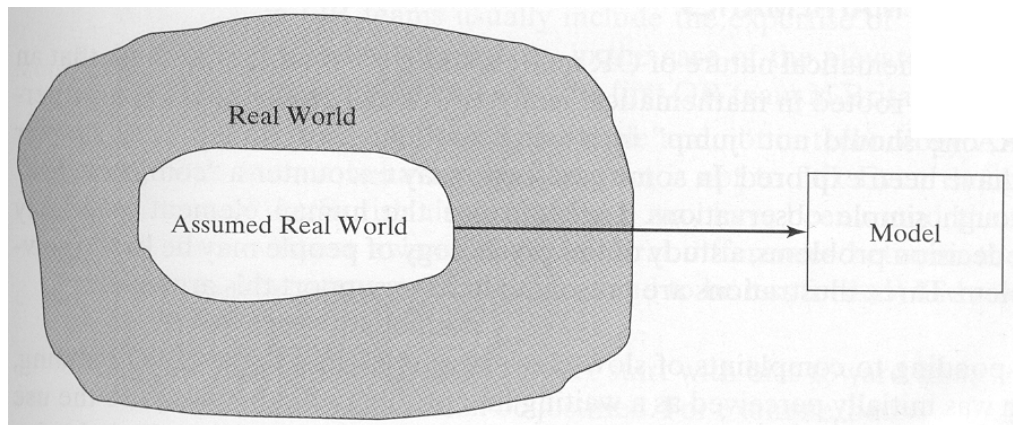


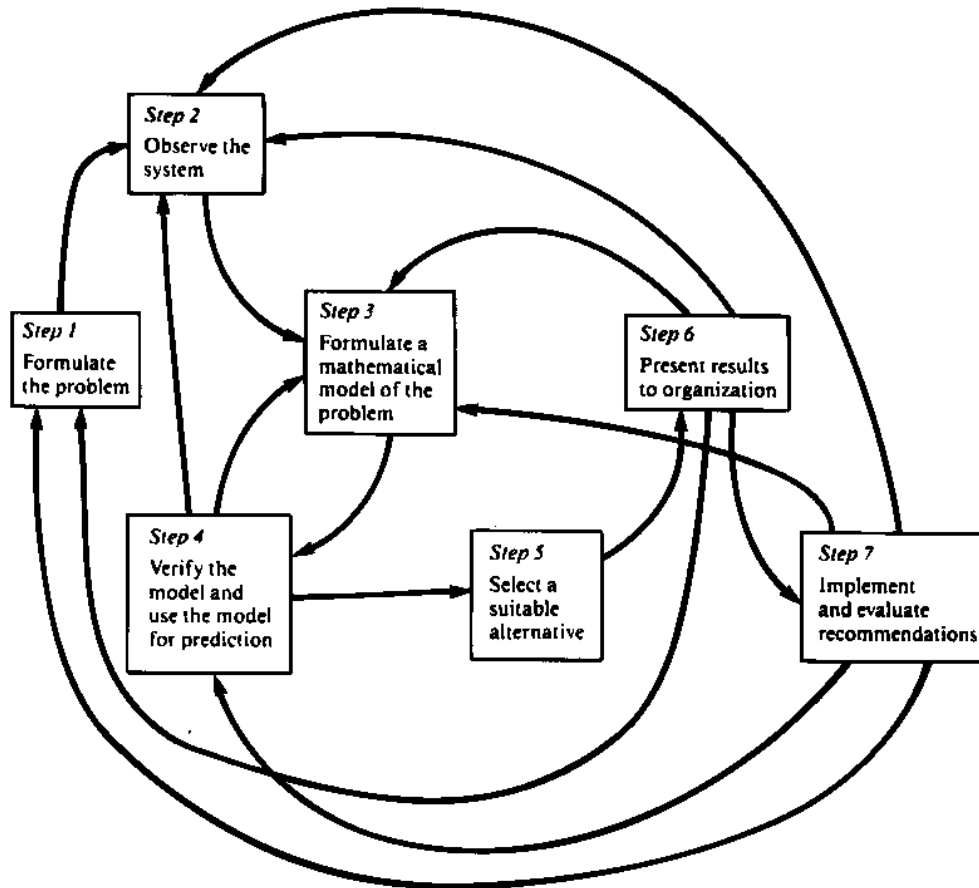
## The OR Modeling Approach

- **What is special about the OR analysis approach?**
  - (i) *A primary focus on decision making.* The analysis must lead to clear suggestions to the decision maker.
  - (ii) *An appraisal resting on economic effectiveness criteria* (e.g. cost, profit, rate of return, etc.).
  - (iii) ***Reliance on a formal mathematical model.***
  - (iv) *Dependence on computers* (due to complexity of real world mathematical models.)
- **What is a model anyway?**
  - *A model is an abstract representation of the real world* physical, social, or other systems in terms of mathematical equations, logical relationships, computer programs, flow diagrams, drawings, or other forms.



- **Types of models**
  - *Iconic (scale) models, e.g., map, blue print.*
  - *Mathematical models.*
- **Math models**
  - A mathematical model defines measurable *observables*,  $\mathbf{f} = (f_1, f_2, \dots)$ , that relate the state of a system,  $\Omega$ , to real numbers,  $\mathbf{f} : \Omega \rightarrow \mathbf{R}$ .
  - E.g., the laws of physics,  $F = ma$ ,  $E = mc^2$ ,  $PV = eT$ .
  - Equations such as these laws relating the observables of a model are known as the equations of states.
  - The model observables are classified into *parameters*, control or *decision variables*, and *output* or *response variables*.
- **E.g., the newsvendor model.**
  - A newsvendor faces a random daily demand of  $X$  newspapers.
  - The cost of a newspaper is  $c$ .
  - The newsvendor sells each newspaper for  $p > c$ .
  - Unsold newspapers have no value.
  - The parameters are  $p$ ,  $c$ , and  $f_X(x)$  the pdf of  $X$ .
  - The decision variable is  $y$ , the number of papers to buy every morning.
  - The response variable is the expected profit,  $\Pi$ .
  - The state equation is  $\Pi = p \left[ \int_0^y x f_X(x) dx + \int_y^\infty y f_X(x) dx \right] - cy$ .

## •Steps of the OR modeling approach



**Step 1.** *Formulate the problem.* Define objective, scope, and data needed.

**Step 2.** *Observe the system.* Collect data to estimate the parameters.

**Step 3.** *Formulate a mathematical model of the problem.*

**Step 4.** *Validate (verify) the model and use the model for prediction.*

Answer these questions: Are the model results reasonable? Are the model predictions close to current values? Is the model *robust*? Go back to Steps 2 and 3 if answers are No.

**Step 5.** *Select the suitable alternative(s).* The model may give the best (optimal) solution. However, this might be costly to implement. Many times one selects *good* solutions rather than optimal ones.

**Step 6.** *Present results to organization.* Decision makers may or may not like Step 5 alternatives based on their experience. Good managers are usually right. Go back to steps 1, 2 or 3 if they reject the alternatives.

**Step 7.** *Implement and evaluate recommendation.* Apply solution and monitor the system to check if objectives are met. Go back to earlier steps.

- **Principles of modeling**

1. All models are approximate; however some models are better than others.
2. Do not build a complicated model when a simple one would suffice.
3. Do not model a problem to merely fit the technique.
4. The deduction stage must be conducted with rigor.
5. Models should be validated before implementation.
6. A model should not be taken too literally (it shouldn't replace reality and human intuition).
7. A model cannot be better than the information that goes into it - JIJO (Junk in, Junk out).