

SemTalk 2.1 Simulation Toolkit



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0. Introduction

The main purpose of the SemTalk Simulation Toolkit is to offer an open and readily adaptable platform to investigate the dynamic behavior of business processes. Process threads are interpreted by a colored Petri-Nets discrete simulation engine. Simulation helps to understand the dynamic structure of a process, to identify weaknesses, media breaks or bottlenecks and it generates a more reliable process trace to compute activity based costing. Simulation data can be used to support a variety of business processes activities such as using SemTalk in conjunction with the [Microsoft Accelerator for Six Sigma](#).

Simulated processes can be analyzed in a single stepping mode or by running multiple processes at once. Object instances such as an *order* object are created and their attribute

values can be manipulated while the process is being executed. VBScript Macros can be attached to every process step in order to program sophisticated computations or to open custom dialogs in a Rapid Prototyping use case.

The SemTalk Simulation Toolkit may be used with SemTalk KSA Edition and all other related BPM methods which have a compatible meta model such as SemTalk FlowChart Edition, SemTalk for E-Government or with BCP (SemTalk IBW Edition). The simulation functionality for EPC is limited by the restricted expressiveness of the language.

1. The SemTalk Simulation Window

You can open the SemTalk Simulation window via the Tools->Simulation:

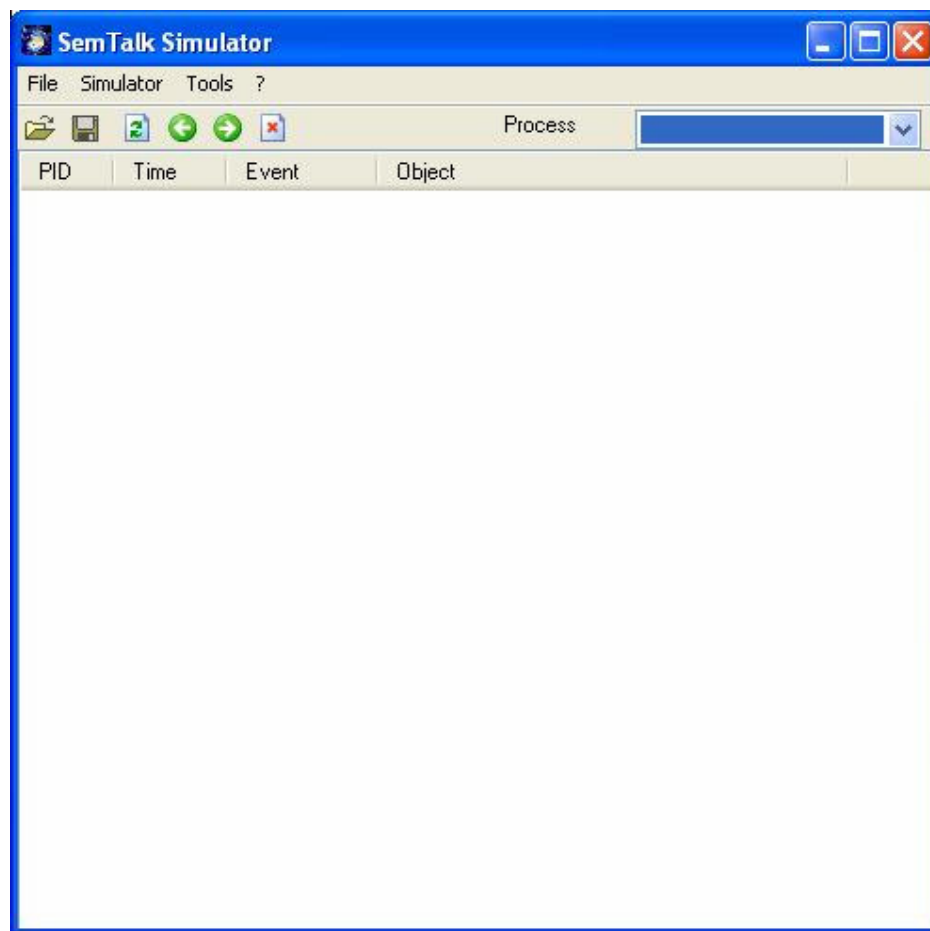







Figure 1: Simulator User Interface

The window consists of three areas:

- Buttons to start and step the simulation
- A combo box to select/filter a current process instance
- A list of events

The Simulation Menu has the following options:

New 	Initialize simulation. Using this command you will start a new simulation. All existing simulation data is kept in memory so that you can compare the results. The simulation engine is being reset and a first simulation step is being executed. The simulation engine is in stepping mode. To continue with simulation you can either executed another step using the “Next/Step” command or enter the running mode using “Last / Run”
First	This command is used to navigate in a completed or stopped simulation trace. The current simulation step (event) is set to the first record. The related Visio object is selected in the drawing.
Previous. 	This command is used to navigate in a completed or stopped simulation trace. Same as above to navigate backward.
Next / Step 	: This command is used to navigate in a completed or stopped simulation trace. Same as above to navigate forward. If the simulator is in stepping mode, a single step of the simulation engine is being executed.
Last	This command is used to navigate in a completed or stopped simulation trace. Same as above to go to the last record. If the simulator is in stepping mode, Run mode is entered.
Run	The simulation continues until the are no more tasks to execute, or the user interrupts the simulation
Break 	This command interrupts the simulation. The simulation is in step mode
Save 	Save the current simulation data to an XML file. You may apply XSLT to simulation data for your own purpose.

