
 Simio
FORWARD THINKING

Extras Library

Introduction to Using Extras Library


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Agenda

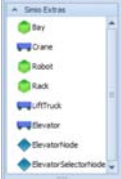
- ▶ Introduction
 - What is Extras Library?
 - Where to get Extras Library ?
 - Compatible Simio Versions
- ▶ Cranes
- ▶ Elevators
- ▶ Rack & Lift Truck
- ▶ Robots

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Introduction

- ▶ The Simio Extras Library is a collection of objects designed to model complex material handling and storage scenarios
- ▶ Objects in the Extras Library include
 - Bay
 - Crane
 - Robot
 - Rack
 - LiftTruck
 - Elevator
 - Elevator Node
 - Elevator Selector Node



- ▶ All the objects in the Extras Library can be used in conjunction with Standard Library objects to develop models.

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Introduction

- ▶ Beta Version of Extras Library is available to Simio Insiders for download from SI Shared Items forum
- ▶ The Library is provided with a short documentation and SimBits
- ▶ Recommended version: Simio 9.147 or later



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Objects in Extras Library



- ▶ Crane
 - Bay
 - Crane
- ▶ Storage & Retrieval
 - LiftTruck
 - Rack
- ▶ Elevator
 - Elevator Node
 - Elevator Selector Node
 - Elevator
- ▶ Robot

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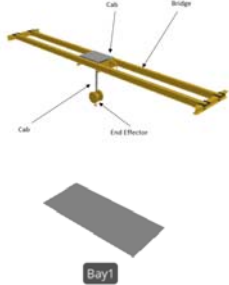
Crane



▶ Simio Crane Object is a collection of


- Bridge: Defines a bridge-like structure that moves left and right spanning the bay area over which the crane operates
- Cab: Defines the trolley that travels along a bridge carrying the crane's lifting mechanism
- Lift: Defines the cable mechanism that raises and lowers a load
- Crane (End effector that actually picks up and drops off entities at nodes)

▶ Cranes are used together with Bays to model cranes moving in a bay



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Crane



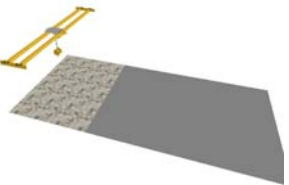
- ▶ Cranes operate by picking up entities at the pick up node, lifting it up to the travel height and moving the crane laterally to the drop off location and lowering the crane to drop off entities at the destination node
- ▶ Cranes can be used to pick up/drop off entities at Transfer nodes or Basic Nodes
- ▶ Crane object can be used to model multiple cranes operating simultaneously in the same bay
- ▶ Cranes support multi level deadlock resolution when using multiple cranes in a bay

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Bay




- ▶ Bay is a static object which defines an area in which a bridge can operate
- ▶ Bay is formed from a collection of Zones
- ▶ A zone can be occupied by only one bridge at a time
- ▶ A single bay can have multiple cranes operating in it
- ▶ Bay can be placed in the facility view by dragging it from the library

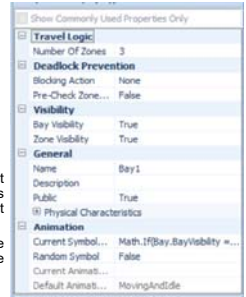


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Bay Properties




- ▶ Bay is defined by properties associated with
 - Number of Zones
 - Deadlock Prevention
 - Visibility
- ▶ Number of Zones: This property defines the number of zones in which a bay is divided
- ▶ Deadlock Prevention: Two properties which define deadlock prevention logic are:
 - Blocking Action: This property defines what actions a bridge will take if any other bridge is blocking it. If set to None, then idle bridge will not be pushed away.
 - Pre Check Zone: This property defines if a crane should check if all the zones are available before initiating a move.
- ▶ Visibility: Defines if the Bay and its Zones are visible when the model is executed

