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Discrete-Event Simulation: Simulation Practices and Trends

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Simulation Practices and Trends

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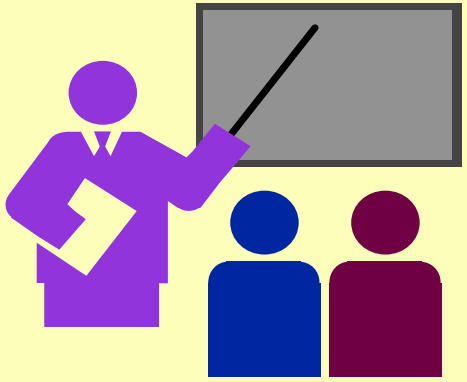


Industrial and Management Systems Engineering

University of Nebraska - Lincoln

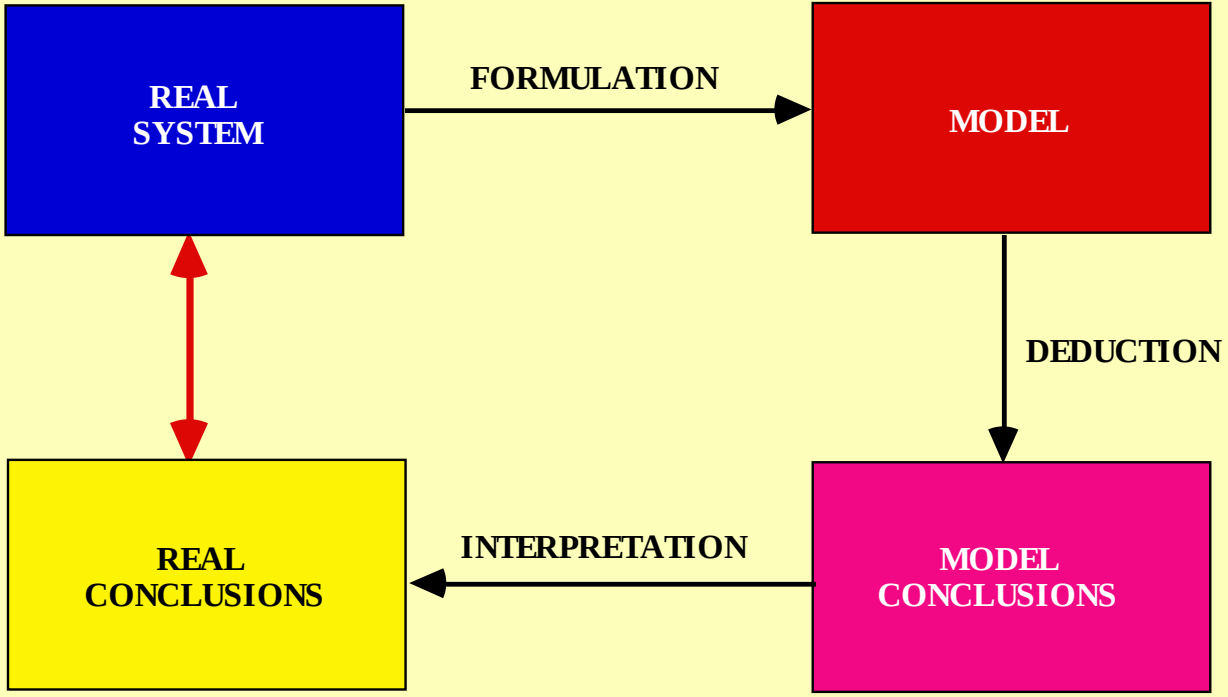
What is a Model?

A **model** is a simplified representation of a system (or process or theory) intended to enhance one's ability to understand, predict, and possibly control the behavior of the system