Tools-> Options	Option for the simulation protocol:	
	New	An entry in the trace list is made for each new activity to be executed
	Done	An Entry for completed activities
	Waiting	Shows an entry if an activity is waiting for a resource
	Using	Shows an entry if an activity is using/occupying a resource
	Storing	Information is being stored to a buffer
	Accessing	Information is being retrieved / removed
	Flushing	Buffer is being flushed, existing or new information is be send. This can happen because a threshold has been reached or periodically
	Releasing	Shows an entry if an activity is not using/releasing a resource
	Syncing	An activity is waiting for multiple inputs
	Flow	An entry in the trace list is made for each new flow of information to be executed
	Interrupt	An activity has being interrupted by a process of higher priority or an activity has been resumed after interruption
	Off-time	Off-time has been entered or finished. Resources will break /resume their current jobs
	Details	At each simulation step all information created in the current process is shown in a portion of the simulation window
	Interactive	In interactive mode, the user can select alternative choices for the flow of control. In non-interactive mode the simulation engine is using probabilities specified on the control flow links. Default setting is non-interactive.
Animation	Each activity, resource or buffer which is touched by simulation will be selected and greyed	

Using “Up” and “Down” keys in the protocol trace list behaves similar to the “Next” / “Previous” commands. The current focus in the list the moved to another object and the object is being displayed in the drawing if this is possible.

Please note that the simulation engine has nothing to simulate until you specify events on some of the entry points in the process model.

2. Preparing for Simulation

Since edit dialogs can be customized in SemTalk you may not directly see all tabs mentioned in the following chapters in all documents. Customization of dialogs is easy and does not do any harm to existing documents. Select the system class in the SemTalk Explorer e.g. “Activity” and choose Object->Customize from the menu.

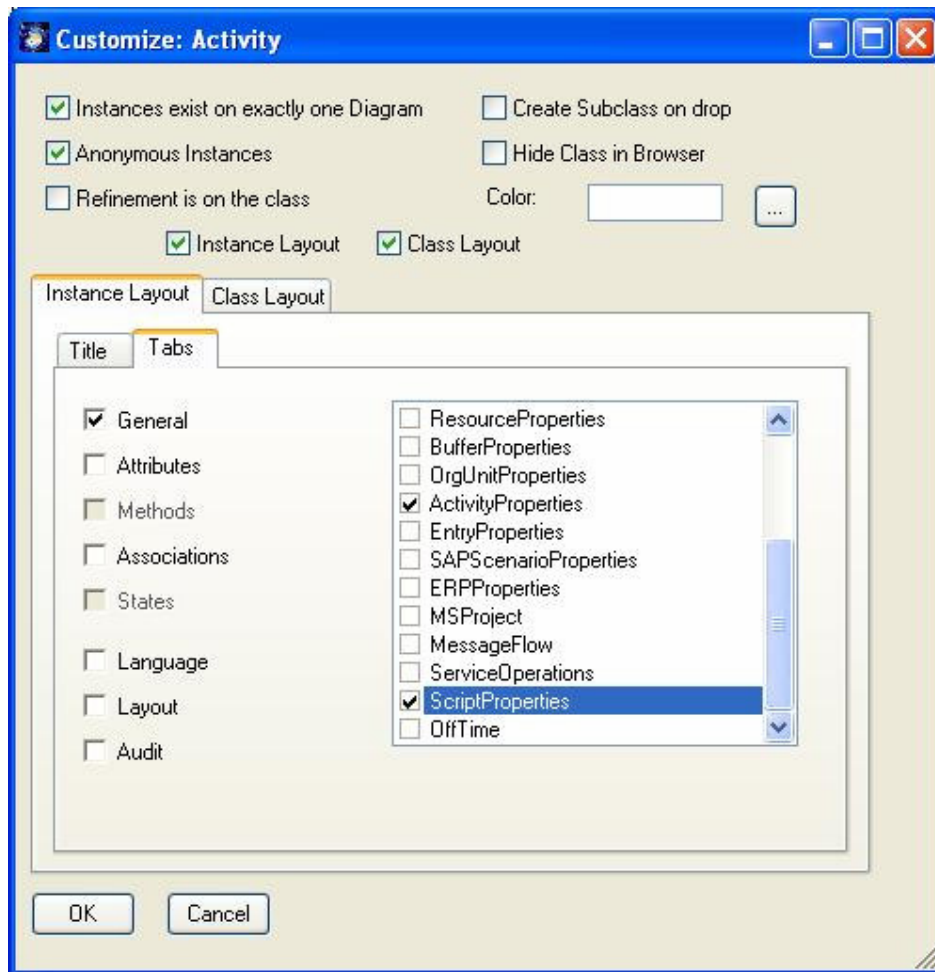


Figure 2: Customizing dialogs

Please select the tabs you need for simulation. For activities “ObjectFlow” and “ScriptProperties” may be useful in some situations. For (human & physical) resources “OffTime” may be needed.

3. Basic Elements of Simulation

The starting elements for the SemTalk Simulation Toolkit are “Entry Points” (or “Events” in EPC notation) which trigger the simulation by a certain amount of events (or “inputs”). Activities are the process steps being executed. The execution of activities (tasks, process steps...) is called a “Job” and takes a specified amount of time. Physical or human resources may be needed to execute an activity. These resources can have a limited capacity, which specifies the maximum number of activities that can be executed in parallel. As soon as resources are not available, a process instance has to wait for resources. Processes and activities may have priority. Jobs with lower priority will be interrupted. The priority of a job is the sum of the priorities of the process (specified at its entry point) plus the priority of the activity.

In order to explain the simulation elements we create a simple simulation. Please add an entry point and some activities as shown in the following picture.

