Applied Simulation

Modeling and Analysis using Flexsim

Malcolm Beaverstock & Allen Greenwood

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Winter Simulation Conference
Integration & Collaboration

Marriott Waterfront Hotel
Baltimore, Maryland
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Applied Simulation

Modeling and Analysis using FlexSim

3D Simulation Software

Malcolm Beaverstock, PhD
Allen Greenwood, PhD, PE
Eamonn Lavery, PhD
William Nordgren, MS CIM

visualizing and optimizing dynamic systems

Authors

- **Malcolm Beaverstock,** B.S.ChE. – MIT; Ph.D. - Cornell
  - Manager Business Simulation, General Mills, Inc (retired)
- **Allen Greenwood,** B.S.I.E – North Carolina State, M.S.I.E – University of Tennessee, Ph.D. - Virginia Tech
  - Prof. Industrial and Systems Engineering at Mississippi State University
  - Consultant for Air Force Research Laboratory, Naval Sea Systems Command, NASA, Northrop Grumman Ship Systems, Nissan North America, General Electric Aviation, and Center for Advanced Vehicular Systems and others
- **Eamonn Lavery,** BSMS, Ph.D. - Queens University of Belfast
  - Chief Technology Officer - Flexsim
- **Bill Nordgren,** BSME, MS CIM – Bringham Young University
  - Founder, president and CEO of Flexsim Software Products, Inc.
  - Founder and Vice President ProModel Corporation

Anticipated student employment environment

- Dynamic
  - Lean
  - Flexible
  - Fast paced
  - Economy driven
- Problem solving skills rewarded
- An increased recognition of simulation's value by management
- Graduates expected to use simulation or significantly contribute to its use as a team member

Industry focus

- General tool for everyone
- Problem solving focus
- Specific practice
- Structured process
- “Hit the ground running”
- Minimal retraining

Academic focus

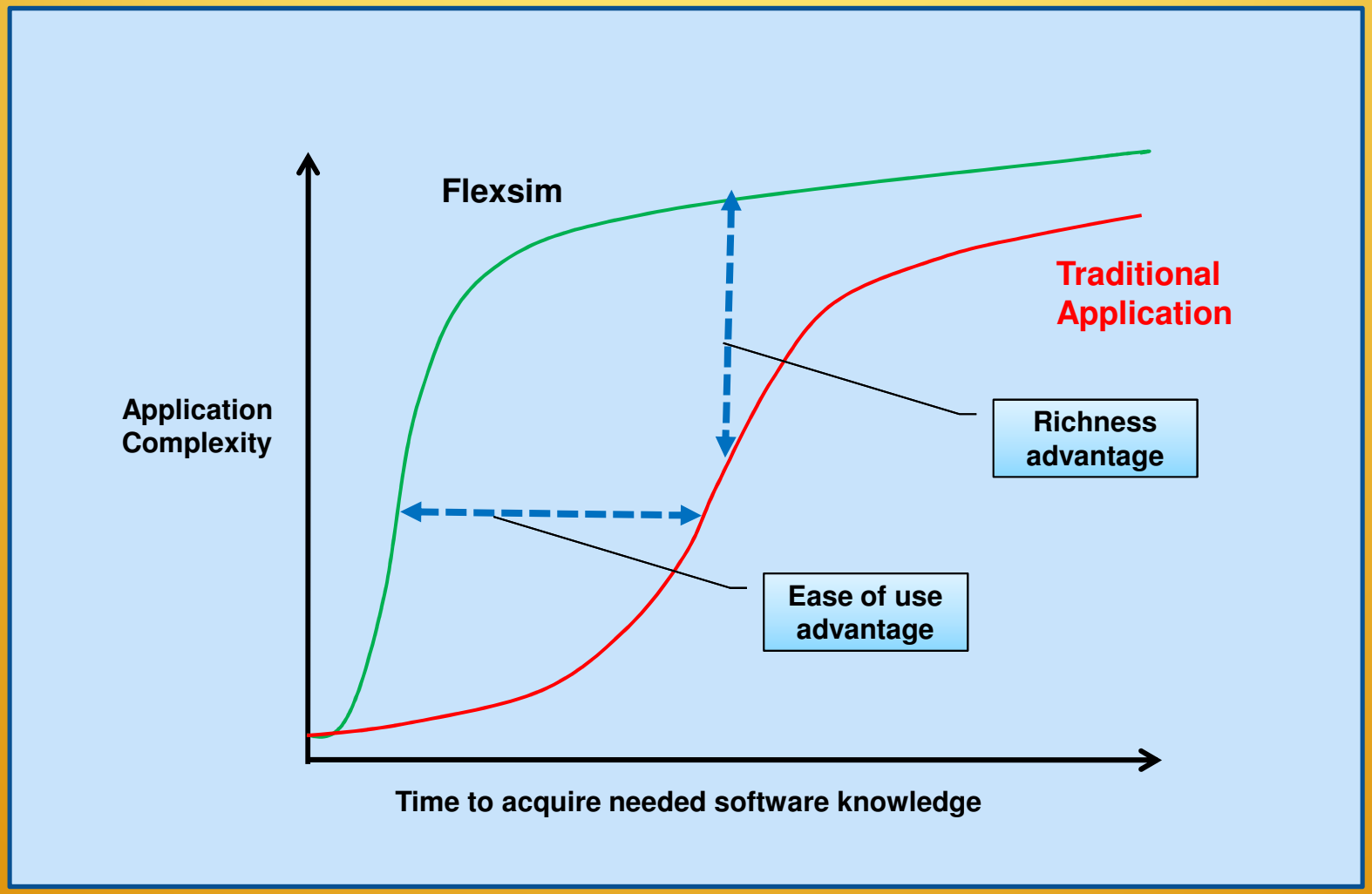
- General practice
- Structured process
- Multiple user levels
- System focus
- Fundamentals, theory
- Robustness
  - Domain
  - Tool

