Math 130: Contemporary Mathematics
Class Project Guidelines and Phases

During the semester you'll complete a mathematics research project. These are the phases of the project you'll be going through, and I'll be looking for in assessing your grade. Note that the phases of research are not necessarily spread evenly over the semester, and different projects have different timelines. The challenges, and what ends up taking the most time, will be different depending on your specific research question(s) and your group's strengths. It's important to keep thinking, whatever your current level of progress. Don't stop working on the project because you reach a tricky part and get stuck, or because you finish a major goal. In each case spend some time brainstorming about where to go next, and talk to me and others to help you move forward. Do most of this work together with your group in the same room.

Work on your project with your group for a few hours every week. If you're stuck about what to do next, ask me.

1. **Become familiar with your introductory puzzle.** Start with your group's favorite puzzle from the Math Puzzles Handout. Try examples, draw pictures, identify and work through difficult aspects, make charts or tables of examples, write down observations. Solve the puzzle, or solve an easier version.

2. **Invent variations, and make the problem your own.** With your group, brainstorm several new variations of your original puzzle. Don't be afraid to completely reinvent the problem so that it bears no resemblance to the original. Also don't worry about whether the story behind the problem makes physical sense in the real world. The important thing is that your question(s) are interesting, and your solution(s) are attainable and interesting. A good problem should take hours, not seconds or weeks, to solve.

   It may help you to reflect on which aspects of the problem were most difficult, most interesting, most tedious, most exciting. How would changing various parts of the problem change the logical process for its solution? Which parts of the problem would make it nonsensical or overly simple if changed? If a variation isn't articulated well enough to actually have a solution, what rules can you add that will make it answerable? If you can't solve your puzzle, which parts are preventing you? Which ideas have you come up with that are new and unique? By making repeated modifications like these, change the problem enough so that it feels like your own and no longer like the one on the handout.

   At the end of this stage, you should discard the original puzzle, and it should not be part of your work going forward.

3. **Give yourselves small goals.** If you have a single hard problem you're working on for weeks or months, then your finished project might look great if you figure it out, but not so great if you don't. Break your problem(s) into small enough pieces that you figure something out regularly. Even if you don't answer the big question you had at the beginning (if you had one of those), you'll still have interesting things to work on.

4. **Build a collection of results.** Record your growing collection of results (answers to questions you've asked) in an organized way – try to make a table and look for patterns. This will often help you decide which question you should ask next.

5. **Summarize your results in a cohesive survey or outline.** Figure out your project's story. How does each question you asked and result you obtained progress logically to the next? As you do this, you'll probably identify jumps that you made along the way, or questions you could have asked but you ended up going a different direction. Try to make a reasonably comprehensive list of what questions you could have worked on, and which you ended up making progress on. If you have time left, try to fill in the gaps. When you run out of time, record the questions you didn't get to as possible directions for future research.

6. **Design your presentation to fit your audience.** Your perspective, after working on your project for a semester, will be different from someone who hasn't thought about the problem before. Introduce your project for someone who hasn't seen it before. This doesn't mean recreating your discoveries in the same order you found them – make your results easier for your audience to understand than they were for you to discover. Explain logical thought processes or vocabulary words that your group has become accustomed to that will seem foreign to someone outside your group. Explain as much as you can, but don't lose sight of the big picture by getting bogged down in excessive calculation.