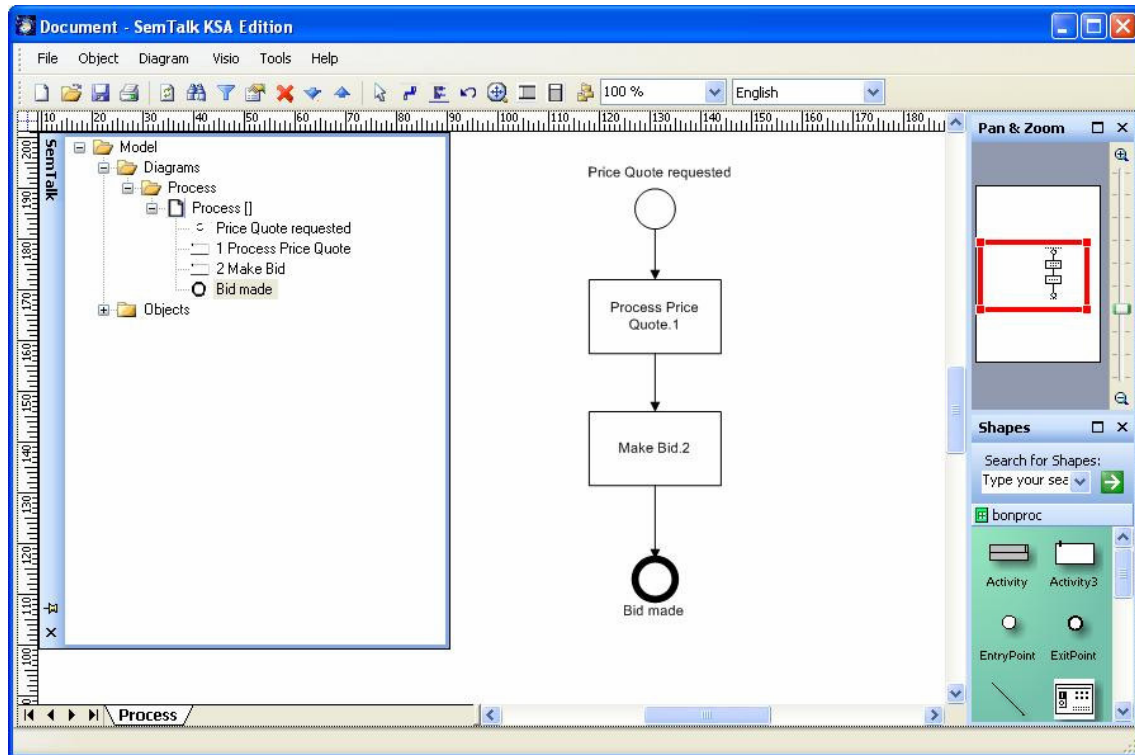


Figure 3: Sample Simulation Process

3.1. Entry Points

Open the “Edit” dialog of the entry point (“Price Quote requested”) and select the “Simulation” tab.

Start	Begin time of this event
End	End time of this event
Period	After each period the entry point is firing events
Priority	Process instances with higher priority interrupt jobs with lower priority events
Inputs	The number of process instances (tokens) to create from this entry point while simulation. You must set this value to something higher than zero in order to activate the entry point.
Distribution	Choose the distribution type from: <ul style="list-style-type: none"> • Constant • Even Distribution • Normal Distribution • Exponential Distribution • Values
Distribution Parameters	Parameters for the distribution: For a constant distribution this is simply the time. For an even distribution we have min time and max time. A normal distribution needs a mean and a std. deviation.
File	For the distribution type “Values” a text file is specified containing all the times is entry is supposed to fire (e.g. a flight plan of an airport). Units a

	seconds.
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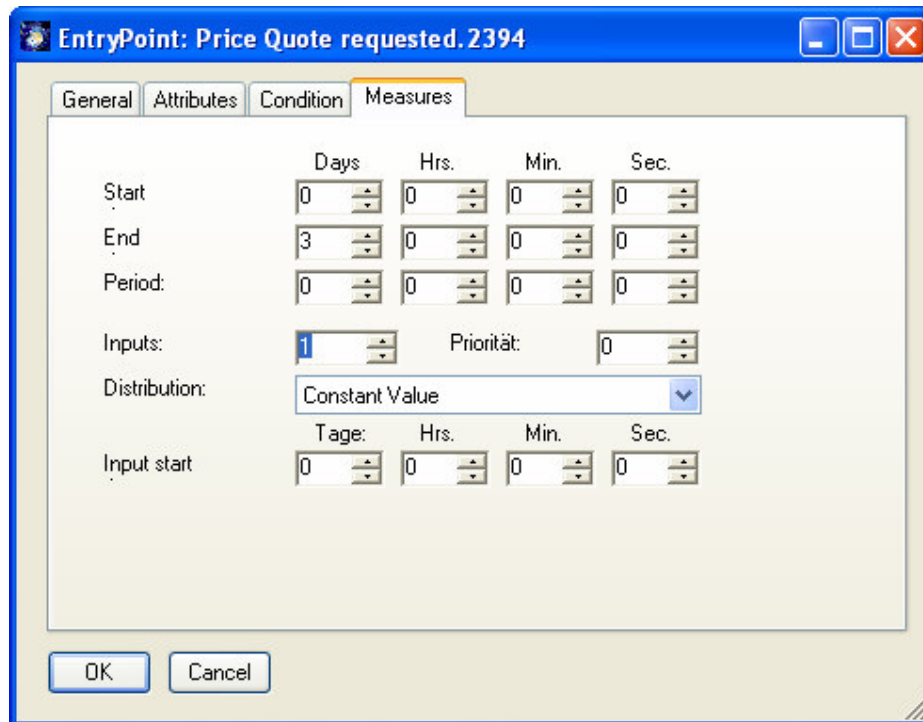


Figure 4: Entry Point Simulation Tab

Please make sure you have specified at least one input.

