at anything else in the report. (See Appendix E for more style notes on the written report.)

Sometimes, if a CAMCOS team is successful in its project, it will produce work that can be published in a mathematical or other scholarly journal. In that case, it is highly recommended (but not required) that team members, especially team leaders, participate in turning the final written report into publishable form. It is also recommended that everyone who participates in writing the publishable paper receive a co-author credit, as is typically the case with mathematical and scientific publications.

5. Academic credit, stipends, and grades

Students in Math 203/CAMCOS earn 3 units for each semester they are enrolled and complete the required work satisfactorily. Team members, especially team leaders, often find that they work harder in Math 203 than in an average class. However, they also often find that there are new sources of motivation for such work, and that the work itself brings concrete rewards in the form of sponsor approval of their work.

Team leaders must also master substantial theory, participate strongly in the team's research, and bear managerial responsibility for the team's work. Consequently, they are also given a stipend-like salary, in addition to the usual academic credit.

Grading in Math 203 is done on a credit/no credit basis. Minimal requirements for passing include participation both in the final oral presentation and the final written report.

Ordinarily, master's students can only use Math 203 as an elective class, and not as one of the 200-level courses required for the master's degree. However, master's students may use Math 203 as one of the 200-level courses required for the master's degree by submitting a brief (around 5 pages) individually written report (**not** just the team's report) on the team's work during the semester. If the faculty supervisor and the graduate studies committee all agree that the student has done an amount and quality of work comparable to a regular graduate 200-level course, then the student may receive 200-level credit towards the master's degree.

Appendix A. Working in a team

> "If a person's too into himself or herself, we wouldn't want that. Everything we do is thought out. We don't need a person who will say, 'Well, [forget] it. I'll cut the red wire.' That doesn't help the people around them."
>
> -- Lt. Jerry Sheehan, NYPD Bomb Squad, quoted in *The New York Times Magazine*

In the real world, people almost always work in teams. Working in a Math 203 team therefore gives students valuable experience that is hard to obtain elsewhere. However, since many students may not be used to working in teams, especially to do mathematical research, there will be some unusual issues for Math 203 students to consider.

The key to working in a team is: If you want your team to succeed, you must think about the success of the team before you think about your own success. If you look at championship sports teams and great musical groups, you'll see that a team that works together towards a common goal will succeed, and a team whose members only pursue individual goals, or worse yet, whose members are working at cross-purposes, inevitably fails. As basketball coach Phil Jackson puts it, "Good teams become great teams when the members trust each other enough to surrender the 'me' for the 'we.'"

Below are a few specific tips for working in a team and for leading a team. The basketball-related items are drawn from the book *Sacred Hoops*, by Phil Jackson (abbreviated SH below), which is highly recommended if you want to read more about working in a team or leading a team, even if you don't know anything about basketball.

1. For a Math 203 team to work well, each team member must have a clear idea of what the goals of the team are, what the plan of the team is, and what his or her own role is in the team. The key to making this happen is good communication among team members, which means that team leaders need to make a point of encouraging and enhancing good communication.
2. Especially for the educational purposes of Math 203, it is crucial that all team members try to contribute to the project, and equally crucial that all team members be given the chance to contribute to the project. As basketball player Bill Cartwright puts it (SH), "A great basketball team will throw the ball to everyone. If a guy drops it or bobbles it out of bounds, the next time they'll throw it to him again. And because of their confidence in him, he will have confidence. That's how you grow."
3. In basketball, "All things being equal, each player will spend about eighty percent of the time *without the ball*" (SH). In a Math 203 team, it may sometimes be the case that your role in the team doesn't seem as important or interesting as what others are doing. Even then, you need to do your job well, as a project can succeed only to the extent that all of its parts succeed. Conversely, if you're leading a team, try to make sure that team members who (metaphorically speaking) aren't holding the ball still have something to do that is both meaningful and well-suited to their talents.
4. Finally, it is crucial that all team members treat each other with respect, and it is a key duty of team leaders to help maintain respect among team members. Note that, as is the case in many great musical groups and sports teams, team members don't necessarily have to be the best of friends outside of work (though we certainly don't discourage that). All a team needs is to maintain a respectful atmosphere in the course of its work.