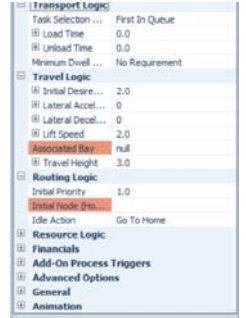


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Crane




- ▶ To use cranes in the model
 - Place a bay in the model
 - Crane can be dragged as a complete object from the library and placed in the facility view
 - Initial node and Associated bay in which the crane is to operate have to be defined
 - Crane is initialized at the Initial Node
 - Initial node has to be within the Associated Bay of the crane
 - If a bay is already placed in the model then the cranes' bay is set to the bay already placed

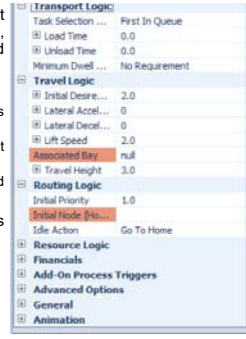


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Crane




- ▶ Cranes provide standard transportation object properties like Task Selection Strategy, Load, Unload time, Dwell requirement and lateral speed and acceleration
- ▶ Properties unique to cranes include
 - Lift Speed sets the speed at which lift travels up/down for pick up and drop off
 - Travel Height defines the height above the floor at which cranes move.
 - Cranes also support lateral acceleration and deceleration
- ▶ Cranes also support all the Add-On Process triggers that are available with transporter objects



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Crane




- ▶ Certain points to be noted
 - Cranes always move in free space
 - Cranes don't support reliability logic
 - If the cranes' idle action is set to Go To Home or Go To Up position then the crane will reject reservation requests until the idle action is completed
 - Cranes capacity is limited to 1 unit
 - Even though Crane is a dynamic object its population is always set to 1
 - Cranes don't support Fixed Route routing type

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Robot




- ▶ Robot object in the Extras Library simulates a jointed robot which is most commonly used in industrial applications
- ▶ Robot can be used as transporter object to transport entities from one node to another in 3D space
- ▶ Robot object can also be used as a resource object i.e. it can be seized as a secondary resource for operations at servers
- ▶ As with the cranes, robot can also be used in conjunction with standard library object




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Robot




- ▶ Robot is composed of five primary components as shown in the figure
 - Base: Base is placed at any node location in the model. It remains fixed at this node location
 - Rotator: Rotator is connected to the Lower Arm and Base. It rotates about the fixed base
 - Lower Arm: Lower Arm is connected to the Rotator and can move to any up/down pitch angle relative to the Rotator.
 - Upper Arm: Upper Arm is connected to the end of the Lower Arm and can move through any up/down pitch angle relative to the Lower Arm
 - Robot Hand: Robot Hand is sub-classed from Transporter and is connected to the end of the Upper Arm and can change its up/down pitch relative to the Lower Arm

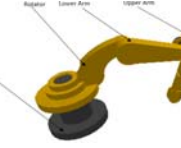


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Robot




- ▶ This configuration provides three axis of rotations. Base is a fixed object and Rotator rotates along a vertical axis, lower arm pitches relative to rotator and Upper Arm pitches relative to Upper Arm
- ▶ Geometry of each robot component can be individually edited by selecting each component

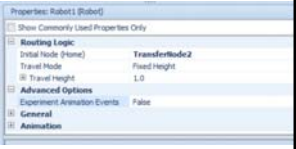


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Robot Properties

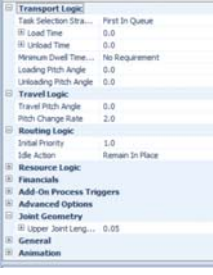


- ▶ To use robots in the model
 - Drag and place the robot object in the facility view from the library
 - Entire robot assembly is placed in the facility view
 - Initial Node (Home) needs to be defined to initialize robot
 - Robot can be resized by dragging the robot base
- ▶ Some points to be noted
 - Robots always move in free space
 - Capacity of robot is always limited to 1 unit
 - Robot provides a property to turn the animation events off during experiment run to speed up model execution.
 - This property is available under Advanced Options property of Robot.