3.2 Activities (FlowChart: “Process”)

Open the “Edit” dialog of an activity (“process Price Quote”) and select the “Simulation” tab.

Cost Driver	<i>Just for documentation</i>
Priority	The priority is added to the priority of the process instance with was specified at the entry
Distribution	Choose the distribution type from: <ul style="list-style-type: none"> • Constant • Even Distribution • Normal Distribution • Exponential Distribution
Distribution Parameters	Parameters for the distribution: For a constant distribution this is simply the time. For an even distribution we have min time and max time. A normal distribution needs a mean and a std. deviation.
Waiting Time	Waiting time is not a simulation parameter. It can be used in reports to compare estimated times with simulated times
Interruption	Specifies the behaviour after the activity was interrupted. “Resume” continues with the remaining time and “Restart” will start the activity again.

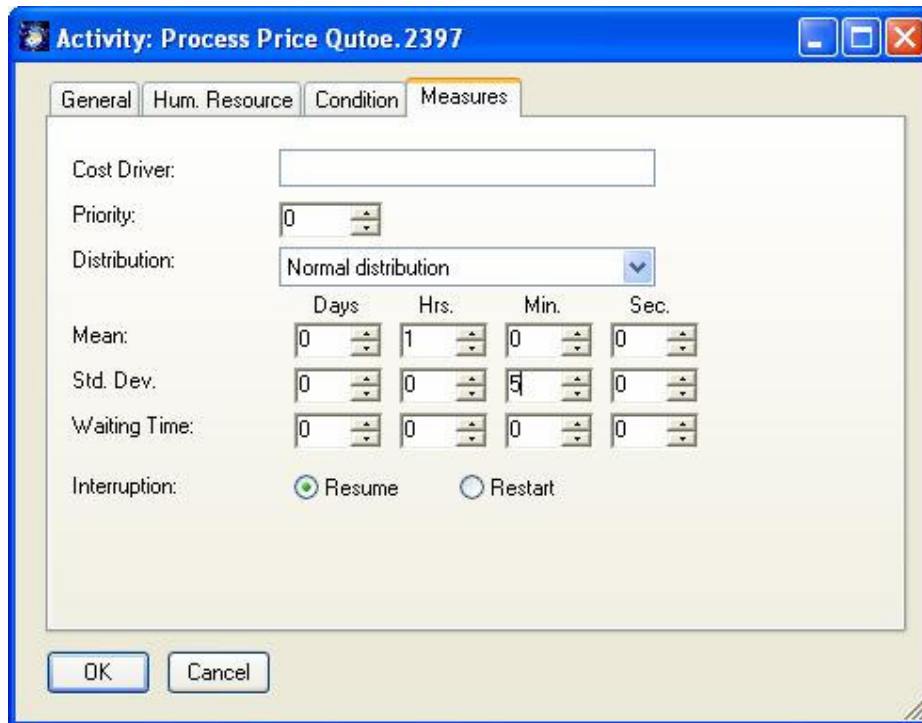
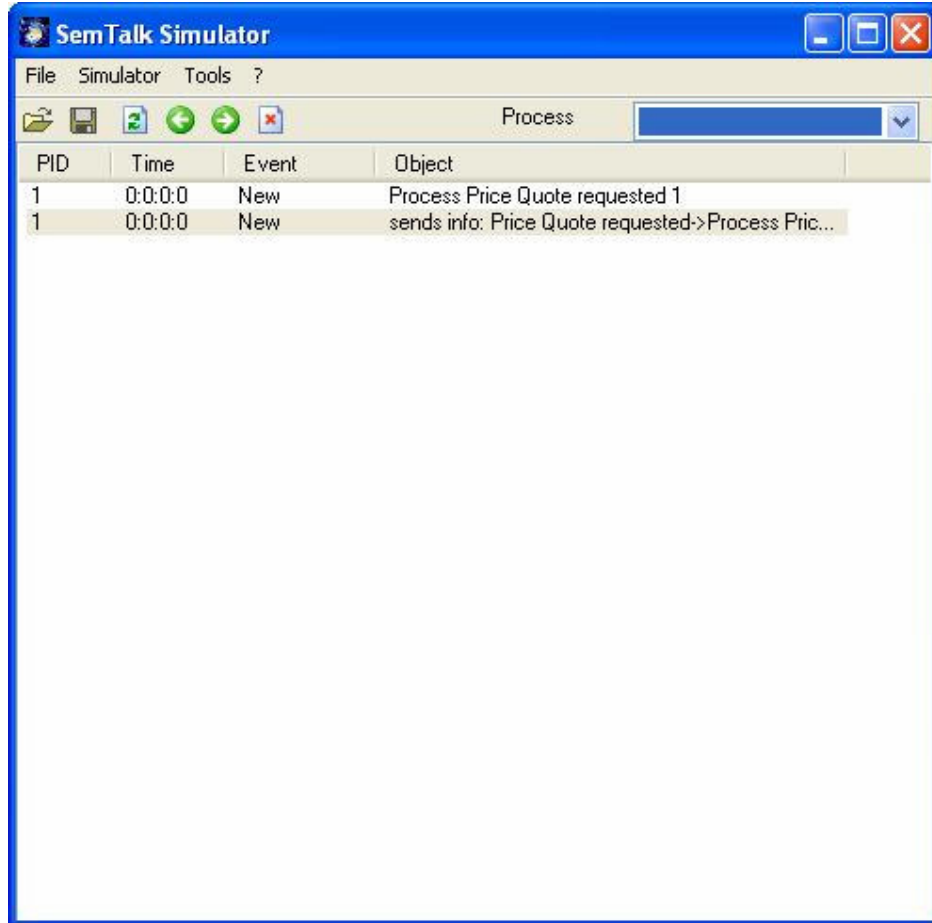



Figure 5: Activity Simulation Tab

Your first simulation is already executable now. Please open the Simulator User Interface from Tools->Simulation if you have not opened it yet. Select Simulator->New to execute the first step of the simulation.