Appendix B. The relationship between sponsors and teams

Each CAMCOS team should be aware, especially if the project sponsor is a commercial company, that the work of the team may be bound by a fairly formal research agreement. For that reason, the team's work has importance even outside of academic matters like grades and credit, and failure to perform that work can have serious effects, even possibly legal ramifications. Therefore, there are some unusual issues that students and faculty supervisors need to consider in Math 203.

The first issue is sponsor-team communications. As mentioned earlier, it is crucial that the team keep the sponsor appraised of the progress and direction of the team's research, through regular communications (especially e-mail), through face-to-face meetings, and at the end of the semester, the final oral and written reports. Conversely, it is also important for the team to make sure that the sponsor's interests are being represented. Again, the key is for the team leader(s) and the faculty supervisor to maintain good communications with the liaison from the sponsor.

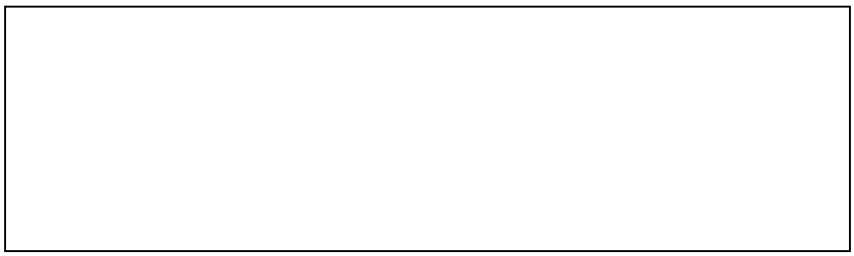
The second (and more unusual) issue is confidentiality. Since knowledge and methods can be very valuable to a company, in a commercial enterprise, the type of information that is normally shared freely in an academic environment can be subject to non-disclosure restrictions, or can even be tightly held secrets. On the other hand, since CAMCOS/Math 203 is first and foremost an educational program, and since this requires the open discussion and possibly publication of results and methods by students and faculty, strict confidentiality is neither appropriate nor feasible.

It is therefore the sponsor's responsibility to make clear to the team, at the beginning, which specific matters are to be held confidential, and it is the team's responsibility to adhere to those confidentiality requirements. In practice, this means that the team's oral report will sometimes use "sanitized" or otherwise non-proprietary data to communicate the team's results in a public setting, while the written report gives a fuller picture. In extreme cases, a team might also have to prepare a confidential written report for the sponsor and a "sanitized" written report for public consumption. (Note that these issues of confidentiality do not extend to classified government work, which is never suitable for CAMCOS/Math 203 projects.)

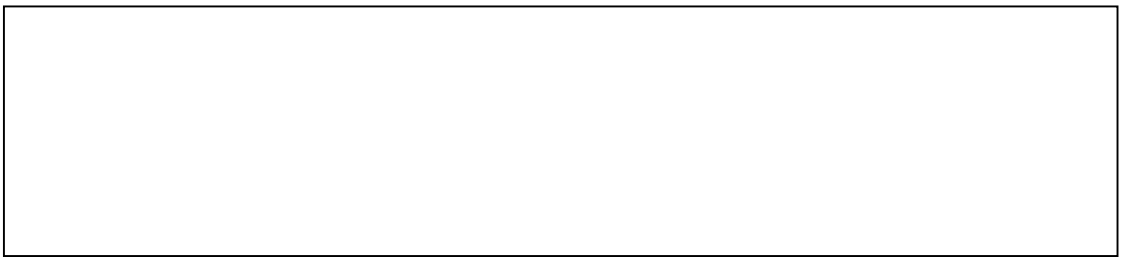
Appendix C. Substance of oral presentations

As part of CAMCOS/Math 203, you are required to give a 25-minute oral presentation at our public Reports Day at the end of each semester. It may surprise some of you to hear this, but especially given that your oral presentations are 25 minutes long, and aimed at a general audience, you are better off thinking of your oral presentation not as a *lecture* on the work you have done, but as an *advertisement* for what you have done. Realistically, not even a mathematically trained audience, let alone a general audience, will understand the technical aspects of what you have done after 25 minutes. Your goal is therefore not to have your audience leave saying, "I understand the math that happened here;" your goal is to have them leave saying, "It sounds like they did interesting work on a worthwhile problem; I'd like to find out more about what they did." (Truly interested parties can then read your written report, which will have complete information.)

To put this another way: When you work on a project, you experience it in roughly the following proportions.



In contrast, the amount of time you spend on these topics in your oral presentation should be in roughly the following proportions.



