

Modeling The Physical World

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People have always made models of the physical world, both to better understand it and to aid in project planning. Computers enable very complex systems to be modeled accurately. It is even possible to model so completely as to create a virtual reality.

See Chapter 5 in *Great Ideas*

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Modeling The Physical World

- ❖ A computer model represents characteristics of some physical phenomenon, and attempts to reproduce or approximate their behavior and/or outputs in response to inputs
 - Trivial example -- the command button in VB6 is intended to look like a metallic button, with shadows and reflection; it appears to depress when clicked
 - Complex example -- Boeing's 777 was designed on-line, using sophisticated techniques from computational fluid dynamics, for example, to design the "optimal wing"

The examples have dramatically different purposes

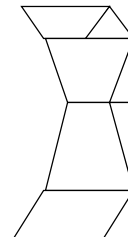
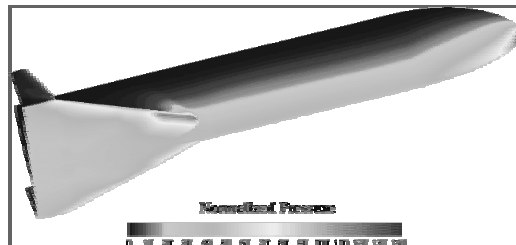
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Computer Modeling ...

- ❖ Physical world models are used in all areas of science and engineering
- ❖ Modeling has the advantage that ...
 - ✦ An artifact need not be created to be studied -- design
 - ✦ Complicated phenomena, too fast or too tiny to observe, can be studied -- chemistry, astronomy, physics
 - ✦ Explanations for phenomena can be checked out before constructing an experiment or going on a field trip -- exploration
- ❖ Modeling has the main disadvantage that it is only as good as the model

Constructing A Computer Model

- ❖ In a model every aspect of reality must be created as program operations
 - ❑ For example, to model the atmospheric heating an aircraft surface as it returns from space flight, the geometry of the plane must be represented in a computer. This typically uses many planar polygons:

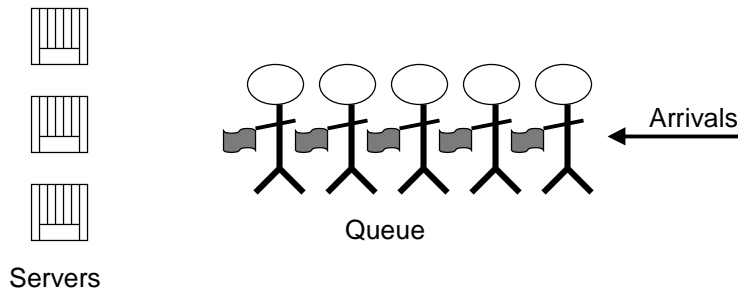


- ❑ The Navier-Stokes equations for air flow must be applied

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Simulation: Making A Model Behave

- ❖ An essential tool of computer modeling is simulation
- ❖ A bank can be modeled using simulated tellers and depositors and mathematics called “queuing theory”
- ❖ Select a random arrival rate (frequency of new customers, and service rate -- teller speed)

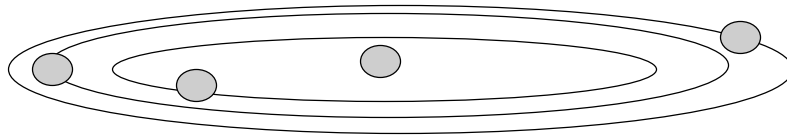


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Representation

- ❖ A key issue in a simulation is the representation of the physical phenomena
- ❖ It is not necessary to give form to all aspects of the phenomena, only those features necessary for the computation



To model the orbits of the planets of the solar system, it is only necessary to know their positions in space (x,y,z) and their mass

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- ❖ A computer model is only as good as the mathematics and programming on which it is founded
- ❖ All computer models ignore features of the physical system and all make simplifying assumptions
- ❖ A computer model's predictive ability is directly related to the features ignored and the assumptions made ... so, do not automatically accept a computer model any more than you would automatically accept a legal contract ... Check the fine print!