A. Design of Experiments

1 Controlled Experiment Versus Observational Studies

A designed experiment is conducted to investigate a cause-and-effect relation between one/one+ (explanatory) factors (or predictors) and a response variable (or response variables) and is usually comparative in nature. For instance, an experiment may be conducted to compare the effects of three types of gasoline additives (treatments) on the performance of automobiles. The factor is type of gasoline additive with three levels (treatments) A, B, and C, say. The response of interest may be the MPG of an automobile (an experimental unit).

**Controlled Experiment** A controlled experiment is one in which each experimental unit can freely receive any of the treatments under study. So the experimenter can assign treatments to experimental units (through randomization).

**Observational Study** In an observational study, an object/entity/subject (as an experimental unit in controlled experiment) is either self-selected into one of a number of known groups (treatments, as in controlled experiments) or it exists in its particular circumstances.

2 Principles of Planning Experiments

Three basic principles in planning experiments are discussed.

1. **Replication** to ensure the estimability of experimental error.

2. **Randomization** to eliminate the effect of unknown source(s) of variations that may bias the estimations in the analysis of experimental data.

3. **Blocking** to reduce the estimation error that can be caused by known source(s) of variations.

   When a known source of variations is planned/ incorporated in experiment, it is called blocking and the variables that is indicative of this source of variation is called a blocking factor. The levels of a blocking factor are called blocks.

   In executing a planned experiment, it is advisable to record the values (or levels) of any known source of variations that is not part of the explanatory factors considered in the experiment (and yet may be of significant consequence to the analysis/conclusion). When a known source of variations is not blocked, it may affect the response(s) in certain way. Such variable is called a covariate (in the analysis). A thorough analysis with the consideration of covariate(s) may lead to more accurate analysis/conclusion or may lead to the recommendation of the inclusion of such variables in the next stage of experimentation (as additional factors, or as blocking factors).