Important software attributes

- Ease of use
  - Intuitive interfaces
  - Consistent structure across objects and data
  - Relevant, pre-built logic options

- Richness
  - Software structure
    - Object oriented
    - Hierarchical organization
    - Open and accessible
  - Comprehensive command structure
  - Extensive inter-object communications
  - Ability to handle wide range of simulation complexity
  - Multiple data management options

Ease of use impact on learning



Classroom topics

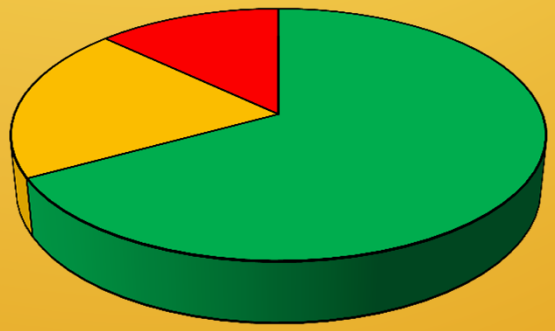
Introduction and simulation basics

Software application details

Application techniques and theory

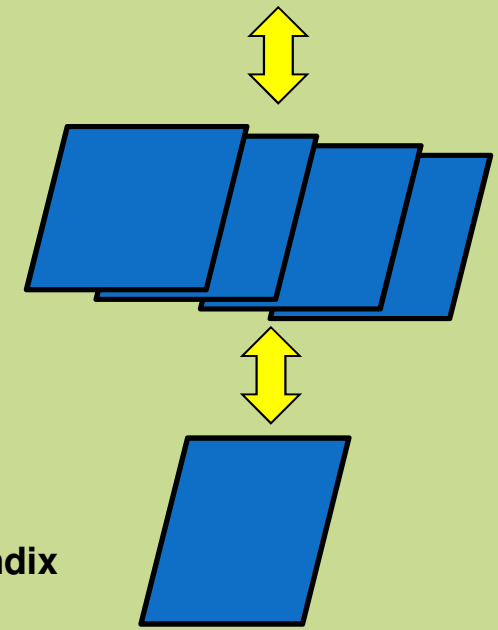
Topic by course time line

Topic by % time



Using the book

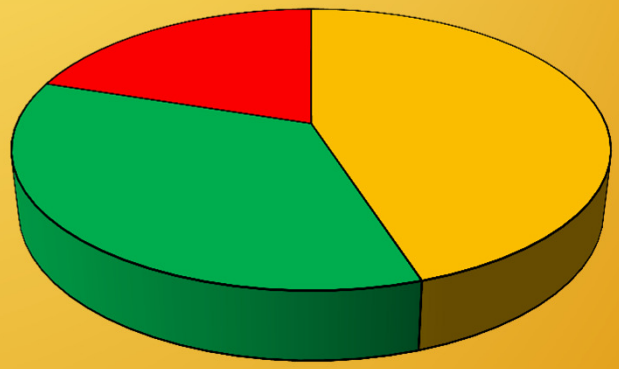
Delivery Method	Focus
Class Room	Application techniques and expanded theory
Book Chapters	Simulation techniques Basic theory
Appendix	Software & other details



Understanding capability levels

- Occasional User
  - Uses pre-built simulations for analysis and decision making
  - Can specify simulation requirements and understand simulation project requirements
- Intermediate User
  - Understands the basic application software structure
  - Builds simulation models using standard objects and logic
  - Manages the placement and use of data in the simulation
  - Is familiar with the theory and practice
  - involved with input/ output analysis and reliability
- Advanced User
  - Understands the underlying software and command structure of the application
  - Can develop custom logic, messaging, and reports

