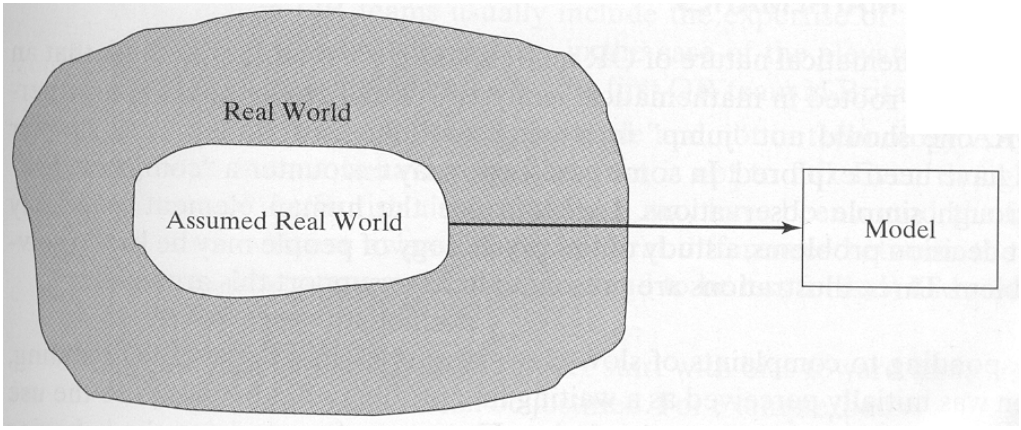
The OR Modeling Approach

- **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.

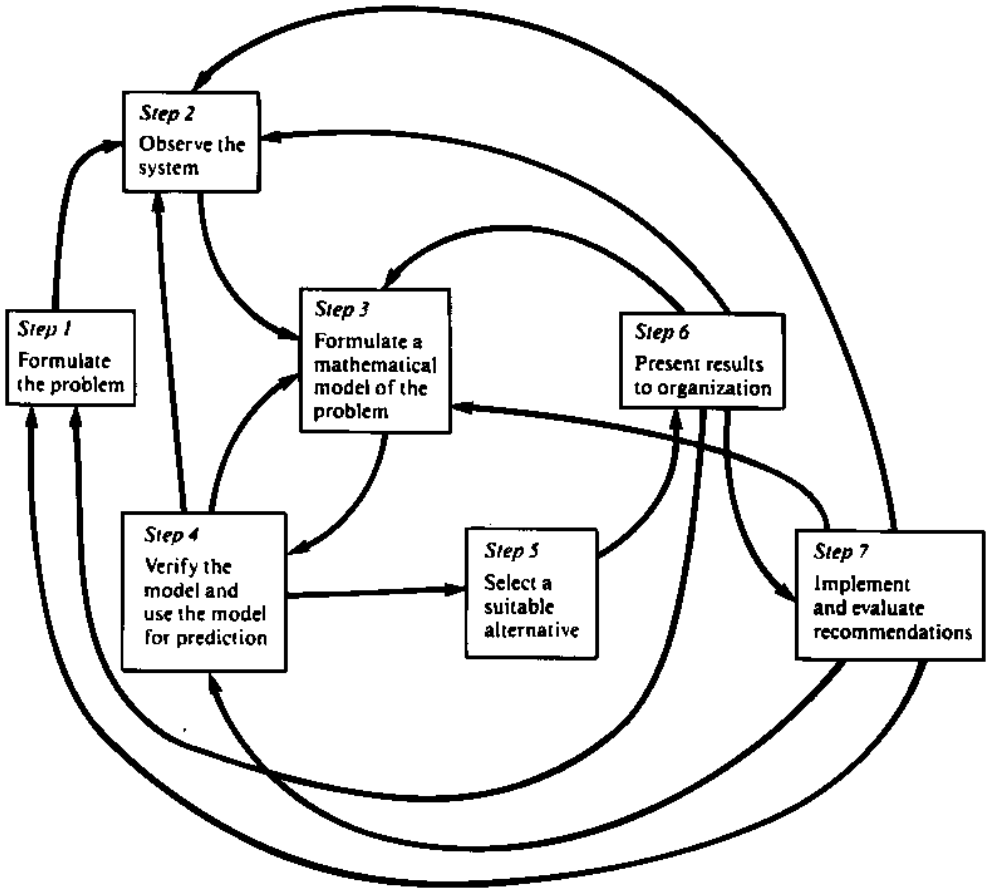


- **Types of models**
  - *Iconic (scale) models, e.g., map, blue print.*
  - *Mathematical* models.

- **Math models**
  - A mathematical model defines measurable *observables*, $\mathbf{f} = (f_1, f_2, \ldots)$, that relate the state of a system, Ω, to real numbers, $\mathbf{f} : \Omega \to \mathbf{R}$.
  - 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, Π.
  - 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).