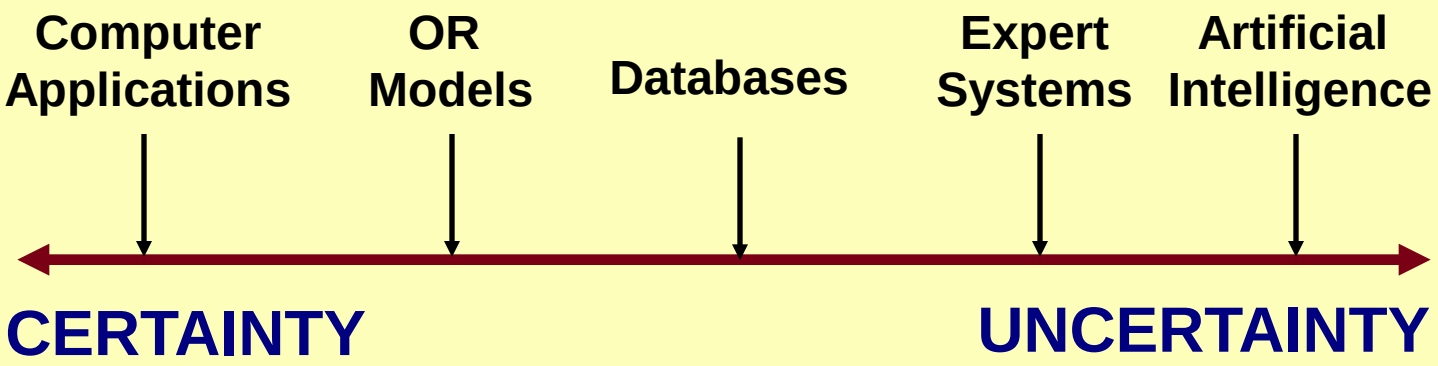
Why Develop a Model?

- an aid to experimentation
- a tool of prediction
- an aid to thought
- an aid to communication
- an aid to training and instruction

How the Model is Used

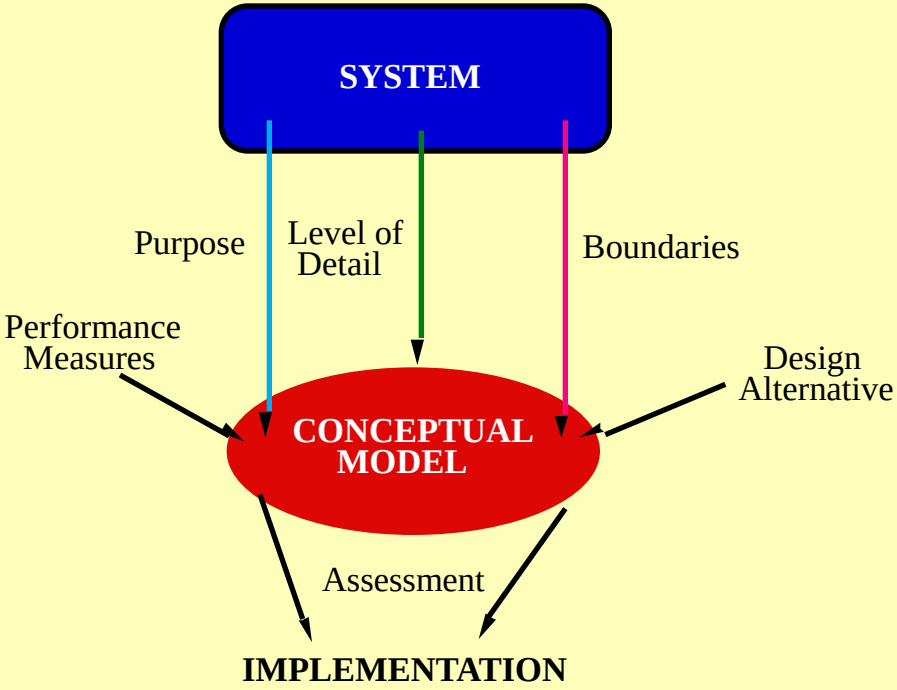


Problem Solving Approaches



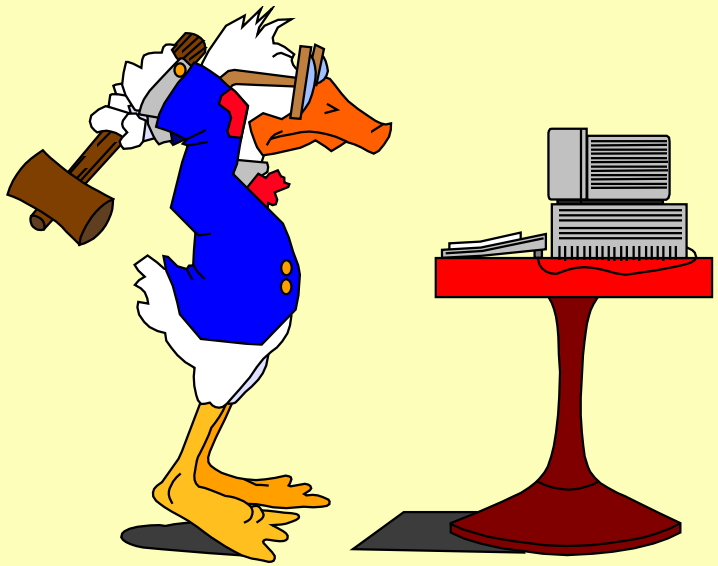
The spectrum goes from physical models or prototypes which are expensive and time consuming to build and need exact conditions to model the real system and proceeds to completely abstract mathematical models

Factors Affecting the Development of a Model



What is a Computer Simulation?