Anticipated percent user capability



Starting with simulation basics

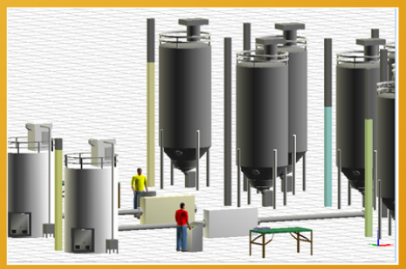
- Simulation background, definitions, and history
- Economic justification
- Identifying where simulation is needed
- Application examples

Container port operations

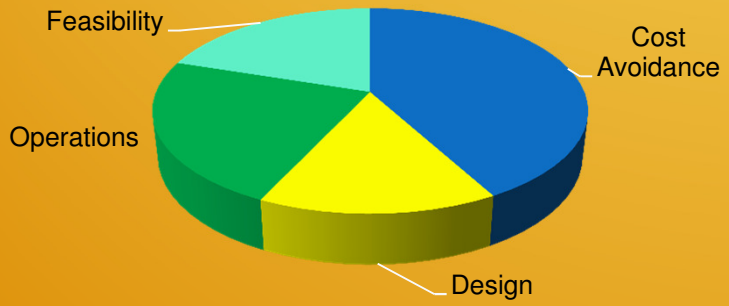
Lean manufacturing options

Health care facility design and analysis

Systems with complex transfer rules



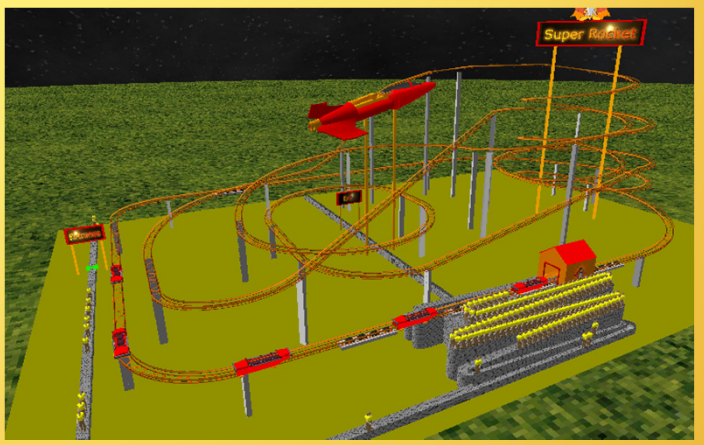
Simulation benefit areas

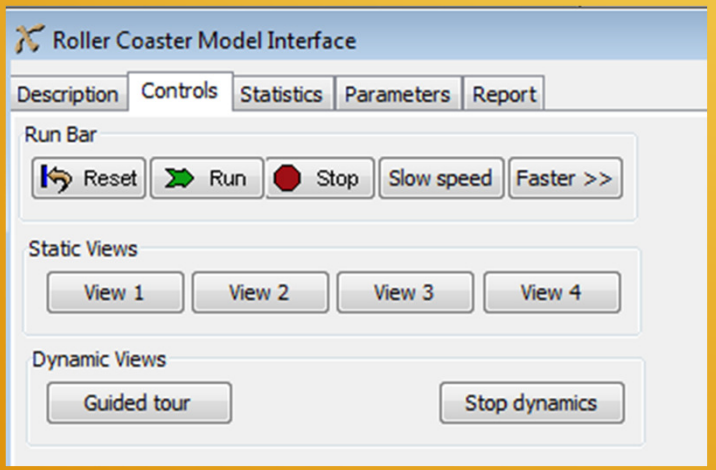


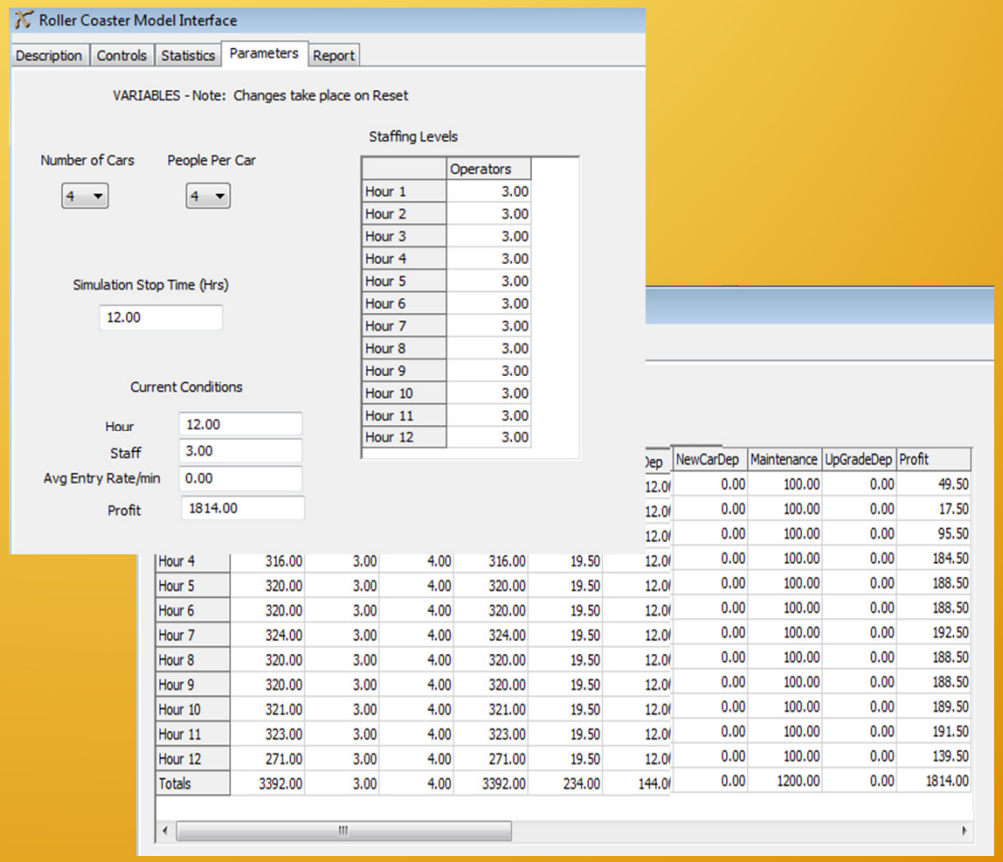
Applying Simulation