In the simulation window you will notice, that the entry point has been fired and the first information flow has been started. You can proceed now in the single step mode Simulator->Next () or run it with Simulator->Run.

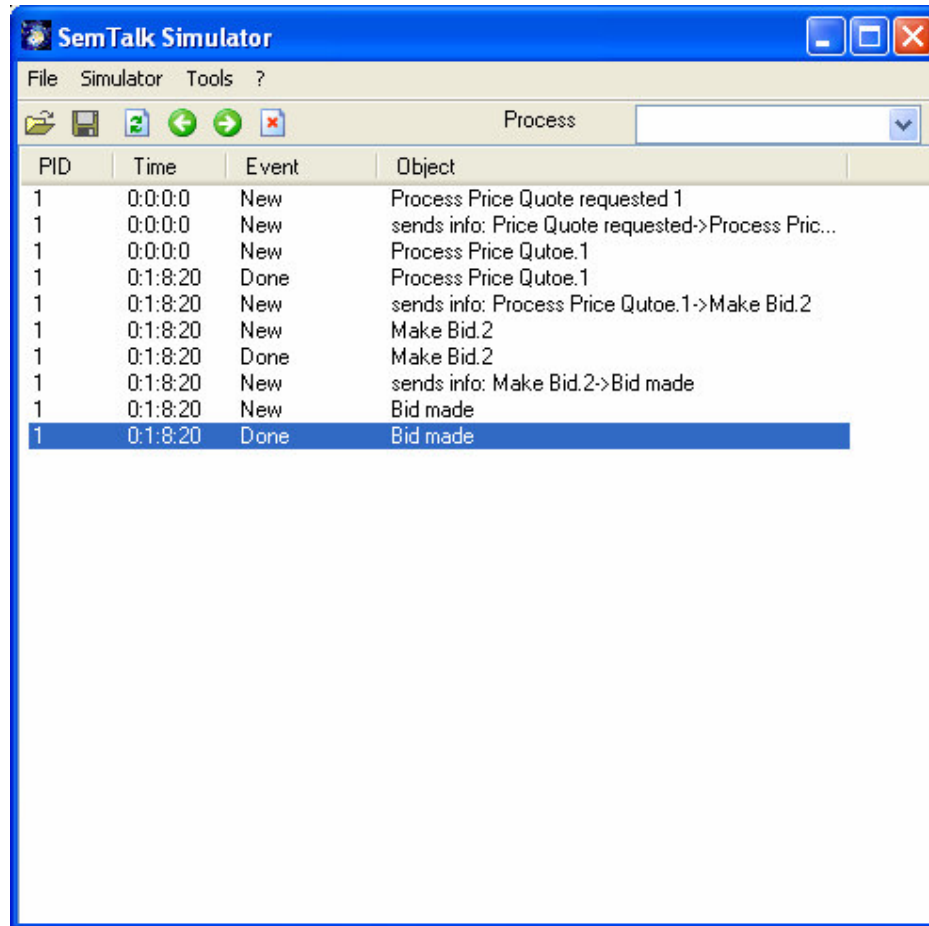


Figure 6: Simulation Trace

Once the simulation is finished or interrupted, you can navigate in the simulation trace using arrow keys or the command buttons. SemTalk will highlight the current object in the drawing.

The trace shows the ID of the process instance, the name of the object, the type of simulation event (started, finished etc.) and the current simulation time. By default all processes are shown. You can filter out single processes by using the “Process” combo box.

Refined activities (subprocesses) are being interpreted by the simulation engine.

3.3 Information flow

The SemTalk Simulation engine supports not only the working time at activities but also the transportation time on information flow links.

On the “Model” tab of an information flow you can specify the type of information, which is passed from activity to activity. On the simulation tab you can specify the transportation time and cost.

Transportation Time	Constant Distribution only
Fixed Cost	To be used in reports. Cost per usage (e.g. a letter)
Variable Cost	To be used in reports. Cost depending on flow time (e.g. a phone call)
Probability	The probability for this information flow, if it is an outbound control flow of an activity with outbound OR or XOR setting (see next

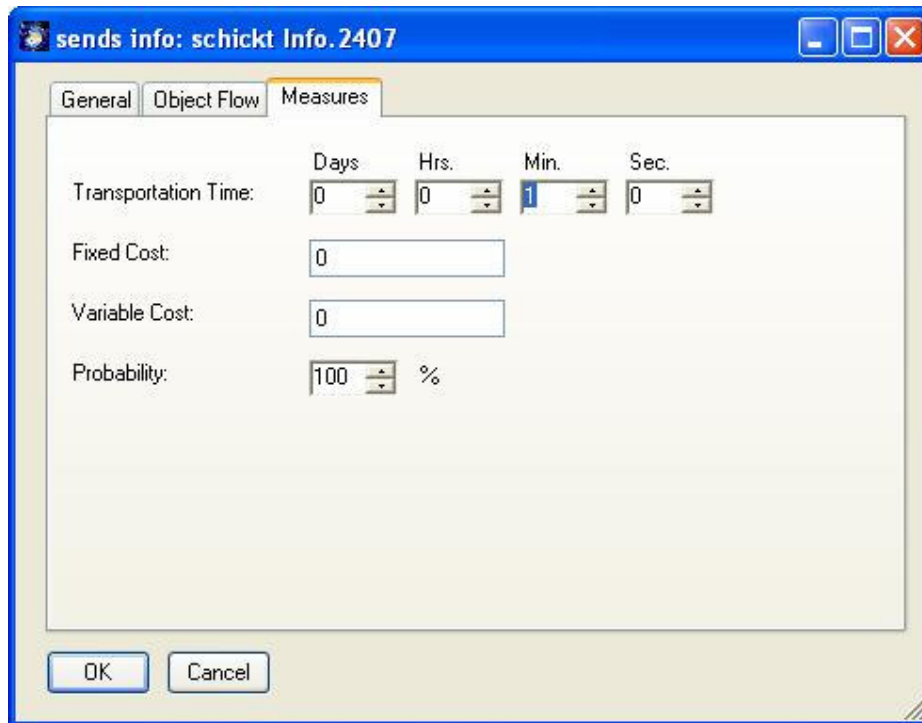


Figure 7: Transportation Time

The flow of control may also depend on the values of object attributes or states as specified on the model tab. This functionality is described in chapter 3.

