

**An-Najah National University**  
**Faculty of Engineering**  
**Industrial Engineering Department**

**Course :**  
**Quantitative Methods (65211)**

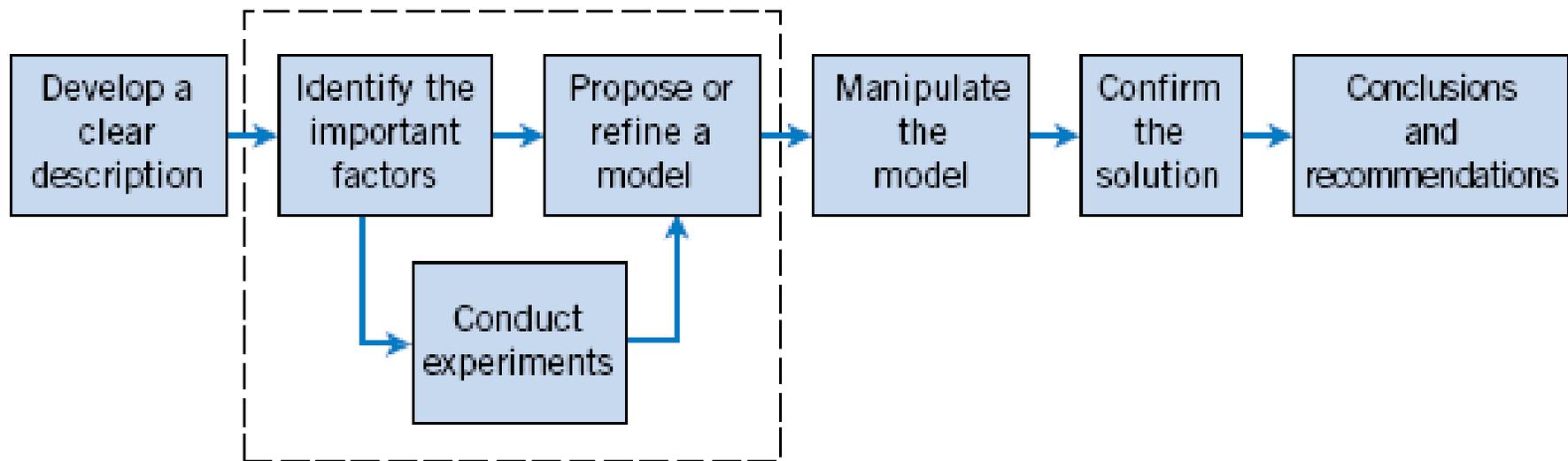
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# Chapter 1

## The Role of Statistics in Engineering

### 1-1 THE ENGINEERING METHOD AND STATISTICAL THINKING:



**Statistics** → collection, presentation, analysis, and use of data to make decisions, solve problems, and design products and processes.

❑ Statistical techniques can be a powerful aid in designing new products and systems, improving existing designs, and designing, developing, and improving production processes.

❑ Statistical methods are used to help us describe and understand **variability**, and **statistical thinking** can give us a useful way to incorporate this variability into our decision-making processes.

➤ **Example:** Sugar Bags Weights

1000, 990, 995, 1005, 1008, 998 (gm)

Weight  Random Variable

This Model is represented as follows:

$$X = \mu + \varepsilon$$

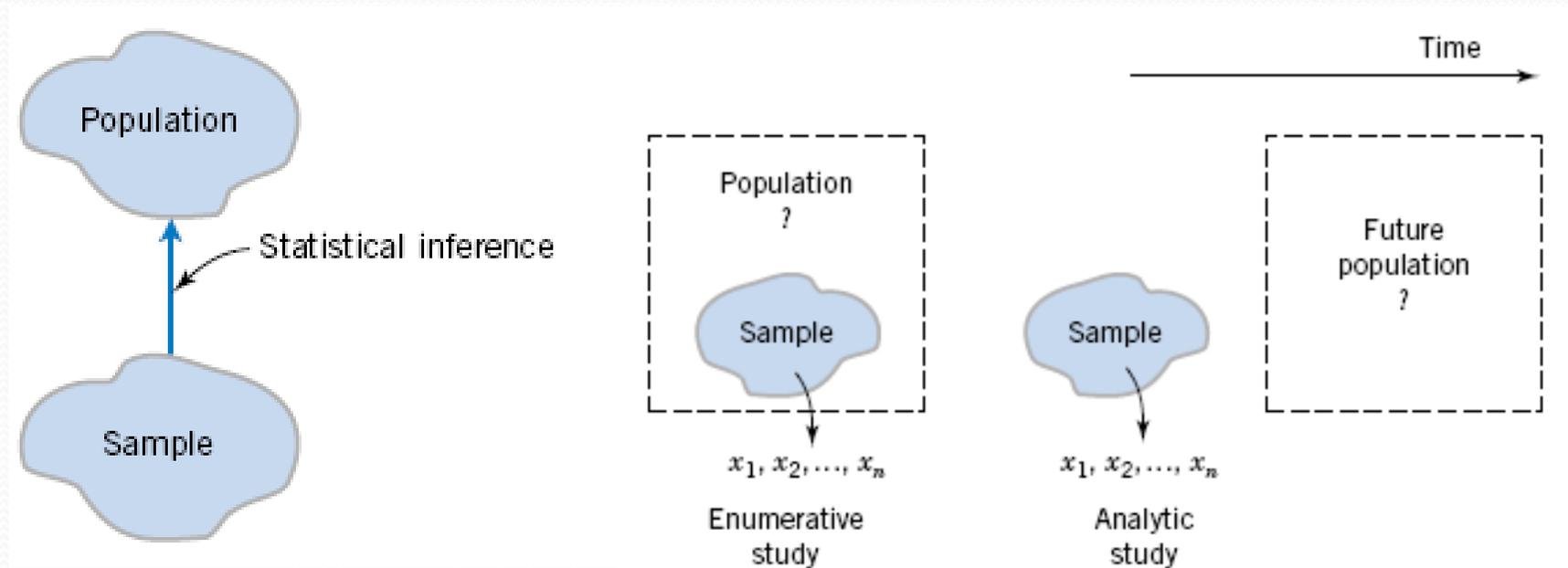
Where:

X : Intended Measurement

$\mu$  : Constant

$\varepsilon$  : Random disturbance

- ❑ **Statistical Inference:** measurements were obtained from a sample of people and generalized to a population



**Enumerative Study:** Collecting data from a process to evaluate current population.

**Analytic Study:** Using Data from current process to evaluate future population.

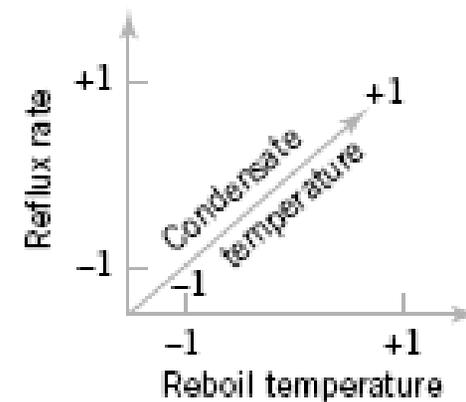
## 1-2 COLLECTING ENGINEERING DATA:

□ In the engineering environment, the data is almost always a sample that has been selected from some population.

Three basic methods of collecting data are

- ❖ A retrospective study using historical data
- ❖ An observational study
- ❖ A designed experiment

Reboil Temp.	Condensate Temp.	Reflux Rate
-1	-1	-1
+1	-1	-1
-1	+1	-1
+1	+1	-1
-1	-1	+1
+1	-1	+1
-1	+1	+1
+1	+1	+1



## **1-3 MECHANISTIC AND EMPIRICAL MODELS**

- ❑ Models play an important role in the analysis of nearly all engineering problems.
- ❑ Much of the formal education of engineers involves learning about the models relevant to specific fields and the techniques for applying these models in problem formulation and solution.

➤ **Example:** Measuring current flow in a thin copper wire.

This Model is represented as follows:

Current = Voltage / Resistance

$$I = E / R$$

This Model is called (***Mechanistic Model***) because it is built from our underlying knowledge of the basic physical mechanism that relates these variables.

Due to Variability, this model can be written as:

$$I = E / R + \varepsilon$$

➤ **Example:** Suppose we are interested in the number average molecular weight ( $Mn$ ) of a polymer.

This measurement depends on three factors:

$$Mn = f(V, C, T)$$

Where:

$V$ : viscosity of the material

$C$ : the amount of catalyst

$T$ : the temperature

Knowing that the form of the function is unknown. A suitable model could be produced in the following form:

$$Mn = \beta_0 + \beta_1 V + \beta_2 C + \beta_3 T + \varepsilon$$

This Model is called (***Empirical Model***) because it uses our engineering and scientific knowledge of the phenomenon, but it is not directly developed from our theoretical or first-principles understanding of the underlying mechanism.

## 1-4 PROBABILITY AND PROBABILITY MODELS

- ❑ **Probability models** help quantify the risks involved in statistical inference, that is, the risks involved in decisions made every day.
- ❑ A probability model is used to calculate this proportion under reasonable assumptions for the manner in which the sample is selected.
- ❑ When populations are extended in an analytic study, the role of statistical inference and the associated probability models becomes even more important.

## 1-5 OBSERVING PROCESSES OVER TIME

### **Time Series Plot**

#### Control Chart Characteristics:

- Center Line
- Upper Control Limit
- Lower Control Limit

