Chapter 1: The Experiment, the Design, and the Analysis

The first chapter of the text deals with some of the fundamental concepts necessary for this course. The objective of this class is to enable you to design, carry out, and analyze the results of experiments, so that you are able to perform high quality research in your area of choice. Toward this end, your text first defines Research as a systematic quest for undiscovered truth.

Using this definition, making the observation "there are a lot of black Honda Accords out there" while drinking a beer on your deck is not research. However, suppose that you were to walk through a parking lot and count the total number of cars that you see and the number of them that are black Honda Accords. If you then observe that "one of the more common types of cars driven by Mizzou faculty, staff, and students is the black Honda Accord," you have done research.

Additionally, we will define a True Experiment as a study in which certain independent variables are manipulated, their effect on one or more dependent variables is determined, and the levels (values) of these independent variables are assigned at random to the experimental units. In this class we will primarily confine our discussions to true experiments.

Before we discuss designing experiments further we need to define a variety of different terms that you will use throughout this course.
Definitions

Suppose that a civil engineer is interested in studying the growth of bacteria in waste water treatment plants. He hopes to discover which set of conditions leads to the most growth of a beneficial bacterial strain. He is interested in studying two types of containers, open and covered, and two different temperatures, 70 and 90 degrees. To perform the experiment, he obtains permission from 10 plants to use their tanks for the experiment. Each plant has both open and covered tanks, but can maintain the water at only one of the two desired temperatures. Thus, the engineer randomly assigns a temperature to each plant, and then measures the change in the number of bacteria in both open and covered tanks at the start and end of a four week period.

Considering this situation, define the following terms:

**Treatment:** The set of conditions which are of interest to the experimenter. In this situation, it is the temperatures and container types.

**Experimental Unit:** The item to which the treatment of interest is applied. In this case, it is the individual tanks at the different water treatment plants.

**Universe:** All possible experimental units, present or future, that are of interest to study. This is all possible water treatment tanks that were or will ever be built.
**Population:** The measurements that could be made upon all of the experimental units in the universe. This is all possible changes in the number of bacteria in the tanks for every tank present and future.

**Independent Variables:** Controllable experimental variables either quantitative or qualitative. These may also be called "factors". In this case, the factors are the temperature of the water, and whether or not the tank is covered.

**Dependent Variables:** Characteristics of the experimental units whose values may be either qualitative or quantitative. Note that these may also be called "response variables". The change in the number of bacteria in the tanks is the dependent variable in this example.

**Qualitative Variables:** Have values which vary by category rather than numerical degree. For this situation, the type of tank is qualitative.

**Quantitative Variables:** Have values that are counts or measurements which vary by numerical degree. In the example, the temperature is quantitative.

**Fixed Effects:** Factors whose levels are set at specified values. In this case, both the temperature and the tank type are set at particular values.

**Random Effects:** Factors whose levels are randomly selected from all possible levels. In this example, we do not have any random effects.
**Treatment Combination:** A combination of the levels of two or more independent variables to be studied in the experiment. This situation has four treatment combinations: open at 70, open at 90, covered at 70, and covered at 90.

**Factorial Experiment:** A design in which at least one response is observed for each possible treatment combination. Our example is a factorial experiment, as the engineer sees at least one tank for each of the combinations above.

**Nested Experiment:** A design in which the levels of one factor are chosen within the levels of another factor. Our engineer has the tank type nested within the temperature. This is because he has to assign one temperature to each plant, and then observes tanks of both types within that plant.

Please read Chapter 1 in the text.
Examples

Example 1: Aaron is an ornamental horticulturist interested in studying the effects of the amount of irrigation on the number of flowers on a tulip plant. He wishes to compare 1, 3, and 7 waterings per week. In addition, Aaron is concerned that the insecticide used to treat the plants may effect the watering schedule, so he selects three of the insecticides available on the market to treat his plants, call them A, B, and C. He has 36 plants available, and he plans to give four plants each of the nine possible irrigation/insecticide combinations. He will count the number of flowers produced by each plant during the one month in which the study will take place.

True experiment?
Experimental Unit:
Universe:
Population:
Independent variable(s):
Dependent variable(s):
Qualitative variable(s):
Quantitative variable(s):
Fixed Effect(s):
Random Effect(s):
Treatment Combinations:
Factorial?
Nested?
Example 2: Bethany is a graduate student studying the nesting habits of big brown bats. She has 100 bat houses which she will be using in this experiment. She wishes to determine whether bats prefer houses placed high (12 feet) or low (6 feet) from the ground, and whether they prefer forested or open terrain. She will consider both heights of house in both terrains. For each house, she will record whether or not bats are present after four weeks.

True experiment?
Experimental Unit:
Universe:
Population:
Independent variable(s):
Dependent variable(s):
Qualitative variable(s):
Quantitative variable(s):
Fixed Effect(s):
Random Effect(s):
Treatment Combinations:
Factorial?
Nested?