



An Introduction to Models and Probability Concepts

J. Reeb and S. Leavengood

According to the Operations Research Society of America, “Operations research is concerned with scientifically deciding how to best design and operate man-machine systems, usually under conditions requiring the allocation of scarce resources.” This publication is the first in a series describing operations research (OR) techniques that can help forest products managers solve complex problems. It will introduce basic concepts of models and probability.

Models

No matter how OR is defined, the construction and use of models is at its core. Models are representations of real systems. They can be iconic (made to look like the real system), abstract, or somewhere in between.

Iconic models can be full-scale, scaled-down, or scaled-up in size. Saw-mill headrig control simulators are full-scale models. A model of the solar system is a scaled-down model, and a teaching model of a wood cell or a water molecule is a scaled-up model. Models can be made of the same material as the system they represent, such as the headrig control simulator, or they can be made of different materials, such as a plastic model of the solar system.

On the other end of the model spectrum are abstract mathematical models (Figure 1). OR professionals often use mathematical models to make simplified representations of complex systems.

Regardless of the type of model used, modeling includes the following steps:

1. Defining the problem and gathering data
2. Constructing a model of the system
3. Deriving a solution
4. Testing the model and solution (Is the model valid; that is, does it do what it is designed to do?)
5. Implementing the solution

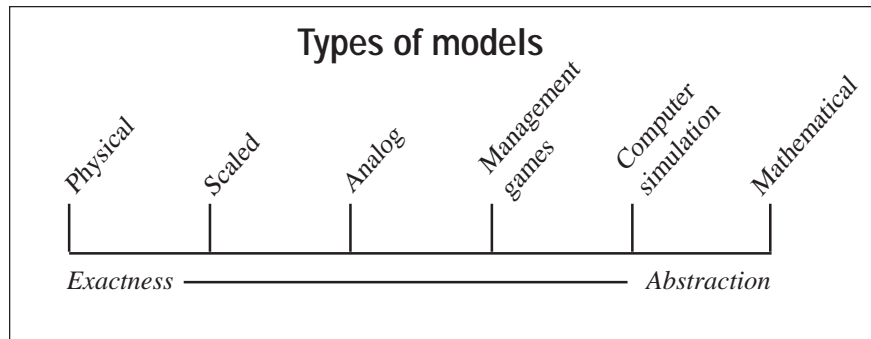


Figure 1.—Models range from physical to abstract (Source: Shannon, R.E. *Systems Simulation: The Art and Science*).

Why use models?

Why not experiment with the actual system? If the actual system is simple enough to manipulate safely, then OR techniques often are not necessary. For example, managers of a sawmill might wish to extend the hours for loading trucks from 5:00 p.m. until midnight. Since the shipping shed is adjacent to the planer mill, they decide to use the planer mill employees and possibly one or two overtime employees from shipping to extend the loading hours for a trial period of 2 to 3 weeks. At the end of this time, they'll have a good idea of how the extended shipping hours affected the rest of the sawmill operations.

An OR professional also could model this problem, perhaps using a scheduling linear program or a simulation model to examine the effect of extending the shipping hours. However, if the real system can be manipulated without causing too much disruption, it would be preferable to do so rather than to have an OR professional model it. Often, it can take weeks or months just to collect enough data to realistically model a system. In this case, it probably would be less expensive to manipulate the real system.

In other cases, manipulating the real system is neither simpler nor less expensive than building a model. For example, very long time periods may be involved, or management may wish to examine substitutes for the real system. Also, real systems often are too complex to experiment with directly. The actual experimentation may be infeasible, disruptive, or too expensive. There are several ways to study a system without experimenting with the real system (Figure 2).

Why use models?

- Real systems may be too complex.
- Models may be less expensive.
- Models can test options without disrupting the real system.
- Modeling provides new insights into the real system.