- **Uses pre-built simulations for analysis**
  - **Background information to define the problem**
  - **User interface for all changes**

- **Exercises**
  - **Roller coaster - make a profit**
  - **Supermarket - manage resources**
  - **Material transfer station - logistics**
  - **Bottling plant - line operation**
  - **Electronic assembly – lean options**
  - **Pie factors - production scheduling**



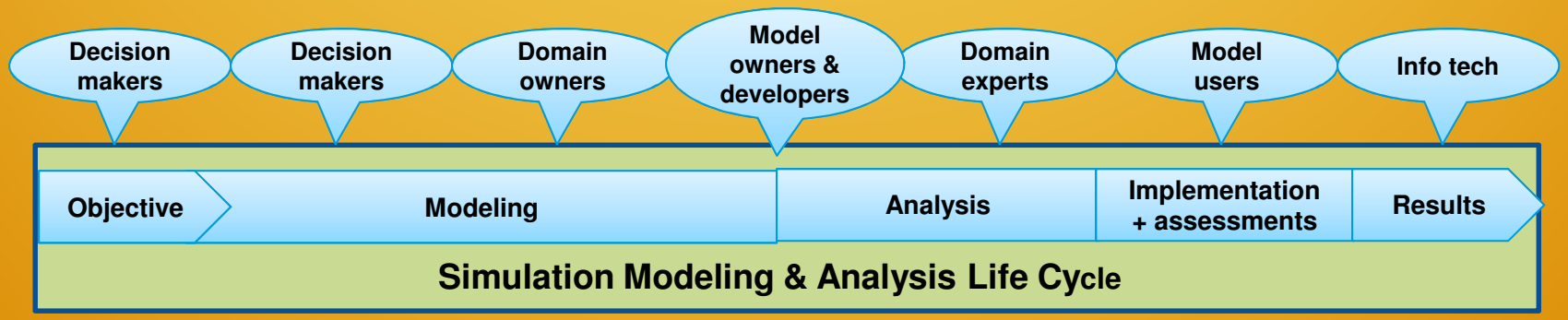




Professional practice of simulation

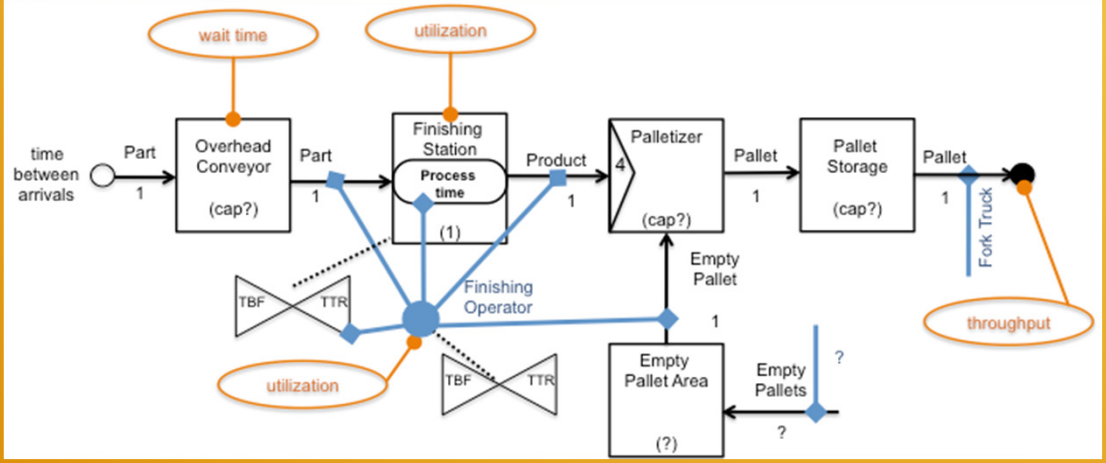
- Building acceptance through confidence in:
  - Simulation technology
  - Simulation user
  - Simulation process