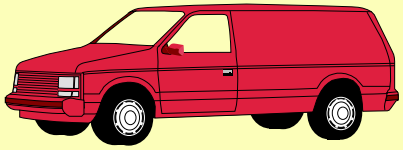
Process of developing a mathematical-logical model of a system and experimenting with that model on a computer



Why Use Simulation?

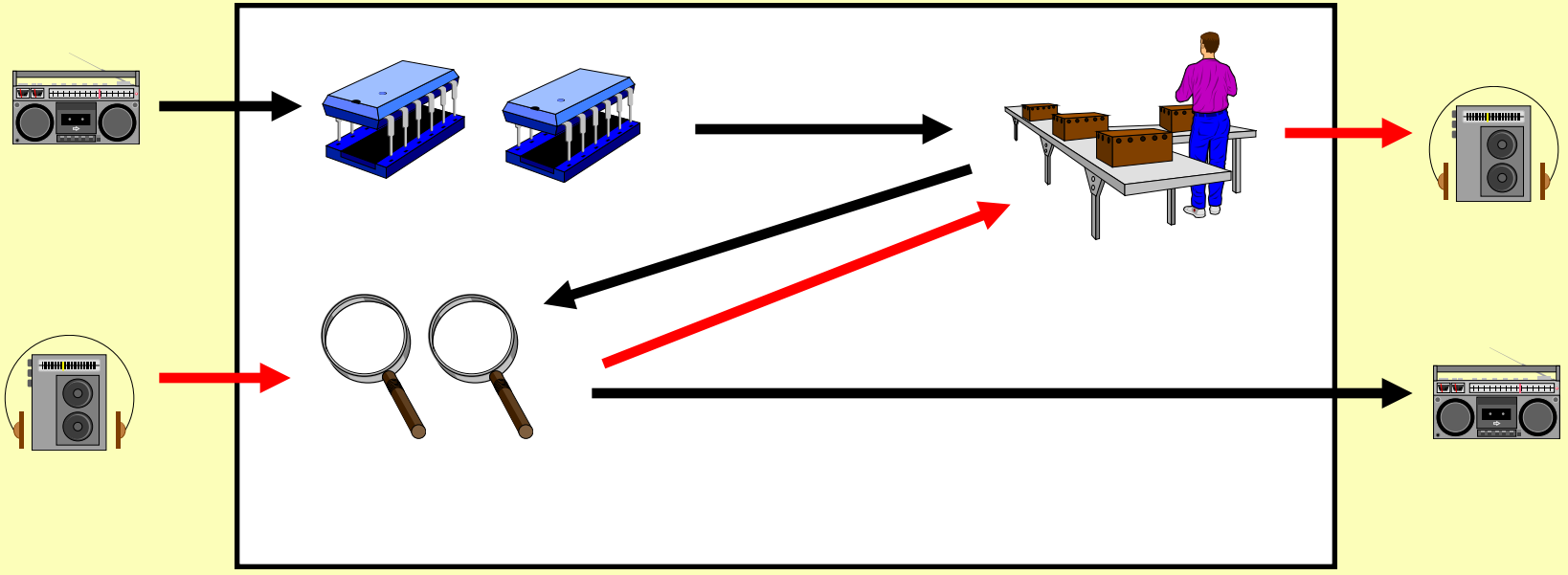
- The real system does not exist and it is too costly, time-consuming, hazardous, or impossible to build
- The real system exists but experimentation is expensive, hazardous, or seriously disruptive

- The real system exists but experimentation may destroy it



- Mathematical modeling of the system has no practical or numeric solutions

A Job Shop Example



Analysis of a Job Shop

Factors affecting our analysis

set-up times; unique production sequence of each part; machine breakdowns; limited waiting space

What types of performance measures would you like to obtain?