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Robot Hand Properties



- ▶ Robot Hand is the actual transporter object which is used to move entities
- ▶ Since Robot Hand is derived from standard vehicle object the basic properties of vehicle are also available with robot hand
- ▶ Robot Hand also supports Add On Process triggers and ability to log resource usage
- ▶ Robot does not support ability to transfer in and out of the objects

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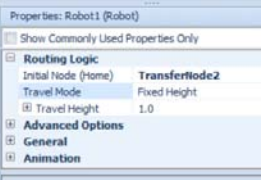
Robot Hand Properties



- ▶ In this section we will go through the properties unique to robot hand
 - Loading Pitch Angle: Defines the angle of End Effector (Robot Hand) relative to the floor
 - Unloading Pitch Angle : Angle of robot hand relative to floor while unloading
 - Travel Pitch Angle: Relative angle of robot hand with respect to floor when robot is moving
 - Pitch Angle Rate: Rate at which robot hand angle changes in degrees per second
 - Upper Joint Length: Offset of interior robot hand from the start of robot arm

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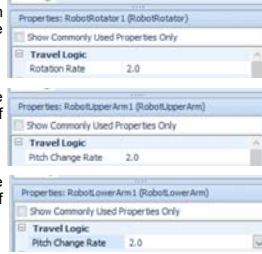
Robot Properties



- ▶ Travel mode is a property unique to Robots. This determines if the robot is going to travel in a direct path to the destination or at a fixed height.
- ▶ Direct path moves execute faster than fixed height moves
- ▶ Travel height defines the height at which robot travels when travel mode is set to fixed height
- ▶ These properties can be accessed by selecting Robot Base

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Robot Rotator, Upper Arm and Lower Arm Properties



- ▶ Robot rotator has a property named Rotation Rate which defines the rate of rotation of the rotator with respect to the base
- ▶ Robot Upper Arm also has a Pitch Change Rate property which sets the rate of movement of upper arm relative to Lower Arm
- ▶ Robot Lower Arm also has a Pitch Change Rate property which sets the rate of movement of upper arm relative to Rotator

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Robot Properties

Each component of robot has a set of geometrical properties which can be edited to change robot geometry. We will consider geometric property of each component in the following slides

Robot Lower Arm

- A. Rotator Joint Length Offset
- B. Upper Joint Length Offset
- C. Lateral Offset

Note: Arrows indicate positive offset

Joint Geometry	
Rotator Joint Length Offset	0.2
Upper Joint Length Offset	-28
Lateral Offset	-3
General	
Animation	

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Robot Properties

Robot Upper Arm

- A. Lower Joint Length Offset
- B. Hand Joint Length Offset
- C. Hand Vertical Offset
- D. Lateral Offset

Note: Arrows indicate positive offset

Joint Geometry	
Lower Joint Length Offset	-66
Hand Joint Length Offset	-15
Hand Vertical Offset	-28
Lateral Offset	0.0
General	
Animation	

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Robot Properties

Robot Rotator

- A. Radial Offset
- B. Vertical Offset
- C. Rotational Offset X
- D. Rotational Offset Y
- E. Rotational Offset Z

Note: Arrows indicate positive offset

None of the geometrical properties need to be redefined unless robot components are resized

Joint Geometry	
Radial Offset	1.1
Vertical Offset	0.5
Rotational Offset X	0.16
Rotational Offset Y	0.0
Rotational Offset Z	0.0
General	
Animation	

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Rack

Rack object is a combination of rack frame and shelves


Rack is a fixed object used to model rack frame

Shelves are dynamic objects created when the model is executed

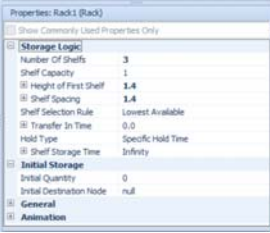
Rack has an input node through which entities enter the rack and an output node through which entities can be retrieved

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Rack




- ▶ Rack can be placed in the model by dragging the rack object from the library
- ▶ Rack is defined with following properties;
 - Number of Shelves: This property defines number of shelves with which the rack will be initialized
 - Shelf Capacity: Storage capacity of each individual shelf in the rack
 - Height of First Shelf & Shelf Spacing: Define rack geometry
 - Shelf Selection Rule: These rules determine the order in which shelves will be used.

