Teaching with the Simio Academic Program

Dave Sturrock
Vice President of Operations – Simio LLC
Field Faculty – University of Pittsburgh
What is Simio

- Simio is a 3D simulation modeling tool that combines the rapid modeling of objects with the power of processes.
  - Modern yet established product
  - 5 years, version 6

- Rapid growth
  - Accelerated use within and across companies.
  - 700 universities, multiple textbooks and languages.
Simio Architecture

► True Object-Oriented Framework
  ▪ Models built from objects.
  ▪ Simio provides Standard, Flow, Extended Flow, Crane, and Transportation Libraries
  ▪ Users can create new objects and libraries.

► Objects are built from processes and require no programming.

► Object instances can be customized with add-on processes.

► Result: **Rapid** and **Flexible** modeling
Why Simio?

▶ Technology
▶ Features
▶ Engaging to Learn
▶ Jobs for Students
▶ Easy to Teach/Transition
“Companies send their fast-track engineers to the Master of Engineering Management program to learn the state of the art -- that is what Simio represents in simulation.”

Chair of the Department of Industrial Engineering and Management Sciences at the McCormick School of Engineering at Northwestern University
Why Simio? - Technology

- Thriving company/product
- Built on the latest .NET technology
- Supports teaching simulation **theory**, **practice**, and modeling **skills** as well as **research**
- Code-free object definition
- Researchers can extend the Simio product itself using any .NET language.
- Multi-processor/distributed processing support
Dr. W. David Kelton

"I've worked with a lot of different simulation software, and Simio is probably the most promising and exciting one I've seen in all that time."

Professor and program director of the Master of Science in quantitative analysis at the University of Cincinnati.
Why Simio? - Features

- Innovations in Object-Oriented modeling
  - Code-free object definition (patented)
- Innovations in modeling and output analysis
  - Powerful add-on process capability
  - SMORE Charts
- Integrated, easy to use 3D Animation with a direct link to over a million free symbols on-line
- Supports Discrete-Event, Agent-based, Systems Dynamics, Continuous, Mass flow, Mixed Mode
- Tightly integrated DES, analysis, and scheduling
“Our graduate students appreciate Simio’s object-oriented approach and easy extensibility. For freshmen, the standard object library is easy to use and the animation is engaging. For research, Simio offers opportunities for optimizing patient flow in healthcare systems using its intelligent objects.”

Associate Professor at The Harold and Inge Marcus Department of Industrial and Manufacturing Engineering at Pennsylvania State University
Why Simio? – Engaging to Learn

- 3D Animation captures immediate attention
- Drag & drop library objects for quick, intuitive modeling
- Add-on Processes to graphically create custom logic (no coding required)
- Full featured to model virtually anything
Ima Irani

“I love Simio so much. Thanks for making Simulation much, much easier and more fun.”

Student at University of Houston,
Intern at Toshiba International
As the technology improves and business becomes more complex and challenging, simulation is becoming widely recognized as a key technology.

Companies all over the world are converting to Simio for its advanced technology, flexibility and rapid modeling.
Capital Equipment/Electronics Manufacturers

- Boeing
- BAE Systems
- John Deere
- LG
- Life's Good
- Aethon
- Ericsson
- Hencon
- Sensata Technologies
- Lockheed Martin
- Nissan
- Honeywell
- Philips
- Tesla
- NASA
Metals & Specialty Equipment Manufacturing

Steel Coils U.S.A.
Transportation & Logistics
Varied Industries & Commercial Academic

Booz | Allen | Hamilton

TJX
THE T.J. XCOS INC.

CAPITEC BANK
Simplicity is the ultimate sophistication

aurecon

MBD
Credit Solutions
asset intelligence

KBR

Leibniz Universität Hannover

SARS
South African Revenue Service

UNIVERSIDAD DEL TURABO

OKLAHOMA STATE UNIVERSITY

Instituto Politécnico Nacional
“La Técnica al Servicio de la Patria”

AUBURN UNIVERSITY
“The power of Simio makes learning the software such a simple matter that students can begin doing research for projects very quickly.”

Professor at Purdue University
Why Simio? – Easy to Teach

► Full course materials with:
  ▪ Choice of books (<$40) and e-books (<$30)
  ▪ Slides annotated with instructor notes
  ▪ Examples, homework, solutions

► On-line learning (all free)
  ▪ You, your assistants, and even your students
  ▪ Short tutorials, FMS video series
  ▪ 8 hour video course and full 12 lab series

► Transition help through user community
“Maybe I’ve suddenly become a better teacher, or maybe I have a better caliber of students, but when I changed to Simio, they understood much faster than ever before.”

Professor of Industrial & Systems Engineering at Auburn University
Learning Resources

Support Ribbon

Publications

Free On-line Videos

Learning Simio Lab Series
► Almost 60 videos organized into 12 lab modules designed to help teach Simio.

