Introduction to Design of Experiment

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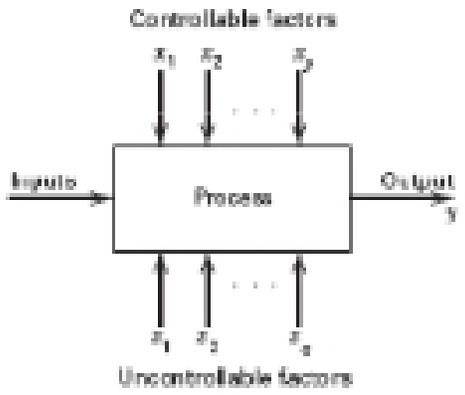
What Are Experiments

- Experiment
  - A test or a series of tests in which purposeful changes are made to the input variables of a process or system to study how these changes can affect the output of the process or system



- Determine which controllable factors X_i affect the output Y
- Determine how to set the values of X_i so that Y can be (nearly) at the desired value
- Determine how to set the values of X_i so that the variability of Y can be small
- Determine how to set the values of X_i so that the effect of Z_i can be minimized

General Model of a Process or System

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Examples of Experiments

Hardness Example. A metallurgical engineer is interested in studying the effect of two different hardening processes – oil quenching and saltwater quenching – on an aluminum alloy. The objective of the experiment is to determine which quenching solution produces the maximum hardness for this particular alloy.

Golf Play Example. You are looking for tricks to help lower your golf score. You want to test how the following factors may influence your golf score:

1. Type of driver used (oversized vs. regular sized)
2. Type of ball used (balata vs. three piece)
3. Mode of travel (walking and carrying the golf clubs vs. riding in a golf cart)
4. Type of beverage (drinking water vs. drinking beer while playing)

See pages 8 – 11 of the textbook for other examples of experiments for different engineering applications.

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Types of Variables

- Design Factors/Independent Variables
  - The variables whose effects are the studied in the experiment
  - Values are described as levels
  - Can be one or more than one in an experiment

Hardness Example: Quenching solution (oil quenching vs. saltwater quenching)
Golf Play Example: Type of driver; Type of ball; Mode of travel; Type of beverage

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Types of Variables (Cont'd)

- Response Variables (Dependent Variables)
  - The variables whose values are affected by the independent variables in the experiment
  - How the dependent variables are measured
    - Ensure reliability of the measurement
    - Minimize measurement error

Hardness Example: Hardness of the tested alloy specimen

Golf Play Example: Golf score

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Types of Variables (Cont'd)

- Extraneous Variables
  - Variables that can affect dependent variables but are of no interests
  - Their effects should be eliminated (or at least minimized)
  - Held-constant variables
    - Their values are held at a specific level
  - Blocking variables
    - Their values can be set at different levels
    - Each level is treated as a block
  - Allowed-to-vary randomly variables
    - Use randomization to balance out their effects
  - Covariance variables
    - Uncontrollable but can be measured
    - Use analysis of covariance to account for their effects

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