work-in-progress; production time; machine/worker utilization

A Heuristic Model

One approach to studying this system is to an analytical technique which seeks to get some unique and/or optimal solution

Due to this complexity, possibly we can build a heuristic model

- **construct a model of the system**
- **observe the behavior of the performance variables over time**
- **based on the observations, hypothesize how the real system is behaving**

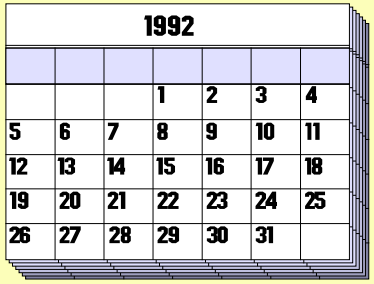
These three tasks describe what simulation performs!

Simulation Disadvantages

- Simulation models are expensive and time consuming to develop

- Simulation models give estimates of performance characteristics and offer few procedures for optimization
- Simulation models produce large quantities of output. This does not mean the model is correct!

The Simulation Process



Step 1: Problem Definition

Develop the preliminary model

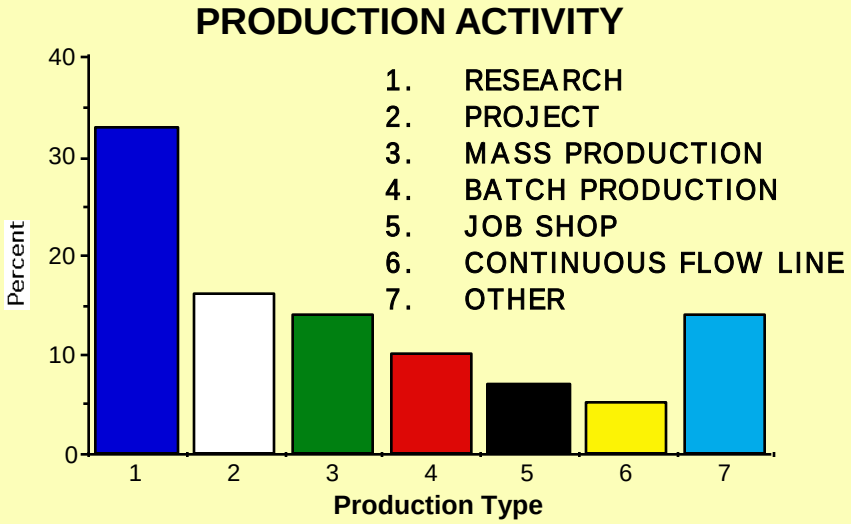
Step 2: Project Planning

Decide on personnel, management support, computer hardware, and budget for the study

Step 3: System Definition

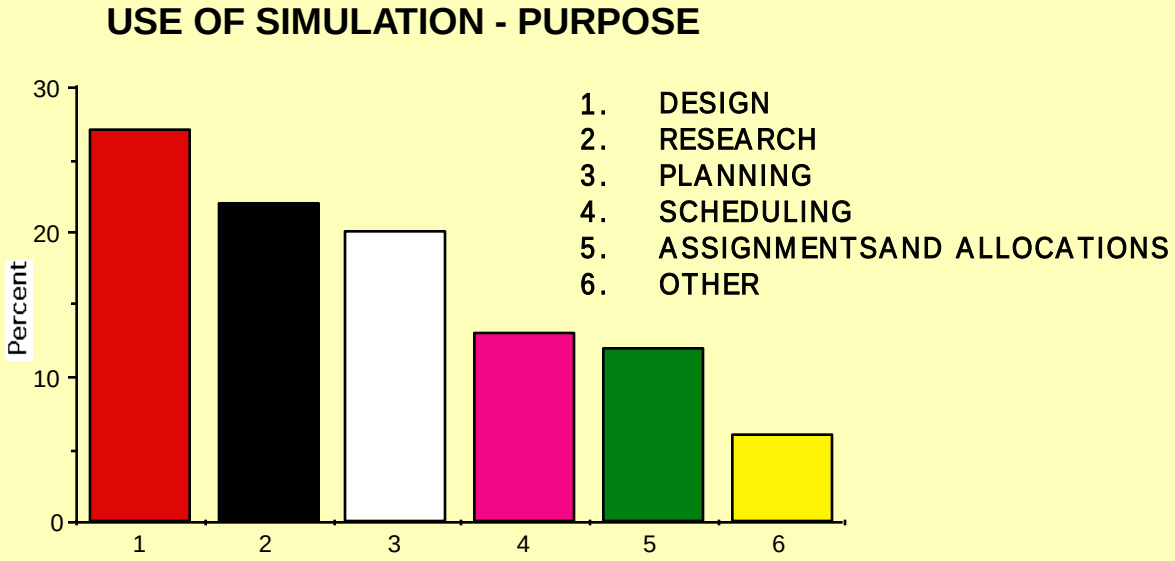
Identify the small subset of characteristics or features of the system to include