You can visualize the probability of flows by customizing the layout of sends info link. Select "Probability" in the list of visible attributes.

3.4. Input and Output Logic of Activities

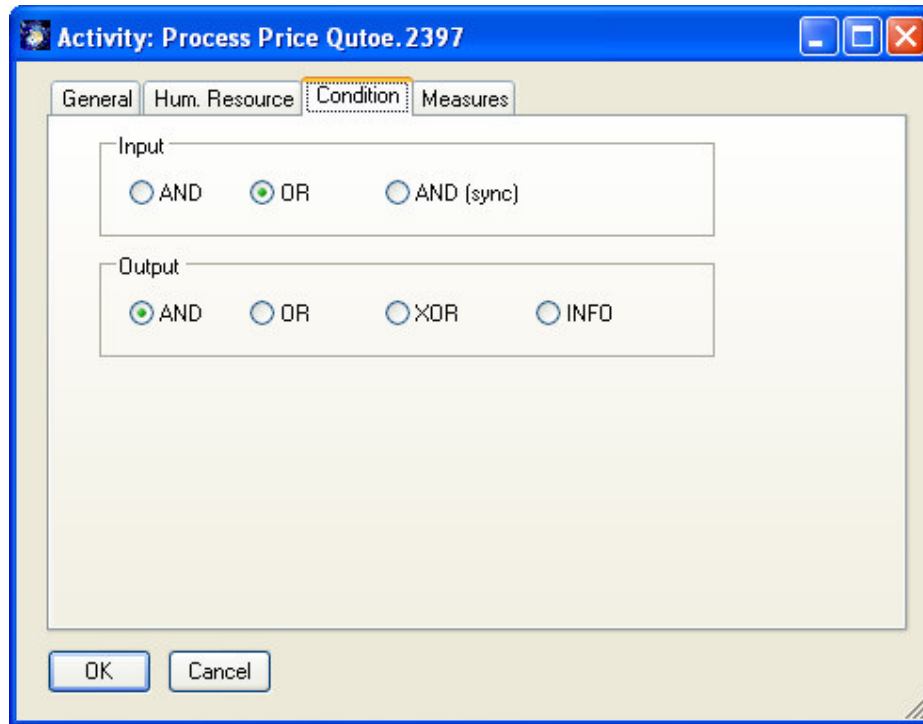


Figure 8: Input and Output Logic

The condition tab allows the specification of input and output conditions. Input and output conditions are used to set the rules for the simulation .

Input conditions:

AND	The process waits until tokens come in from all inbound sends info links.
OR	The process waits until a token comes in from one of the inbound sends info links.
AND (sync)	The process waits until a token from the same original Entry Point (color) comes in from all inbound sends info links. The option is used for synchronization.

Output condition:

AND	A token will be sent to all outbound sends info links
OR	This is a non-exclusive OR. A token will be randomly sent to single or multiple outbound sends info links depending on whether the random number is lower than the probability specified on the sends info link.
XOR	A token will be sent to the first outbound sends info link where the random number is lower than the probability specified on the sends info link.
INFO	A token will be sent to those outbound sends info links where the object expression specified on the object flow tab of the send info link is true e.g. Person.Age>10

3.5. Resources

The next step is to add the human or physical resources required to execute the activities. For each resource we can specify the following attributes:

