Model Behaviour

Simulation is a computer technique that allows you to experiment with what would otherwise be a dangerous or expensive situation. Home computer simulations can be very educational

One of the most important uses of computers is in the area of simulation. This is a method of forward planning in which a model of the situation to be analysed is 'simulated' on the computer. A model gives a simplified view of the situation, retaining the significant features of the problem and discarding minor details that will have little influence on the results.

Let us take the example of two glasses, one containing white wine and the other red wine. If a spoonful of the red wine is added to the white, thoroughly mixed and then a spoonful of the mixture is returned to the red glass, which glass has the greater impurity?

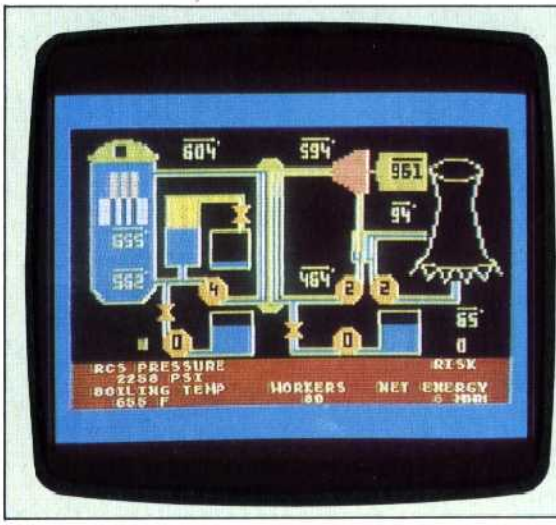
There are many ways to solve the problem, but one of the simplest is to use a model. For example, we could set up a model in which the volume of wine in each glass is exactly one spoonful. It is easy to see that in this instance both glasses will end up with the same degree of impurity (an equal mixture of red and white wine). Extending our model for larger quantities of wine will show that the same is true in these cases.

Models appear in three main forms. A pictorial model — for example, a photograph or a map — shows spatial arrangements and relationships between elements in that picture. Then there are models whose components behave in relation to each other in a similar way to the real elements they represent in the problem — for example, the problems solved by analogue computers (see page 238). The third type are symbolic models that use abstract symbols and mathematical relationships to represent the situation. It is this last type that digital computers use in simulation.

There are four main situations in which we might choose to solve a problem by simulation on a computer. The first is where the situation might be too dangerous to experiment with — for example, determining what level of radioactivity is safe in the countryside around a nuclear reactor.

The second situation, of which a good example is a model of the national economy, is where it would be almost impossible to find a pure mathematical solution to the set of equations that make up the problem. It is better to set up the equations in the form of a model on the computer and observe the effects on them of different actions and events.

The third case is where the problem to be analysed involves so much expense that any adjustments must be put into effect at the model stage before a commitment is made to the final version. In the planning of a proposed new airport for London, for example, extensive simulation work was done for the engineering and planning problems. This simulation investigated noise and other environmental considerations, as well as the flow of people and traffic around the proposed site.



Under Control
An important use of simulation is in education, where people are trained on models of real systems. An example is Atari's simulation of a nuclear power station, in which the user has to control the various cooling systems to prevent the reactor from overheating. The documentation explains fully the various control functions within such a power station, and there is also a demonstration mode that will run the program for you

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The other situation in which a model is valuable is one involving a problem that is totally theoretical and in which it is impossible to carry out physical experiments. Astrophysicists, for example, speculate on how stars are formed, and models are used to evaluate one cosmological theory — say the 'Big Bang' theory — against another.

In every simulation the first job is to construct the model. A model is made by studying the situation and deciding what the important elements are and how they interrelate.

Systems and their models fall into two families: 'deterministic' or closed systems, and 'stochastic' or open-ended systems. When a family budgets its expenditure the money can be allocated in many ways, but the books must balance in the end — making it a deterministic system. However, if the family based every decision to spend money on the toss of a coin, rather than the amount of money left in its account, the system would be stochastic.

With theoretical simulations it is not possible to be absolutely certain that your chosen model is the correct one. People thought that the earth was the centre of the universe until Copernicus provided a far simpler mathematical model, with the sun at the centre. Today astronomers observing distant galaxies of stars find that they are all receding from us at ever-increasing speeds, which once again