Organizational Activities and Simulation



One third of practitioners perform simulation research

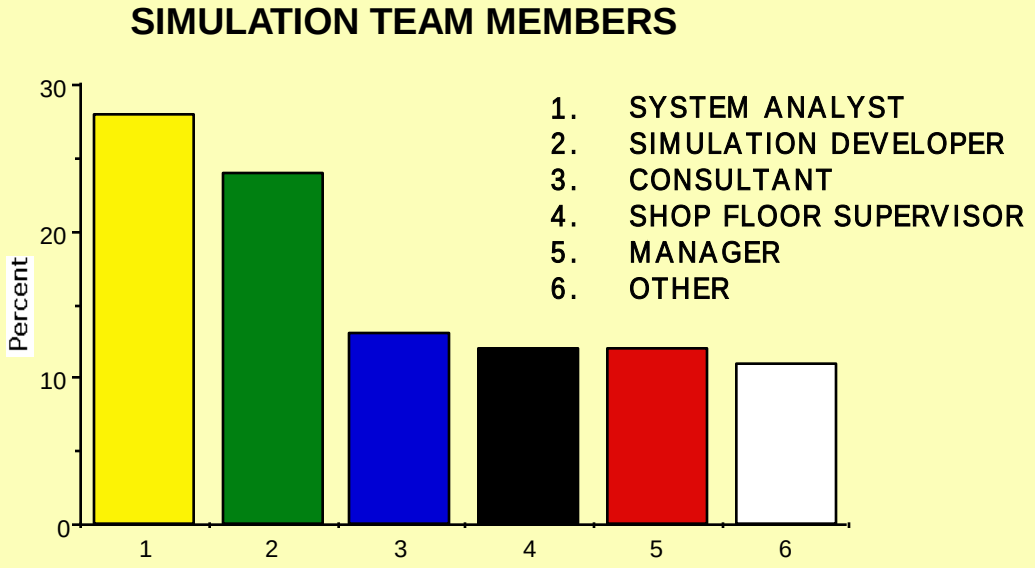
Organizational Activities and Simulation



Simulation is highly used for design, research, and planning

Industry uses simulation most for design and planning

Project Contributors



Simulation developers and systems analysts usually lead the analysis team

The Simulation Process

Step 4: Conceptual Model Formulation

Develop the preliminary model

Step 5: Preliminary Experimental Design

What output do you want?

Step 6: Input Data Preparation

Collect data and fit probability distributions to it

The Simulation Process

Step 7: Validation

Does the model describe the real system?