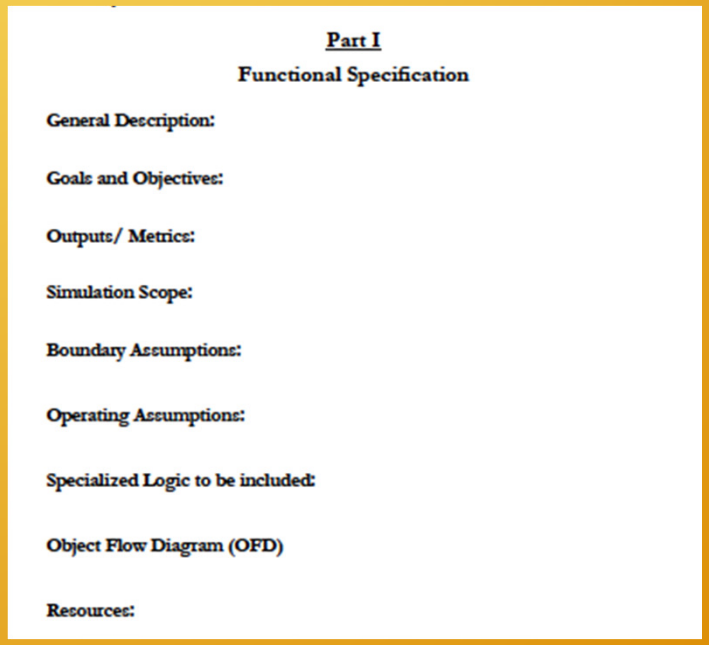
- Consistent process – SMA life cycle
  - Realizing how the practice of simulation works in an organizational environment
  - Establishing a formalized methodology
  - Understanding the roles people play in the process



Managing a simulation project

- **Standard execution of project steps**
  - Design ✚ Build ✚ Use
  - Resource estimation based on queuing theory
- **Object Flow Diagram**
  - Visual project understanding
  - Required expansion of value-stream mapping
- **Project template**
  - Standard means of documenting objectives, assumptions, and methods





Part I

Functional Specification

General Description:

Goals and Objectives:

Outputs/ Metrics:

Simulation Scope:

Boundary Assumptions:

Operating Assumptions:

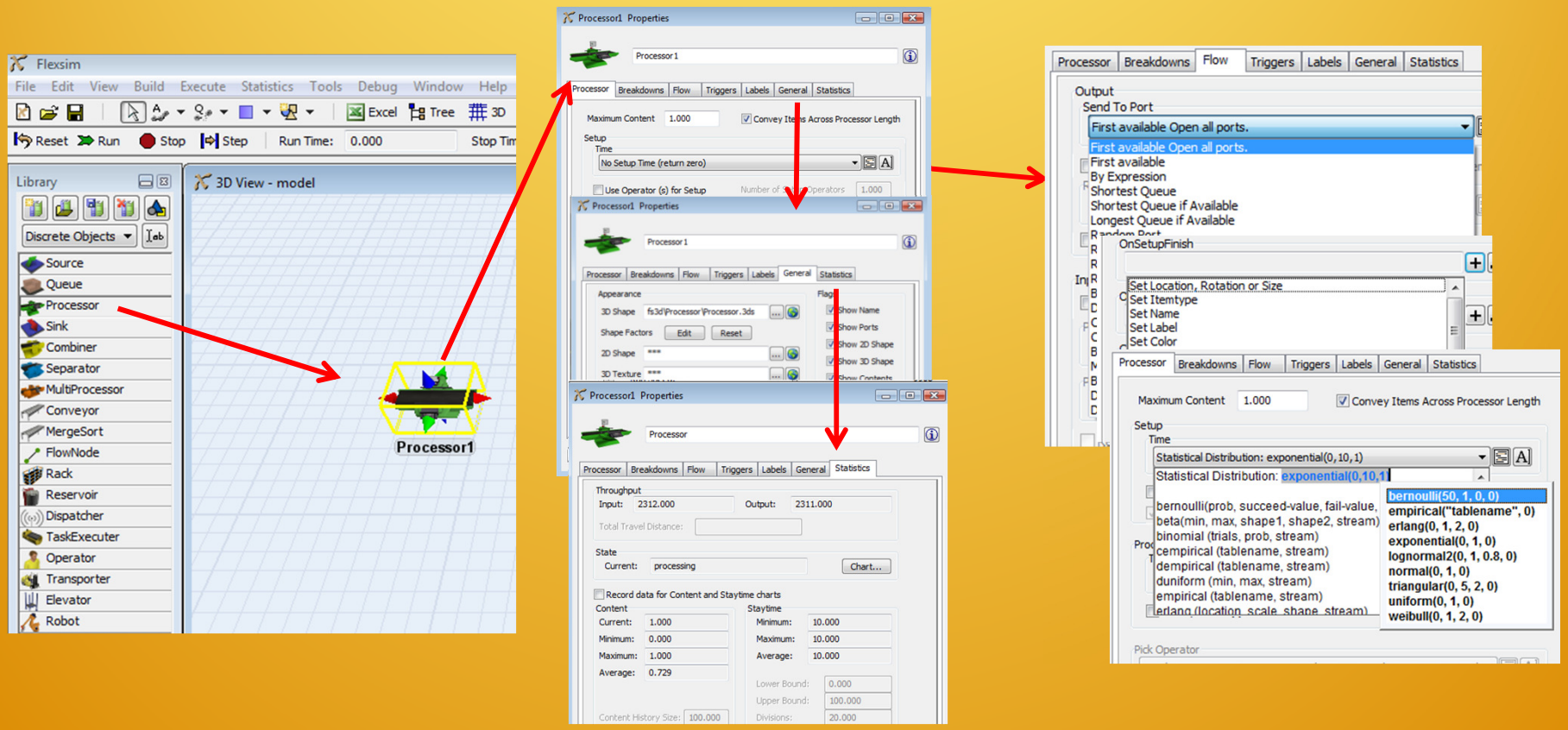
Specialized Logic to be included:

Object Flow Diagram (OFD)

Resources:

Building Basic Simulation Models

- **The Environment**
  - Tool bars, files, drag & drop
  - Basic Definitions
    - objects, flowitems
    - ports
- **Basic functions**
  - Processing
  - Making connections
  - Moving objects
  - Using resources
- **Structured interface**
  - Tab structure
  - Consistent usage
  - Extensive prebuilt logic choices



Exercises

- **Exercise Structure**
  - **Background**
  - **Problem statement**
  - **Operational information**
  - **Expected Results**
    - **Object flow diagram**
    - **Solution statement**
  - **Discussion topics**
    - **Simulation scope**
    - **Assumptions**
    - **Data location**
    - **Required logic**

Background:

Your cousin has a great idea to sell customized picture frames and wants to get set up in time for the Christmas holiday season. The store is a small location where customers can

Problem Statement:

Simulate the frame shop during a ten--hour period and help decide how to best utilize the three workers in the store.

Operating Data:

he frame shop operates from 9am to 7pm. At 7pm the front door to the store locks. Customers in the store are serviced and the store cleaned until 9pm. The procedure is

Expected Results:

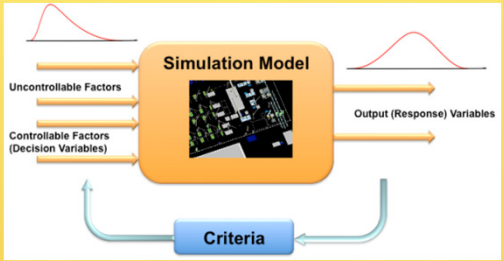
Create an OFD for the system
Simulate 5 days of operation
Where should additional workers be used – cashier or

Modeling and Analysis Issues

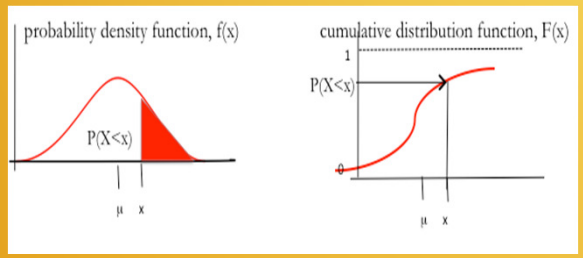
- How can you increase the number of people on the checkout or custom counter without having to add additional objects?
- What activities take place in the store?
- What logic can be used to get people to the right place after they are done shopping? After finishing shopping what decision will a customer make?
- Consider how an object like a queue, even though not a physical part of the simulation, can be used as a decision device to direct the flow using standard logic.