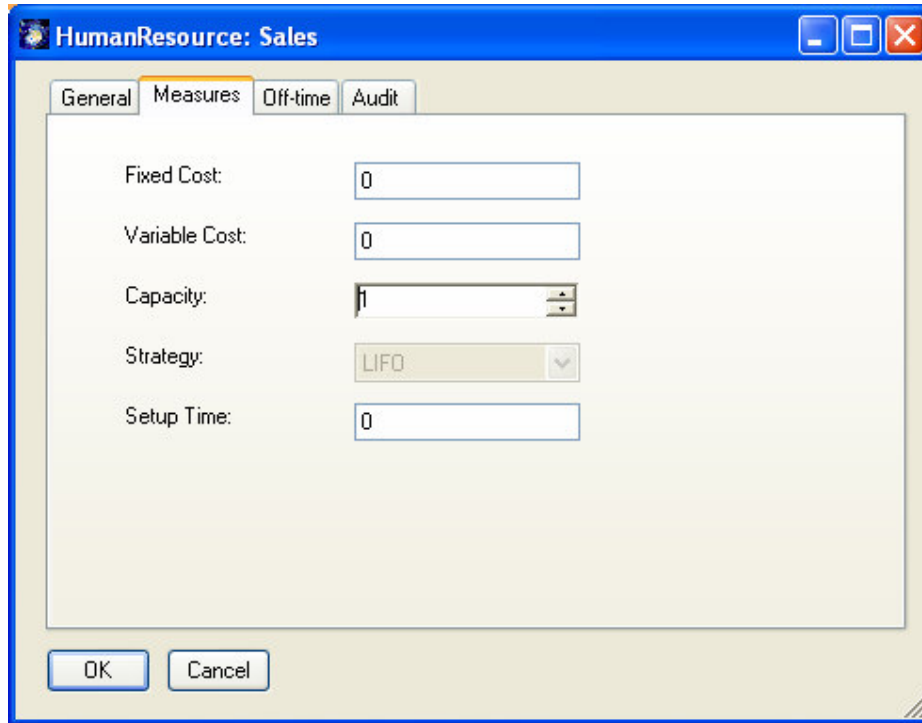


Figure 9: Attributes of a resource

Capacity	The number of activities which can be executed in parallel. For organizational units or positions this should correspond to the number of people. Default value is 1
Fixed Cost	To be used in reports. Cost per usage
Variable Cost	To be used in reports. Cost depending on working time
Setup Time	<i>Amount of time needed additional to the working time to set-up</i>
Strategy	<i>Processing strategy is not supported. Resources always execute the job first in first out unless a job arrives with a higher priority</i>

Off-times (unavailability times for resources) can also be added.



Figure 10: Off-times

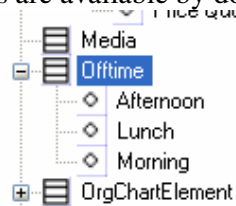
Off-times have a start time and an end time that are specified as seconds. If an off-time is reached in a simulation, resources will break and then resume when the off-time is over.

In the demo model, Sales is assigned as a resource in the first activity. The work time is changed in this example to one day in order to show the impact of a lunch break.

PID	Time	Event	Object
1	0:0:0	New	Process Price Quote requested 1
1	0:0:0	New	sends info: Price Quote requested->Process Pric...
1	0:0:0	New	Process Price Qutoe.1
1	0:0:0	Using	Process Price Qutoe.1 Sales
	0:4:0	Begin	Lunch
1	0:4:0	Interrupt	Process Price Qutoe.1
1	0:4:0	Releasing	Process Price Qutoe.1 Sales
1	0:4:0	Waiting	Process Price Qutoe.1 Sales
	0:5:0	End	Lunch
1	0:5:0	Resuming	Process Price Qutoe.1
1	0:5:0	Using	Process Price Qutoe.1 Sales
1	1:1:11:48	Done	Process Price Qutoe.1
1	1:1:11:48	Releasing	Process Price Qutoe.1 Sales
1	1:1:11:48	New	sends info: Process Price Qutoe.1->Make Bid.2
1	1:1:11:48	New	Make Bid.2
1	1:1:11:48	Done	Make Bid.2
1	1:1:11:48	New	sends info: Make Bid.2->Bid made
1	1:1:11:48	New	Bid made
1	1:1:11:48	Done	Bid made

Figure 11: Off-time in the protocol

It is also possible to manipulate off-time definitions using the SemTalk Explorer. The off-time attributes for start and end times are available by double-clicking on the named off-time.



Use either the swimlanes or the model tab for activities to assign human resources to activities. Then add a working time to the existing activities “make Bid” and “check Discount” and increase the number of inputs in the entry point to 5.