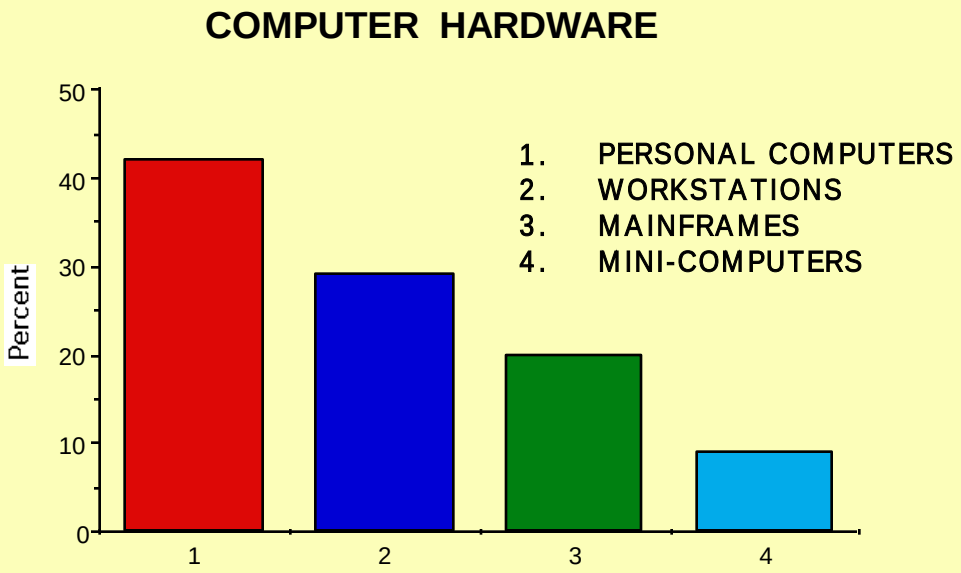
Step 8: Model Translation

Formulate the model in an appropriate language

Step 9: Verification

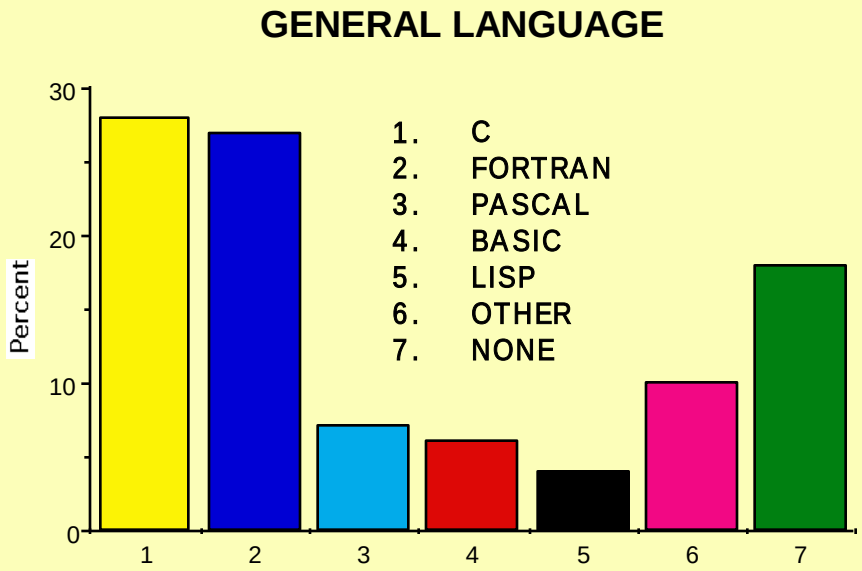
Does the computer simulation model execute as intended?

Hardware Configuration



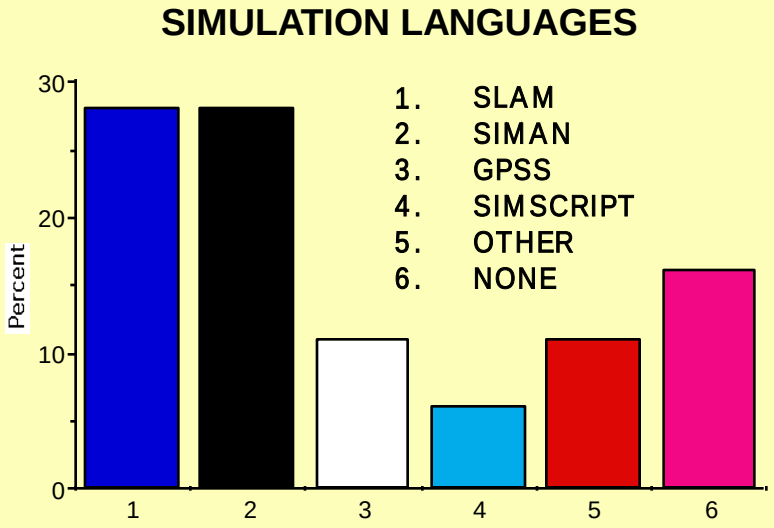
PCs and workstations are widely used simulation platforms
Mainframes are least preferred by industry

Simulation Software



C and FORTRAN are widely used, PASCAL is not used in industry

Simulation Software



SLAM and SIMAN are equally popular

Industry prefers SIMAN to SLAM, Universities prefer SLAM to SIMAN

A Banking System

Customers arrive according to an exponential distribution with a mean of 2 minutes

Service time is between 2 and 5 minutes

SIMAN Simulation Model

```
CREATE: EXPON(2):MARK(ArrivalTime)
QUEUE, WaitTellerQ;
SEIZE: Teller;
  DELAY: UNIFORM(2,5);
RELEASE: Teller;
TALLY: TimeInSystem, INT(ArrivalTime);
DISPOSE;
```

The Simulation Process

Step 10: Pilot Runs

Collect a small quantity of output

Step 11: Validation

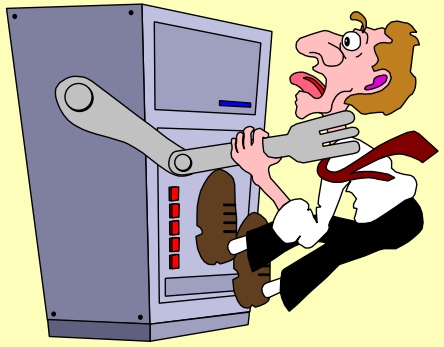
Does the simulation model approximate what would be expected?

