HW1 Solution Notes

2.

(a) Describe the three kinds of paper airplanes you decide to compare.

(b) List materials needed, e.g. paper (including weight and size), paperclips, tape, et cetera. If there is the possibility of unwanted variation in "normal" sources of these materials, how might you minimize this variation?

(c) Fifteen experimental units, or quantities of material necessary to make a paper airplane, are to be randomly divided into three groups of equal size, with one airplane design to be implemented using the 5 units in each group. Assignment rules that provide equal probability to each possible division of the material could be implemented with playing cards, here using 5 cards from each of 3 suits. Once this has been accomplished, the units (with treatments assigned) could be numbered from 1 to 15, and 15 identical paper tags numbered from 1 to 15 could be mixed in a "hat" and drawn out one at a time, without replacement, to determine the order of execution.

(d) The word "procedure" implies not just general discussion of what the paper airplanes are like, but specific step-by-step instructions on how the planes should be constructed. Specificity is an important aspect of writing experimental "protocols" because it helps to minimize variation that might otherwise occur if implementation details are left to those who carry out the application of treatments to units.

(e) The response of interest is "time-of-flight" under stated standard conditions. What is the most reliable and/or precise way to measure this (without spending a fortune on esoteric equipment)? One can think of methods involving a stopwatch with an operator, and two careful "observers" who verbally announce when the airplane leaves physical contact at launch, and when it first touches the floor. Might a better method be based on use of a digital video recorder?

3.

(a) Design A can potentially generate the largest sample sizes (but may not if most of the individuals you poll don't use the brands of interest to you); there is substantial uncontrolled variation with this plan, associated with the kind of vehicle driven by each poll respondent. Design B is more tightly controlled than Design A, but risks confounding "weather" with "brand" if the season changes during your 3-month test period. This confounding is less likely with Design C.

(b) Designs B and C lead to studies that can be regarded as experimental, in that "treatments" are assigned to "units" in a controlled manner, while Design A is a survey rather than an experiment. However, neither of Designs B or C assigns treatments to units in a *randomized* manner, so each risks bias due to other influences.

5. Treatments are defined in terms of two *factors*, the fertilizer and variety used in each case. *Replication* requires that multiple plants be grown that are of the same variety and receive the same fertilizer. In this case, a variety cannot be *randomly applied* to a plant, but randomization can be used to assign plants to fertilizers, and to locations within a garden bed. Continued experimentation in a second year may be desirable, but the potential for systematic effects due to differences between growing seasons (e.g. climate and pest populations) might suggest treating the two years as *blocks*.