Relevant Theory

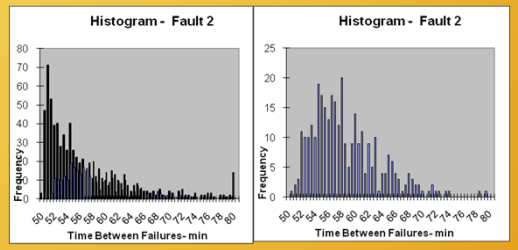
- **Modeling Randomness**
  - Obtaining samples from distributions
  - Generating random numbers
  - Distribution selection
  - Using *ExpertFit*

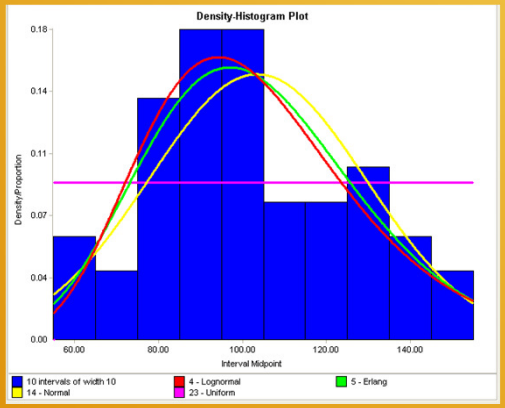


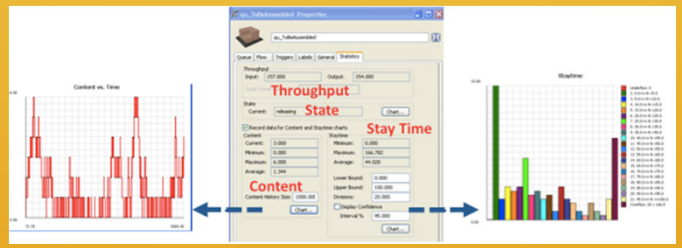
- **Reliability**
  - Downtime clock time
  - Downtime by state
  - Competing downtimes

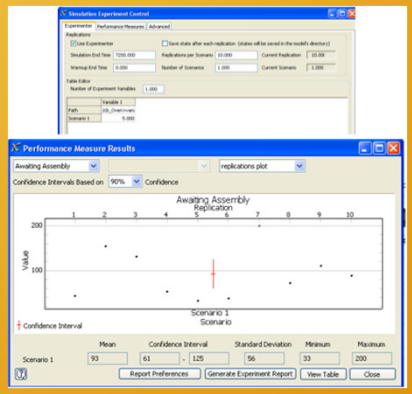


- **Output analysis**
  - Object statistics
  - Creating Experiments
    - Scenarios and replications
    - Performance measures
    - Comparing alternatives
  - Run length – terminating and non terminating systems