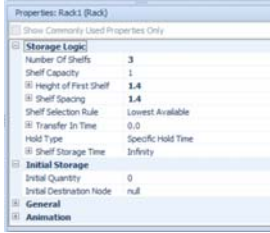


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Rack




- ▶ Transfer In Time: Defines the amount of time needed to transfer an entity into a shelf
- ▶ Hold Type : This property determines if the retrieval will be based on a specific hold time or release interval.
- ▶ Rack can be initialized with initial number of entities set by using Initial Quantity property of rack
- ▶ If rack is being initialized with initial quantity then the entities will be placed based on the Shelf Selection Rule




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Lift Truck




- ▶ Lift truck can be used with racks to model a storage and retrieval system
- ▶ Lift truck is a composite object derived from the standard vehicle object supporting all the capabilities that vehicles provide
- ▶ Lift truck is composed of a truck (transporter) and lift device (entity)
- ▶ Lift truck is initiated the same way vehicles are initiated and is initialized at the Initial Node
- ▶ Initial node is a required property for Lift Truck

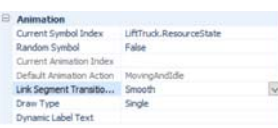


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Lift Truck




- ▶ Lift truck's properties are similar to vehicles properties
- ▶ Two additional properties associated with lift truck are Vertical Lift Speed and Lift Travel Height
- ▶ To animate the movement of lift truck correctly set the Link Segment Transition property to Smooth




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Elevator




- ▶ Elevator object is used to transport entities between elevator nodes
- ▶ Elevator is comprised of three objects Elevator, Elevator Node and Elevator Selector Node
- ▶ To model elevators, place the Elevator object from the library in the facility view
 - To model single elevator, place elevator nodes for each floor and define a list of elevator nodes
 - Each elevator node is associated with elevator that can visit it
- ▶ To initialize, elevators' Initial Node and Elevator Node List is required
 - Elevator Node List is a list of elevator nodes that the elevator can visit (required properties)




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Elevator




- ▶ Since elevator object is derived from vehicle it shares most of the properties with vehicles
- ▶ The movement logic for the Elevator is to move in a single vertical direction (up or down) until all drop offs and pickups have been completed in that direction
- ▶ Once all pickups and drop-offs in the current direction have been completed the elevator changes direction and continues with additional pickups and drop-offs.

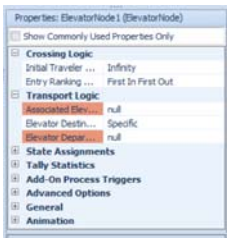


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Elevator Node




- ▶ Elevator Node is used to represent floors to which the elevator can travel to pick up and drop entities
- ▶ Apart from the Transfer Node properties, properties unique to Elevator Node are
 - Associated Elevator defines the Elevator which can visit the node
 - Elevator Destination Type is the method used to set destination node of the elevator. It can be either Specific, Continue or By Sequence
 - Elevator Departure Node defines the destination node of the elevator if the Elevator Destination Type is set to specific




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Elevator Selector Node



- ▶ Elevator Selector Node is used when elevator banks are to be modelled
- ▶ Elevator Selector Node is used at each level to select appropriate elevator
- ▶ Selection is made based on the elevator that must travel the least distance to accomplish the pickup
- ▶ Elevator Node List Name is used to define the list of Elevator Nodes to which the associated elevators can visit



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