In other words, you really need to communicate what the problem was that you were working on, why that problem is interesting, and what progress you made on that problem. If you can also get them to understand something about how you did it, great, but that's not really your goal here.

One corollary to this is that your presentation should contain almost no algebra and probably very few formulas. (Complicated formulas, integrals, calculations, and computer code are almost guaranteed to be incomprehensible in an oral presentation.) A good rule of thumb is, every time you want to include a formula or a piece of algebra in your talk, ask yourself: Does your audience absolutely need to see this formula either to understand the problem you're working on, or to understand the results you've obtained? If the answer is "no," get rid of the formula. (Try replacing it with a picture.)

Appendix D. Style of oral presentations

It is important to learn to give good oral presentations: No matter what kind of job you get, you can be sure that you will have to present your ideas to other people from time to time in order to keep your job, get support for projects, sell your product, and so on.

From experience, we know that most students can learn to give excellent reports. On the other hand, most students need some suggestions and feedback to help them learn to do that. Here is how you should prepare for your final presentations.

1) Study your subject thoroughly. As much as possible, master all the details. Also, think about what kind of questions the audience might ask and be ready to discuss those as clearly as you can. If there is an important question that no one asks, bring it up yourself during the question period and discuss it. Always try to know more than you put into the formal talk; the depth will definitely show.
2) It happens sometimes that you cannot understand a certain point, even after consulting with others ahead of time. If that occurs, say so in a straightforward way and continue your talk. (Don't be overly apologetic, because that distracts people from the line of thought.) You could ask during the question period if anyone else can explain the matter.
3) Give careful thought to what the audience probably knows already or is likely to remember quickly, so your presentation will neither assume too much nor go too slowly.
4) Don't rush. It is far better to say less and be clear than to say so much that people cannot follow, so make careful choices about exactly what to say and what to emphasize. It is almost never wise to try to cover all points in all detail; instead do some things in depth and just indicate quickly how other things go.
5) When in doubt, say less, especially since you will only have 20 minutes for your presentation (plus 5 minutes for questions). A rough guide: Figure out what you want to say, and then cut it in half. Repeat. There is no stopping point, and each time you cut the material, the presentation will get better. For a more concrete rule of thumb, use 1 or 2 slides for every minute of your presentation, assuming roughly 6-10 lines per slide. (If you use Power Point, which puts somewhat less material on each slide, you can use 2 or 3 slides per minute.)
6) Start by saying what you will tell them; then tell them; then summarize. A very good way to accomplish this is to let your first transparency be a title and the second one a summary of the talk; then use that summary transparency again at the end of the presentation. It also helps to end with a list of achievements or "deliverables" that have resulted from the project.
7) If you have an accent, it is **very** important to make transparencies that contain the major words, definitions, and ideas. The first few times you use one of these major words or ideas, point to it on a transparency. That way the audience's ears get "educated" to the sound of your voice saying that. Then you can talk about the concept, and the audience will be able to follow fairly well, even if they still don't understand every word you say.
8) Your transparencies (or Power Point slides) should be easily readable and should serve **only as an outline** for your talk. They should **not** contain much, if any, detail. (To supply details, distribute written notes.)
9) Maintain eye contact with the audience as much as possible, and avoid giving your talk to the projector screen or the laptop you're using. One key to this is good positioning: Plan to stand to the side of your projector screen(s), so the audience can read the screens and see you at the same time.
10) If you use Power Point or some similar computer projection system, get an infrared clicker (mouse, etc.), so you can change slides without having to stand near your laptop. If you end

up having to use the laptop directly, try to put the laptop at a low height between you and the audience, so you can still maintain eye contact while occasionally glancing down to change slides. Alternately, if you have a podium, some people find using a mouse to move a cursor more effective and easier to control than a laser pointer for indicating things on a screen.

