The Experimental Design Project

The Design Project is a major component of this course. Briefly, you must design, execute, analyze, interpret, and report on an experiment of your own choice. Here is how to proceed.

1. Select a system to study.
   Ex. 1: baking soda biscuits
   Ex. 2: your bicycle

2. Choose 3 or more controllable factors at 2 or more levels each.
   Ex. 1: flour type (white or whole wheat), amount of baking soda (none or 1/4 tsp.), fat source (vegetable oil or butter)
   Ex. 2: tire pressure (65 or 90 lbs in^{-2}), seat height (up 4 cm or up 8 cm), riding position (upright or "aerodynamic")

3. Choose a response variable (the performance attribute you will measure).
   Ex. 1: "quality" of the finished biscuit (How might you measure this? It requires thought.)
   Ex. 2: elapsed time to travel a set course on your bicycle

4. Select the experimental units.
   Ex. 1: each experimental unit (e.u.) is a batch of biscuits
   Ex. 2: each e.u. is you and your bicycle at a particular time and place [If you wanted to increase the scope of the experiment, you might obtain a collection of bicycles and a collection of riders. Then each e.u. would be a randomized combination of bike and rider.]

5. Assign the treatment combinations (t.c.'s) to the e.u.'s completely at random [unless you have a good reason to use some other design structure like randomized complete blocks or split-plot designs]

6. Execute the experiment. Be sure to run your experiment as it was designed!! For example, don't design your experiment as a CRD and then run it with split-plots. Be sure to control the inputs carefully so that you don't introduce unnecessary noise.

7. Measure the response. Again, do this carefully so that you don't introduce noise through sloppy work. Keep a record of the order in which the results were obtained and record any other concomitant variables that may have affected the results, e.g., air temperature.

8. Perform the data analysis, including an analysis of residuals, data re-expression if indicated, analysis of means, and interpret the practical meaning of the results.

9. Write a report in which you communicate your research question, what you did to investigate the question, how it turned out, and what the results mean. (See back of this page for report specs.)

Project Evaluation

I will evaluate your project on the basis of the following elements:

a) your choices of study system, research question, factors and levels. (There is no magic formula here, but it is a good bet that if you find the project interesting, then I will too.)

b) the thoroughness of your data analysis and interpretation

c) the quality of your discussion, and

d) the presentation of your final written report (The finished report should have a professional look.).

Deadline: Monday of the last full week of classes. Late penalty: 5 percent deduction per day late.

See Chapter 7 of the F2150 course text for an example of a student design project along with its analysis and interpretation.
Final Report Specifications
Minimum size
Your experiment must have at least 3 factors, each at no less than 2 levels, and each treatment combination must be run at least twice (= 2 replications). So the smallest experiment allowed will have 2x2x2x2 = 16 runs.

Report Format Specifications
Follow the Faculty of Forestry and the Forest Environment Writing Manual and Style Guide in all matters having to do with margins, section headings, tables, figures, literature citations, and so on. You can buy the Writing Manual in the Bookstore or rip it off at:
http://flash.lakeheadu.ca/~yprevost/Teach/ManualWeb.htm

Report Contents
Title – Do not exceed 15 words. Do not include redundant words such as "An investigation of the effects of ..." or "A report on ..."
Abstract – State the problem. Tell briefly what you did. Tell briefly the major result(s). Do not exceed one paragraph.
Table of Contents, List of Tables, List of Figures – See the Writing Manual and Style Guide for format.
Introduction – What problem, question or issue motivates your work? Briefly, what did you do? Briefly, what was (were) the major result(s)?
Methods and materials – Describe what you did in sufficient detail so that the reader could replicate your work. Include a map of the experimental layout.
Results – Present your data and the results of all statistical analyses. Analyses should include: the linear model for your experiment, the associated EMS table, the ANOVA table, an examination of ANOVA residuals to determine whether or not the ANOVA assumptions have been met (look for lack of symmetry, lack of homogeneity of variance, and outliers), re-expression of the data if indicated (followed by a new ANOVA and subsequent check of the new residuals), and an analysis of treatment means along lines indicated by the ANOVA F-test results. In the analysis of means, consider the statistically significant high-order interactions first, plot the interaction means and use ellipses to indicate groups of means that are not significantly different. Plot the 3-way and at least one 2-way interaction in order to show me that you know how to make these plots and interpret the post hoc test results associated with them. If the interactions are statistically significant, then you the interaction plots and post hoc test results belong in the body of your report. If you plot an interaction that is not significant in order to show me you know how to do it, then add an appendix to your report that contains the not significant results. If possible, plot residuals against run order and against any concomitant variables that you may have measured. Look for trends in these plots and, when you believe you see a trend, ask whether the trend makes sense. Try to give possibly meaningful trends a plausible interpretation. Report only the significant digits in your results. That is, if you measured your results to the nearest 0.1 kg, don't report that the average weight was 11.3276486 kg.
Discussion – "Discussion" in the context of a scientific or technical report means "discussion of the results." You should discuss the degree to which your data meet the ANOVA assumptions. And, you should discuss the practical interpretation of the analysis of treatment means. In the Introduction and again in the Discussion, you should address yourself to practitioners in the field you have studied. For example, if your experiment had to do with driving golf balls, write about the problem (in the Introduction) and about the practical results (in the Discussion) using language that a golfer would understand and appreciate.

See Chapter 7 in the F2150 classnotes for an example that illustrates the analyses to perform and how to write the results and discussion sections of a report.