Statistics for Engineering, 4C3/6C3

Mini-project: Design and analysis of experiments

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This DOE (design of experiments) mini-project gives you an opportunity of learning about designed experiments in a more hands-on manner.

The project is *not long*, and should *not be elaborate*. You only have a few weeks to plan your experiments, perform them and then analyze the data. You will hand in a short report (about 4 pages) on your work. Some more examples are given below, but it could be something like optimizing a favourite recipe or dessert, a hobby or sport, or it could be related to work from another course project or your graduate research (600-level students).

The intention is that you discover for yourself how important these topics are in DOE. Once you decided on a system to investigate you will be faced with:

- Which variables should we use?
- What range should these variables cover?
- How do we measure these variables (especially the response variable)?
- What other variability is in the system, is it measurable, is it controllable?
- Choosing the type of experimental design, center points, fractional designs, confounding pattern, and handling constraints.
- How many experiments should be run, are replicates possible, and how to randomize the runs.

These are topics that are not easily reproduced or understood from assignment questions and exams.

1 Project topics

You probably have a passion for your hobby, for cooking, or your research area, *etc*, so coming up with a system to investigate is no problem. However, some systems are too complex for the short time you have available, and you might have to cut back to something simpler. So below are some ideas that you can think about and modify, but please use anything you are interested in, or anything you have ever wondered about.

- Yield of stovetop popcorn or microwave popcorn
- Rise height of bread
- Algae growth in an aquarium
- Amount of tips received
- Gas mileage of a car
- Dissolving table salt
- The perfect meringue from egg-whites
- Time to melt ice
- Taste of pancakes (average of 4 tasters)
- Time taken to go down a ski slope
- Factors related to seed germination and growth (e.g. does Miracle-Gro work?)
- Growing plants from root cuttings
- Foam produced when pouring soft drinks into a glass

- Strength of wood glue bond
- Stain removal from clothes
- Hover time of a paper helicopter
- Flight time or distance of a paper plane or model plane
- Shot distance of tabletop hockey puck
- Factors related to paper towel absorbency, cost, softness, strength
- Burst time of soap bubbles

You might be fortunate that you have access to a lab for another course, or that one of your other courses overlaps in some way. You may even have an industrial partner from your co-op or current research area (grad students) with whom you can work. For example, a blown-film line, an extruder, a configurable heat-exchanger. Try to work with these as much as possible.

Finally, the system under investigation can be anything, however, you cannot merely copy-paste a problem that you found in a book, technical journal, website, or some other resource. You must be able to prove you planned and performed the experiments yourself. Also, if you have any ethical doubts (e.g. experiments on animals or people) then rather choose another system.

2 Group work

You may perform this project by yourself, with one other person, or with two other people. Try to ensure that the system is of interest to all group members, and that you can all contribute to the work.

3 The project report

Please structure your report according to these sections:

1. Describe your objective for the system under investigation.
2. Define the problem parameters: what are they, what is/are the outcome variable/s and how are they measured?
3. Plan an experimental program to change the system's parameters. Be specific on disturbance factors and how you control for them. Be specific on how you chose your design.
4. Execute the experimental program, logging all relevant details (e.g. experiments that are "weird", unusual events).
5. Analyze the experimental results using the tools introduced in the course.
6. The conclusions, related back to your original objectives.

The final report is to be about 4 pages (I prefer shorter than longer). Any appendices and extra information can be attached, specifically the original/scanned run sheet from your experiments. The total report should not be longer than 7 pages.

4 Guidance

- Feel free to email me with any questions.
- If you are uncertain if your system is suitable, run your idea by me before you go too far.
- Due to the short time line for this project you should consider systems where experiments can be done rather quickly, and results obtained soon.

5 Example of a previous project

A good example of the style and type of report required is in Box, Hunter and Hunter, page 215 to 219 (second edition), pages 368 to 272 (first edition).

6 Time line

15 March 2010, or earlier (optional) Hand-in a single page, and using bullet points, describe your system, and its parameters. Also discuss disturbance factors you think will affect your results, and your **planned** experiment (i.e. points 1, 2 and 3 from the main report). I will provide general comments in person or by email.

26 March 2010 (required) Hand-in of the final report (no late hand-ins please).