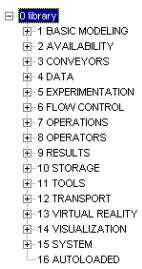
## Library Overview (1)

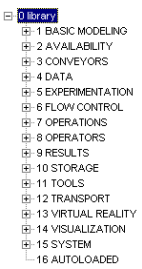
- **Basic Modeling**
  essential atoms to make basic models
- **Availability**
  time schedules, mtbf, mttr, switch
- **Conveyors**
  accumulating, non-accumulating
- **Data**
  tables, connecting with spreadsheets & databases
- **Experimentation**
  experiment, pfm, optimization atoms
- **Flow control**
  lock, unlock, controller






## Library Overview (2)

- **Results**
  monitors, reports, Gantt-chart
- **Storage**
  warehouse, kanban bin, reservoir, fast queue
- **Tools**
  a variety of atoms to simplify your simulation life
- **Transport**
  transport, robot, crane, elevator
- **Virtual Reality**
  Collection of atoms to make VR representations
- **Visualization**
  Collection of atoms to help you visualize your model





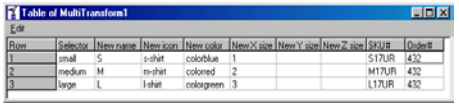

## The SingleTransform Atom <Tools>

- Used to change characteristics of the products passing through
- The “Atom selection rule” defines which of the products passing through are to be changed



## The MultiTransform Atom <Tools>

- Used to assign multiple labels or when atom characteristics are transformed by product type
- “Atom selection rule” is the first filter criteria
- “Row selection rule” is the second filter, and defines what on the product (name/label/icon) will be used to compare to what is entered into the “Selector” column of the table






## Assembler-atom

- The Assembler atom is used to join products per a “bill-of-material” table.
- The products can maintain their individual characteristics if “Pack contents” is checked.
- If box is not checked, sub products are destroyed and main product continues.
- Channel 1 is for the container or main product.
- Channels 2-n are for contents or sub products.
- Double-click to edit bill-of-material table.
- The table can have multiple columns in order to define multiple assembly types.



## MultiService-atom

- A “Concurrent Processor”
- Useful for modeling several parallel servers with a single atom (works well for cure times)
- Capacity defines the number of servers or number of products which can be concurrently processed.
- Cycletime applies to each individual product separately
- Not FIFO

## Conveyors

- A product will be allowed entry to a conveyor if any space is available.
- Accumulating conveyors allow products to accumulate when conveyor is blocked, and Non-Accumulating do not.
- The conveyors can be rotated with the use of the popup menu or the window menu



## Lock and Unlock-atoms

- Lock is used to prevent more than a specified no of atoms to pass this atom
- If used with Unlock it prevents that more than the specified no of atoms are processed at the same time.
- These atoms do not add storage capacity to the model as they have “lock-on-block” logic built in.



## Atom Manipulator-atom

- Gives you the possibility to perform operations (like move, copy or delete) on a number of atoms at the same time
- Can also be used to make sub models very quickly by moving a selection of atoms into a Composition Container atom



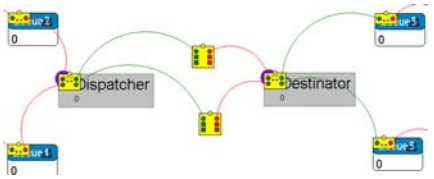
## Composition Container <Tools>

- Can be used to create submodels
- Useful for organizing a model into hierarchical levels
- The user can define if the contents are to be shown and at which scale
- Very simple to save a submodel as an atom. An extra “*.cmp” file is created where all atom specific variables are stored
- In combination with ‘File-Merge’ other models can be easily inserted



## Transporter

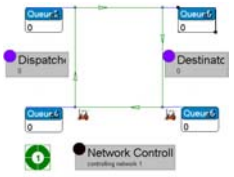
- Can be used either *with* and *without* network
- Use Dispatcher atom if more than 1 pickup place
- Use Destinator atom if more than 1 destination






## Transporter: using a network

- Create network (including network controller)
- Connect network to the pickup places and destinations
- Connect transporter(s) to network



## ArrivalList atom <Tools>

- Used to generate products per a defined time schedule
- The following information is entered in a table for each “arrival”
  - Arrival time (conversions like hr(2.5) are OK)
  - Name
  - Labels
  - Quantity (may be an expression like duniform(5,10) )
  - Channel (output channel where the arrivals will exit)
- You may choose different options for repeating the schedule:
  - No repeat
  - Continuously repeat schedule
  - Repeat time period



## Atom Characteristics

Default atom characteristics:

- name
- color
- 2D-icon
- vricon
- xsize
- ysize
- zsize



## Atom Labels (1)

- Labels are used to define distinguishing characteristics to products in your model.
- Labels are assigned to products using:
  - Creation trigger on a source
  - Trigger on entry/exit of other atoms in a model
  - Single or Multi Transform atoms
  - Arrival List atom
- The purpose of labels is similar to the purpose of a bar code label on a real product - it can provide information on how to route and/or process the product.



