STATISTICS 402 - Assignment 4
Due February 11, 2009

1. For each of the following descriptions indicate what the response is, what the conditions are (i.e. factors of interest) and what the experimental material is. Then discuss whether or not the experiment adheres to the three fundamental principles of a designed experiment: control of outside variables, randomization, and replication within the experiment. If the experiment adheres to a principle describe how. If the experiment does not adhere to a principle indicate how you would change the experiment to make it better. Be specific and be sure to comment on all three principles.

   a) An aluminum smelting operation makes its own carbon anodes for use in their aluminum smelting pots. The density of the anode is an important quality characteristic because it affects the usable life of the anode. An experiment is conducted to see the effect of bake temperature on anode density. Twenty anodes are made using the same raw materials, methods and people. Five anodes are assigned at random to each of four temperatures, 500, 525, 550 and 575 ^{o}C. A temperature is picked at random and the five anodes are baked in the oven at that temperature. One of the remaining temperatures is picked at random and the five anodes are baked in the oven at that temperature. This random selection of a temperature and baking 5 anodes continues until all temperatures have been used once. The density of each anode is then measured. The order in which the anodes have their density measured is completely random.

   b) A chemist wants to compare a new, and simpler, method for determining the concentration of a solution with the standard method. She prepares a batch of solution, divides it into 40 specimens, and then selects 20 at random. She asks her technician to analyze these 20 specimens using the new method and the remaining 20 using the standard method. The technician finishes analyzing the 20 specimens using the new method in the morning. He takes a break for lunch and does the remaining 20 specimens using the standard method in the afternoon.

   c) A research psychologist wishes to investigate the difference in maze test times for mice trained using different types of reinforcement; no reinforcement, positive reinforcement (food given for a correct choice), negative reinforcement (mild electric shock given for an incorrect choice). Thirty mice are available for the experiment. For each mouse a fair 6-sided die is rolled. If the roll is a 1 or 4 the mouse is assigned to group 1 (no reinforcement). If the roll is a 2 or 5 the mouse is assigned to group 2 (positive reinforcement). If the roll is a 3 or 6 the mouse is assigned to group 3 (negative reinforcement). After rolling the die 30 times there are 7 mice in group 1, 12 mice in group 2 and 11 mice in group 3. The design of the maze used to train the mice is the same for all mice. After training, a new maze design is used to test the mice. Each mouse is run in the new maze and the time to complete the new maze is recorded. The design of the new maze is the same for all mice.

2. Below are two scenarios for an experiment involving chocolate chip cookies. Different recipes for the cookies are used. Trained tasters evaluate the cookies on moistness, texture, flavor, greasiness and appearance. The evaluations are combined to give an overall appeal score for the cookie with higher values indicating greater appeal.

   - Scenario 1: One batch of cookie dough is made with vegetable margarine, one batch with vegetable oil, one batch with butter and one batch with vegetable shortening (Crisco). Twenty cookies are baked from each batch of dough.

   - Scenario 2: Five batches of cookie dough are made with vegetable margarine, five batches with vegetable oil, five batches with butter and five batches with vegetable shortening (Crisco). Four cookies are baked from each batch of dough.

   a) What is the response? What are the conditions (i.e. factor of interest)? What is the experimental material?

   b) What is the planned systematic variation in the experiment?

   c) For each of the scenarios describe what the chance variation is in the experiment and the source of this variation. Be specific.

   d) Suppose cookies made with butter are found to have a significantly higher mean appeal score than those made with vegetable products. For each of the scenarios discuss what sort of generalization can be made?