Flexible Manufacturing Video Series
► 11 part video series illustrates how to build and operate a small flexible manufacturing cell

Introduction to Simio
► 7 part training session that parallels free Rapid Modeling e-book.
Simio Academic Program

- Simio is available to professors, students, and researchers via an automatic grant.
- Our academic products are functionally equivalent to Simio Design Edition.
  - **Academic Version** for school computers. May be used in student labs as well as by professors and researchers.
  - **Student Version** for undergraduate and graduate student use on their own computers. One year licenses are available directly to students for a nominal fee and supports large models.
  - **Evaluation/Training Version** is freely downloadable but only supports small models.
Simio Academic Program

▶ See simio.com/academics for details
▶ Apply on-line and tell us how many copies you need for professors and labs
▶ Simio will provide a grant to you and your department for the software requested
▶ The software is good for a nominal 2 year period (ends June 30) at which time you are eligible for free renewal.
▶ Choose node-locked or network licensing
▶ Apply to permit students to purchase optional $25 1-year student versions.
Simio in Action

▸ Build a quick model.
▸ Embellish the animation.
▸ Examine the results.
▸ Let’s start with a quick overview…
# Key Simio Object Concepts

<table>
<thead>
<tr>
<th><strong>Object:</strong></th>
<th>Defines data, logic, behavior, view, events, and interaction with other objects.</th>
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<tbody>
<tr>
<td><strong>Model:</strong></td>
<td>An object that is executable.</td>
</tr>
<tr>
<td><strong>Project:</strong></td>
<td>A collection of models/objects. A project can be loaded as a library.</td>
</tr>
<tr>
<td><strong>Properties:</strong></td>
<td>Static inputs to an object.</td>
</tr>
<tr>
<td><strong>States:</strong></td>
<td>Changeable values associated with an object</td>
</tr>
<tr>
<td><strong>Events:</strong></td>
<td>Supports communication between objects. Fired when key things happen.</td>
</tr>
<tr>
<td><strong>Resource:</strong></td>
<td>Constrains the system. Any object (even an entity) may be a resource.</td>
</tr>
<tr>
<td><strong>Entity:</strong></td>
<td>A dynamic object that may move through system</td>
</tr>
<tr>
<td><strong>Transporter:</strong></td>
<td>An entity that can “work on” or carry other entities. Vehicles and Workers are entities (and resources).</td>
</tr>
</tbody>
</table>
Simio User Interface

- Files Menu
- Ribbons
- Project Tabs
- Libraries
- Project
- Current Model
- Properties
- Facility View
Object Types

**Fixed**: A single location

**Link**: Pathway for entities

**Node**: Intersection between links

**Entity**: Dynamic objects that move

**Transporter**: Pickup/transport/drop-off entities

Intelligent Object
- Agent
- Entity
- Transporter
# Standard Library

<table>
<thead>
<tr>
<th><strong>Source:</strong></th>
<th>Generate entities of a specified type and arrival pattern.</th>
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<tbody>
<tr>
<td><strong>Sink:</strong></td>
<td>Destroy entities.</td>
</tr>
<tr>
<td><strong>Server:</strong></td>
<td>Capacitated process, such as a machine.</td>
</tr>
<tr>
<td><strong>Workstation:</strong></td>
<td>Capacitated process, includes setup, process, tear-down.</td>
</tr>
<tr>
<td><strong>Combiner:</strong></td>
<td>Batches entities with a parent entity (e.g., pallet).</td>
</tr>
<tr>
<td><strong>Separator:</strong></td>
<td>Splits batches or copies entities.</td>
</tr>
<tr>
<td><strong>Resource:</strong></td>
<td>Seized/Released by objects.</td>
</tr>
<tr>
<td><strong>Vehicle:</strong></td>
<td>Fixed route or on-demand pickups/drop-offs.</td>
</tr>
<tr>
<td><strong>Worker:</strong></td>
<td>Moveable resource, for stationary and non-stationary tasks.</td>
</tr>
<tr>
<td><strong>BasicNode:</strong></td>
<td>Simple intersection, fixed object input.</td>
</tr>
<tr>
<td><strong>TransferNode:</strong></td>
<td>Change destination/get rides, fixed object output.</td>
</tr>
<tr>
<td><strong>Connector:</strong></td>
<td>Zero travel time.</td>
</tr>
<tr>
<td><strong>Path:</strong></td>
<td>Entities independently move at their own speeds.</td>
</tr>
<tr>
<td><strong>TimePath:</strong></td>
<td>Entities complete travel in a specified time.</td>
</tr>
<tr>
<td><strong>Conveyor:</strong></td>
<td>Accumulating/non-accumulating conveyor devices.</td>
</tr>
</tbody>
</table>
Experimentation Features

- Create and execute scenarios with controls, responses, and constraints.
- Distribute replications across multiple cores / computers for fast execution.
- Use and develop third party add-ins (e.g. OptQuest, KN Ranking and Selection).
- Drill into your results using the Pivot Grid for easy data mining.
- Assess error and risk using SMORE plots.
SMORE Plot

Max

Upper Percentile

Median

Mean

Lower Percentile

Min

Upper Percentile Confidence Interval

Mean Confidence Interval

Lower Percentile Confidence Interval
1) In all cases except scenario 1, the “expected” profit is well above the $30,000 required.

2) The 20%/80% box plot indicates that more than 20% of the time scenario 6 fails the profit criteria.

3) Simply looking at the expected value, you might conclude that scenarios 8, 11, & 13 are equally good.

4) The 20%/80% box plot indicates that scenario 11 has a lower variability and is less likely to “surprise” you.

5) The range line indicates that while scenario 3 has some risk of missing the goal, there is also a good chance of exceptional profit.
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- Embellish the animation.
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