## Atom Labels (2)

- A label is simply a variable assigned to an atom
- Labels can have any name to refer to
- Labels have a value or string assigned to them
- Labels do not need to be “declared”
- A product (or any atom) can store as many labels as you want to assign to it.
- Labels are assigned to individual atoms, not to all atoms in the model at once.
- Setting a label to the value 0 deletes label.



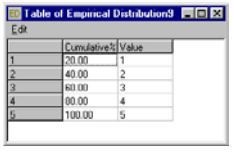
## Atom Labels (3)

- Query syntax:
  label(*[labelname],atom reference*)
- Update syntax:
  *setlabel([labelname],value* ***or*** *string* ***or*** *expression,atom reference)*
- Important: name of the label is case sensitive
- Labels can also be queried via menu ‘Tools-View atomlabels’ or using atom-labels-button 



## Empirical distribution atom

- Maximum 50 records per distribution
- Use an alias name to assign the distribution directly



## Excel, ExcelTableRead, ExcelTableWrite

- DDE (=Dynamic Data Exchange) connection, so spreadsheet must be opened to read or write
- Excel atom only connects (automatic) to Excel spreadsheet
- ExcelTableRead connects and reads data from Excel
- ExcelTableWrite connects and writes results to Excel with a certain time interval



## Database-atom

- Connect to database:
  - Ms-Access
  - Dbase
  - Paradox
  - SQL Server
- For connection with ODBC (= Open DataBase Connection) you must create alias (Control panel - ODBC settings)



## Table Atom

- Indirect referencing use:
  - `setcell(1,1,123,c)`
  - `cell(1,1,c)`
- Direct referencing use
  - an alias name has been created eg: times
  - `settimes(1,1,123)`
  - `times(1,1)`
- Column and row 0 are the header columns and rows
- Index out of range will not give an error message, but results in the return of 0



## The Graph atom

- Used to create a user-defined graph.
- You must define the “value” to be plotted, and the “label” associated with each value.
- In the definition of the “value” and the “label”, you may reference the following two graph variables: **`gp`** and **`gs`**
- **`gp`** (*graph point*) will be incremented from 1 to “No of points”
- **`gs`** (*graph series*) will be incremented from 1 to “No of series”



## Operators

- Use to model people or other resources who can work at different locations
- Operators are called when needed at a specific location
- Operators are freed when they finished their task

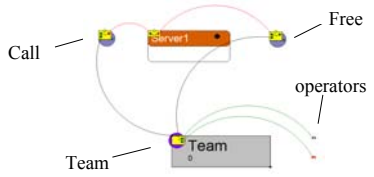


## Operators

- Calling and freeing operators by using:
  - Call and free atoms
  - 4Dscript
    - `calloperators`
    - `freeoperators`
- Operators are grouped in teams
- Important difference: the call atom is like a buffer

## Operators: call and free

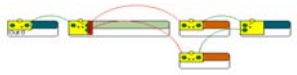
- Click on team to connect operator to a team
- Connect call and free atom to central channel of team
- Click on call and free to configure call for operators






## Flow control: important 4D Script

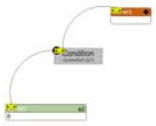
- To open (all) input- or output channels of an atom you can use:
  - `openinput, closeinput, openoutput, closeoutput`
- Very powerful for flowcontrol





## Condition control

- Atom to control input and/or output of atoms by monitoring a custom condition
- Condition may involve other atoms in model
- Connect in- and outputchannels to central channels of other atoms
- Be careful: slows down simulation speed





## More atoms: Function Editor

- Can be used to write your own functions
- The function name becomes a “normal” 4DScript word
- If you assign “public” the word will also appear in the 4DScript overview.
- In order to use it in a new ED session, the function atom should be in the model or in the library.



## More atoms: Initialize

- The Initialize atom executes code every time the model is reset or when the simulation starts



## More atoms: Atom Organizer

- Atom organizer organizes most Tool atoms like:
  - functions
  - tables
  - experiment
  - empirical
  - database
  - excel
  - word

## The Data Recorder atom

- Used to collect user-defined variables.
- Variables are written to this atom's table as products pass through.
- This atom does not add capacity to your model because it does not allow products to enter unless they can immediately pass through without queuing up.



## Introduction: Atomeditor

- Some theory about atoms
- Atomeditor



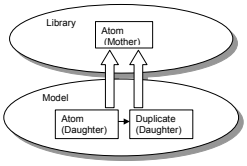
## Theory: Atom Categories

- Baseclass
  - "bare" atom, no functionality
  - library atoms are created by adding functionality to a baseclass atom
- Daughter
  - inherits functionality from it's mother (original)
  - when creating an atom by dragging, you create a daughter
- Duplicate
  - direct copy
  - there is no inheritance of functionality between the original and the copy



## Theory: Atom Relations

- The library atoms generally:
  - are mother atoms
  - do not have mothers
- The model atoms generally :
  - are daughters of the library atoms
  - do not have daughters






## The Atom Editor

- Menu: 'View - Atom Editor'
- Enables you to modify 'anything'
- Used by 'developers' who wants to:
  - Modify or create atoms
    - behavior
    - animation (2D/3D or VR in v3.0)
    - number of channels
  - Modify or create applications
- Detailed explanation in 'Advanced Course'