11) Practice your talk before a few friends if possible, using your transparencies/Power Point. Time the talk and adjust it as necessary so that you will stay within the allotted time.
12) Technical details on slides/Power Point:
    a) Put only a few lines on each slide, 4-6 at most.
    b) Use the largest natural font Power Point gives you (at least **28-32 point**). If you put so much on a slide that the font starts to get smaller, you've put too much on the slide; cut something more or split the slide into two or more slides.
    c) Use plain, almost boring fonts; avoid fancy background and special effects (fade-ins, words wandering in from outside the frame, etc.), as they are distracting and reduce visibility. You should especially avoid blinking, which can cause epileptic seizures (seriously!). The one exception to this is computer animation, which can communicate certain ideas very clearly that can't be communicated another way.
13) Technical details on transparencies:
    a) Use a laser printer, a **bold block type** font, and use **28-32 point** size, **boldface,** and **sans serif** (like Helvetica). If computer font cannot be made large enough, plan for that and enlarge each sheet on a copy machine before making transparencies. If a laser printer is not available (e.g., if you have to make a new slide at the last minute), then print neatly by hand with a soft felt-tip black pen.
    b) Allow margins all around of at least 1.5". Otherwise, some of your writing will be cut off when you project the transparency.
    c) Your very first transparency should contain the title of your presentation and the names of everyone involved in the project, including sponsor, liaison, faculty supervisor, and all student team members.
    d) Put only a few lines on each transparency, 4-6 at most. Use a "bullet" in front of each line.
    e) Laser print each sheet and then make transparencies of these sheets.
    f) It is often effective to add color highlights to transparencies with colored pens, either ahead of time or as you give your talk.
14) It can be effective to include a little humor—it keeps people awake and makes them want to listen to you. The humor should have something to do with your subject if possible. For example, if you want to tell about a difficult problem you are working on, you could briefly show a cartoon showing people trying to unknot a big ball of string. However, be careful not to offend anyone.
15) Dress and appearance: Your goal should be that your appearance does not distract the audience from your talk. (In the technical world, it is **much** better to lean toward the drab than to wear clothes or colors or hairstyles that are too noticeable.) So dress appropriately for your audience and the setting. In particular, since your audience will probably include some visitors and potential employers, as well as university officials, you should dress as if you're going to a job interview. Males should wear a shirt, tie, and slacks, and females should wear a neat shirt and skirt or slacks with a restrained hairstyle. A jacket always makes you look more professional; a suit would be very nice, if you already own one. Also, wear shoes that match your outfit, and not sneakers; the suit-and-sneakers combination seems to be a particular problem with mathematicians, and really does look goofy.

Appendix E. Style of written report

The basic principle to follow when writing a mathematical or scientific paper is:

Write so your reader can learn as much as possible
after reading as little as possible.

Put less cynically, you can think of this as writing in the "inverted pyramid" style used in many newspapers: first the headline, then the one-sentence summary, then an overview, then the details. The motivation is the same in both situations: Readers may want to move on after glancing at what you did, so you should try to get across as much information as possible in that glance.

This principle should start with the title of your report, which should contain as much information as possible. To give an example by comparison:

- Bad title: "A curve-fitting method"
- Better title: "A method for fitting exponential curves in biology"
- Even better: "A method for fitting exponential curves to DNA testing data"

Note that the last title allows the lazy/busy/otherwise interested reader to learn something about what happens in the report without actually reading it, while at the same time drawing in the reader who is interested in either curve fitting or DNA testing.

The report title should be followed immediately by a one-paragraph abstract that describes the work you have done. Start with a sentence or two about the context of your work and why it is of interest. Then, in the rest of the paragraph, summarize your results. Unless your methods are of unusual interest, either leave them out of the abstract, or describe them using standard short phrases ("Using parametric methods, we...").

The first section of the body of your report should be an introduction, and it is the most important part of your paper. The introduction should have roughly the following structure:

- First, in no more than one or two paragraphs, explain the problem you worked on, and summarize your progress on the problem. (In a theoretical math paper, you would briefly explain the problem you worked on, and then state your main theorem.)
- Next, essentially starting from the beginning, give a concise but thorough exposition of the background, context, and motivation for your problem. Give lots of references for readers who really want to know more about your topic. (This is often the most useful and interesting part of a research paper.) It's also nice to advertise your results here; that is, list some consequences of your results, some methods you have improved, some problems that you have now rendered trivial, and so on.
- Finish the introduction with a more detailed listing of what's in your report. ("In section 2, we discuss background material. In section 3, we discuss blah blah. In section 4....")

Note that because of what goes into the introduction, it's often a good idea to write it last.

After the introduction comes the straightforward part: Describe what you did. This is the part you've been waiting for, so we'll just leave it at that.

Skipping to the end, unless your report finishes the project or completely kills the problem, it's nice to finish with a section discussing directions for further research, possible generalizations, and so on. (From a practical point of view, this is how you get funded again.)