Step 12: Final Experimental Design

Design an experiment to yield the desired output

The Simulation Process

Step 13: Make Production Runs

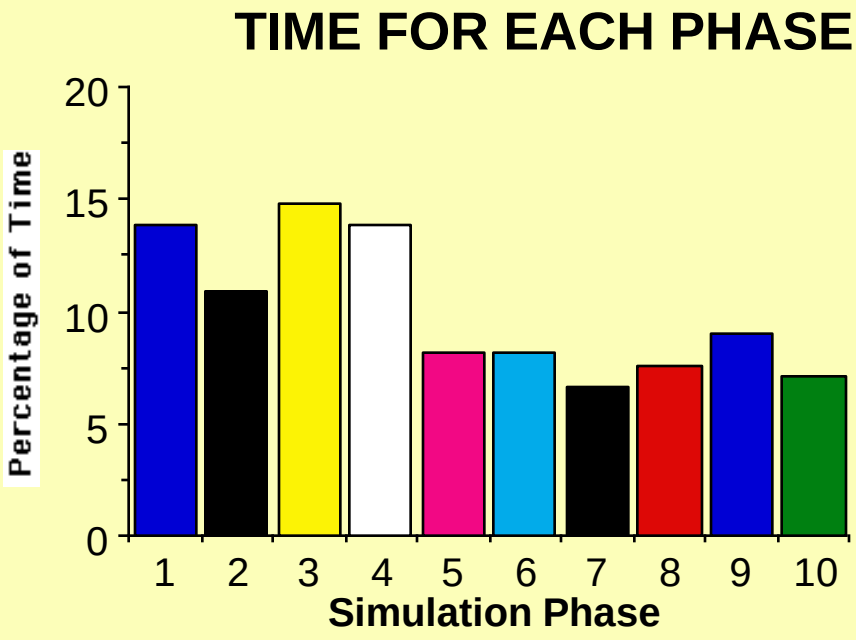


Step 14: Output Data Analysis

Compute averages, standard deviations, and confidence intervals on performance variables

Step 15: Documentation, Presentation, and Implementation

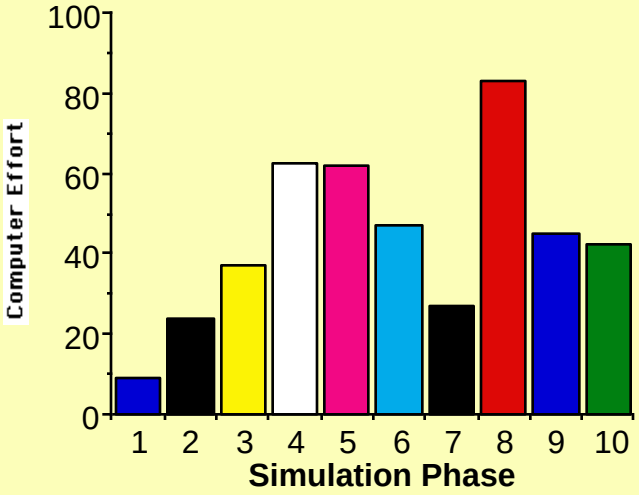
Project Effort Allocation



1. MODEL FORMULATION
2. MODEL BUILDING
3. DATA ACQUISITION
4. MODEL TRANSLATION
5. VERIFICATION
6. VALIDATION
7. STRATEGIC AND TACTICAL PLANNING
8. EXPERIMENTATION
9. ANALYSIS OF RESULTS
10. IMPLEMENTATION AND DOCUMENTATION

Available Computer Assistance

COMPUTER EFFORT FOR EACH PHASE



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What You Should Remember

Simulation only provides an estimate of the true performance characteristic, not the characteristic itself

Simulation DOES NOT give an exact answer!