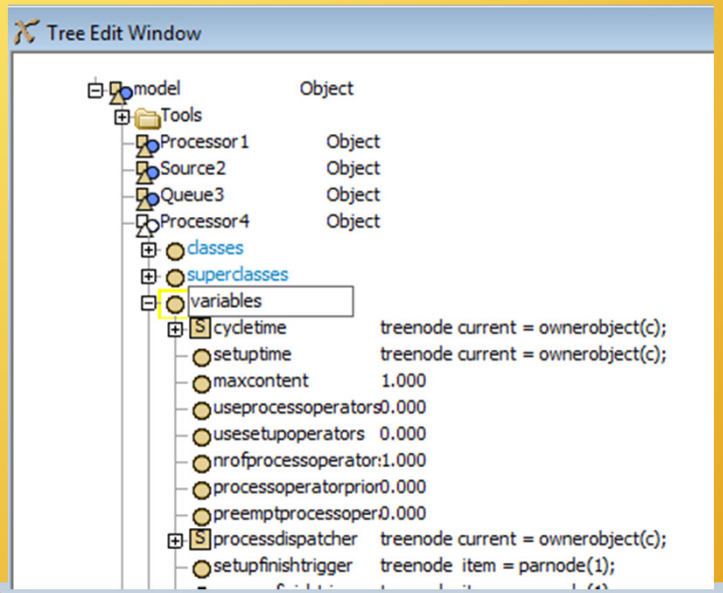


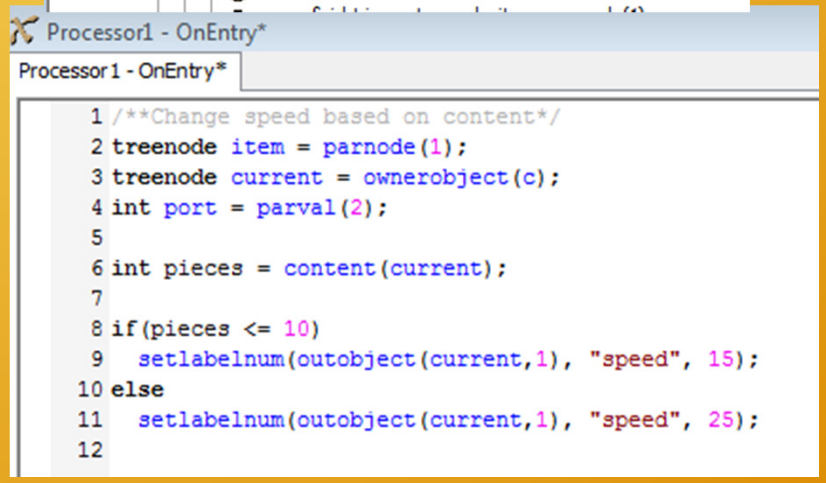




Customizing Model Logic

- **Basics**
  - **How simulation programs work**
  - **Software structure**
    - **Object based**
    - **Hierarchical, visible organization**
  - **Script (C++ based)**
    - **Extensive error checking**
    - **Automatic color coding of commands**
    - **Smart completion**
- **Developing custom logic**
  - **Command set**
  - **Event triggers**



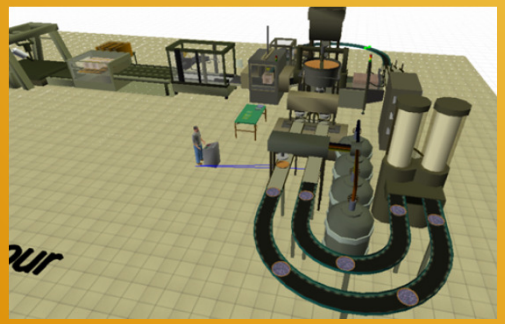


Simulating specialized activities

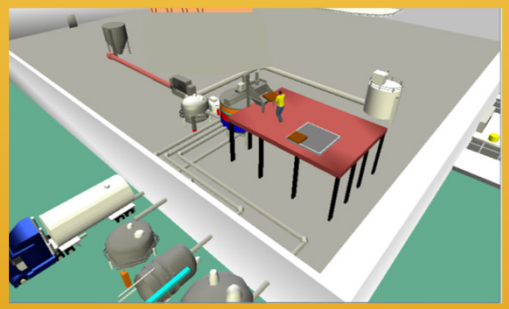
- **Advanced logic and messaging**
  - Command set
  - Communicating within the simulation
- **Using visualization**
- **Simulation of fluid/continuous flow**
  - Basics of fluid flow
  - Batch mixers
  - Fluid and discrete operating interfaces
- **Simulating production schedules**
  - Single and multiple line control
  - Changeover and processing parameter change by product type

Surgery Center Operations

Production Scheduling



Batch Operations

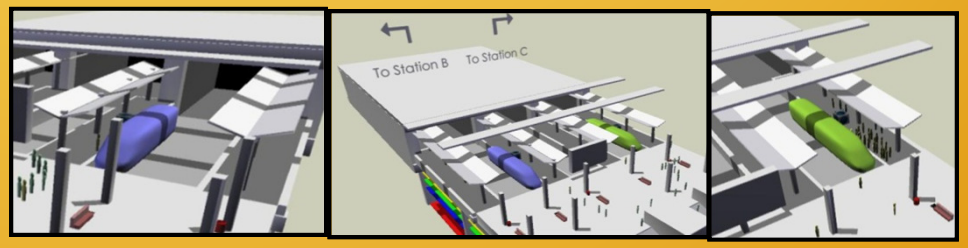


Barge loading

Overview of special topics

- **Flexsim software design**
  - Underlying Architecture
  - Interoperation of the various engines
- **Distributed simulation**
  - Collaborative virtual environments
  - Distributed computing
  - Grid computing
  - High level architecture (HLA)
- **Agent based simulation**

Synchronized, highly detailed simulations on separated computers allow trucks to load at a bottling plant, travel a highway network, and reach a distribution center



Agent based simulation of people arriving at a transportation center

Appendix

- Additional details of Flexsim software
- Exercise help
- Advanced Flexsim topics
  - Command list
  - Visualization techniques
  - Creating user interfaces
  - Building custom task sequences
  - Outputting AVI files
  - Data exchange with Excel and AutoCAD
- Overview of other Flexsim based applications
  - Health care
  - Container Terminal
  - Dryfork – presentation software

Special support for adopters

- Educator web area (password required)
  - Updates, general information
  - Support material
    - Models for all exercises and to emphasize points
  - Classroom materials from Prof. Greenwood
    - Lecture slides
    - Sample exams
  - Exchange folders (moderated by the authors)
    - Lecture slides
    - Examples for additional assignments, exams
    - Suggested ideas for new exercises
    - Supplemental notes
  - Link for emailing authors on questions, comments
  - Discussion board
- Student web area (password required)
  - Updates, general information
    - Additional files needed for completing exercises in the book
    - Models for Chapter 3, production control library, etc.

Questions ?
Comments ?

Visit us at the Flexsim Booth