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3.1 INTRODUCTION

- Activities common to most simulations:
 - Random-number generation ... draws from U(0, 1) distribution
 - Random-variate generation ... draws from probability distributions specified as part of the inputs to the model
 - Advancing simulated time
 - Determining the next event from the event list, and passing control to the appropriate event logic
 - Adding records to lists, deleting records from lists
 - Collecting output statistics and reporting results
 - Detecting error conditions
- Simulation software packages are designed to do these things (and more) for you

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3.2 COMPARISON OF SIMULATION PACKAGES WITH PROGRAMMING LANGUAGES

Advantages of simulation packages

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- Provide most modeling features, so "programming" effort, cost is reduced, often significantly
- Natural framework for simulation modeling
- Usually make it easier to modify models
- Better error detection for simulation-specific errors
- Advantages of general-purpose programming languages
- More widely known, available
- Usually executes faster ... if well written
- May allow more modeling flexibility
- Software cost is usually lower

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3.3 CLASSIFICATION OF SIMULATION SOFTWARE

- General-purpose vs. application-oriented packages
 - Traditionally: simulation languages and simulators
 - Languages were flexible but required programming, simulators were easy to use but not very flexible
 - Now, almost all simulation software uses graphical interface so is relatively easy to use, learn
 - Distinction now is between general-purpose simulation software and applications-oriented package
 - Specific applications include manufacturing, call centers, telecommunications, etc.

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3.3 Classification of Simulation Software (cont'd.)

Modeling approaches

- Event-scheduling approach as in Chaps. 1 and 2
 - · Can uses general programming languages, or some simulation languages
 - During processing of an event, no simulated time passes
- Process-interaction approach
 - · Now used by most simulation software
 - Instead of identifying events, identify *entities* (a.k.a. *processes*) that are created, flow around or through the system, maybe leave
 - · May have multiple realizations of an entity/process
 - · May have different kinds of entities/processes
 - "Program" consists of a description of what happens to the different kinds of processes (including their entry and exit)
 - · Usually expressed graphically, like a flowchart
 - · During processing of an entity/process, simulated time usually passes

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3.3 Classification of Simulation Software (cont'd.)

- Common modeling elements
 - *Entities* represent customers, parts, messages, paperwork, airplane, etc.
- Attributes Information stored with each entity
 - Usually, every individual entity has the same set of attributes, but the values differ to distinguish the entities
 - · Some attributes are automatic, others are user-defined and user-maintained
- *Resources* servers, machines, workers, nodes, links, runways, gates, agents, clerks, etc.
- Queues where entities wait if resources are not available

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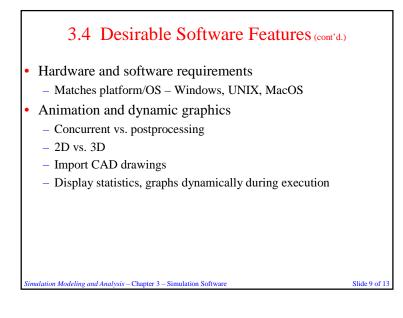
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3.4 DESIRABLE SOFTWARE FEATURES

- General capabilities
- Modeling flexibility ability to drill down to lower levels of programming, create custom modeling constructs
- Ease of use
- Hierarchical modeling submodels containing submodels, etc.
- Fast execution speed
- Ability to create user-friendly front/back ends for template creation
- Run-time version for wide distribution of model
- Import/export data from/to other applications
- Automatic execution of models for different input-parameter combinations
- Combined discrete/continuous modeling
- Ability to initialize in other than empty & idle state
- Save state at end to re-start later
- Affordable

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3.4 Desirable Software Features (conf'd) Statistical capabilities - Adequate random-number generator for basic U(0, 1) variates • Statistical properties, cycle length, adequate streams and substreams • RNG seeds should have good defaults, be fixed – not dependent on clock - Comprehensive list of input probability distributions · Continuous, discrete, empirical - Ability to make independent replications - Confidence-interval formation for output performance measures – Warmup - Experimental design - Optimum-seeking Customer support and documentation Output reports and graphics - Standard defaults, customizable - stored in database for postprocessing ion Modeling and Analysis - Chapter 3 - Simulation Software Slide 10 of 13

3.5 GENERAL-PURPOSE SIMULATION PACKAGES

- See text for discussion of two popular general-purpose simulation packages Arena and Extend
 - In each, builds a model of a small manufacturing system
- Mentions some additional general-purpose simulation packages
 - AweSim, Micro Saint, GPSS/SLX, SIMPLE++, SIMUL8, Taylor Enterprise Dynamics

3.6 OBJECT-ORIENTED SIMULATION

- OO programming and OO simulation originated in the same product SIMULA, from the 1960s
- OO simulation has objects that interact as simulation progresses through simulated time
- Objects contain data, methods
- Also have encapsulation, inheritance, etc.
- Recent software product for OO simulation MODSIM III

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3.7 EXAMPLES OF APPLICATION-ORIENTED SIMULATION PACKAGES

- Oriented toward specific classes of applications see book for software packages for:
 - Manufacturing
 - Communications
 - Process reengineering and service systems
 - Health care
 - Call centers
 - Standalone animation links to multiple simulation-modeling packages

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