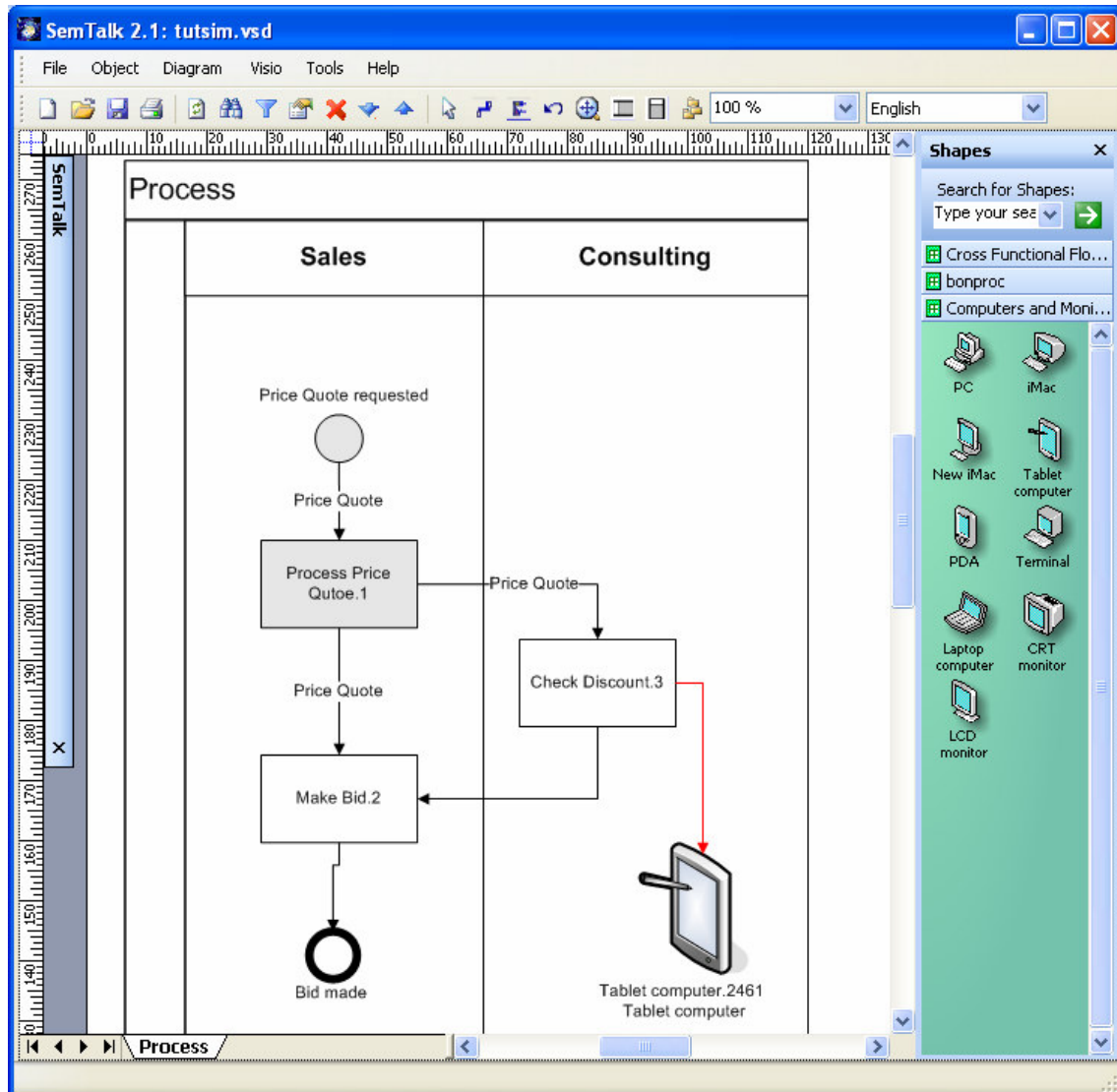


Figure 12: A Process with multiple Resources

In the simulation trace you will notice now that some process instances are waiting for resources (process instance 2 is waiting for Sales, which is already busy processing the price quote in process instance 1).

PID	Time	Event	Object
1	5:1:6:24	New	sends info: Process Price Qutoe.1->Price Quote ...
1	5:1:6:24	New	Make Bid.2
1	5:1:6:24	Done	Make Bid.2
1	5:1:6:24	New	sends info: Make Bid.2->Bid made
1	5:1:6:24	New	Bid made
1	5:1:6:24	Done	Bid made
2	5:2:4:23	Done	Process Price Qutoe.1
2	5:2:4:23	Releasing	Process Price Qutoe.1 Sales
3	5:2:4:23	Resuming	Process Price Qutoe.1
3	5:2:4:23	Using	Process Price Qutoe.1 Sales
2	5:2:4:23	New	sends info: Process Price Qutoe.1->Price Quote ...
2	5:2:4:23	New	Check Discount.3
2	5:2:4:23	Using	Check Discount.3 Tablet computer.2461
2	5:2:4:23	Using	Check Discount.3 Consulting
2	5:3:4:23	Done	Check Discount.3
2	5:3:4:23	Releasing	Check Discount.3 Tablet computer.2461
2	5:3:4:23	Releasing	Check Discount.3 Consulting
2	5:3:4:23	New	sends info: Check Discount.3->Make Bid.2
2	5:3:4:23	New	Make Bid.2
2	5:3:4:23	Done	Make Bid.2
2	5:3:4:23	New	schickt Info.2408
2	5:3:4:23	New	Bid made
2	5:3:4:23	Done	Bid made
3	5:3:16:34	Done	Process Price Qutoe.1
3	5:3:16:34	Releasing	Process Price Qutoe.1 Sales
4	5:3:16:34	Resuming	Process Price Qutoe.1
4	5:3:16:34	Using	Process Price Qutoe.1 Sales
3	5:3:16:34	New	sends info.2446

Figure 13: Process trace with multiple inputs

You can now vary the capacities of your resources or you can move tasks from one resource to another in order to optimize your business process. In order to get a better overview of where processes use time and/ or increase costs, you can use the simulation reports described in chapter 5.

4. Object Instances

In the sample process, objects (information instances) are being created for each process instance. For each process instance, an information instance for each information type is created as the process is being executed. This only happens for the classes that are included in the process flow. In this process there is a “Bid” and a “Price Quote”. For each class exactly one instance is created during simulation.

When you restart simulation, all information instances will be deleted.

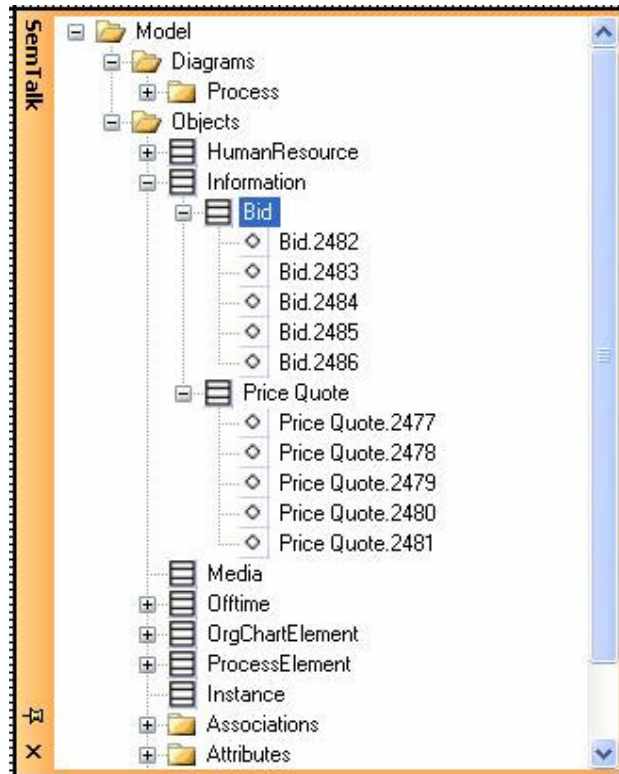


Figure 14: Information Instances

Activities can have post execution conditions, which are able to change attribute values or states of the information instances after the activity has been executed. ¹

¹ The post conditions are specified using the Object flow tab on activities. This tab needs to be made visible using Object “Customize” when the “Activity” is selected in the explorer

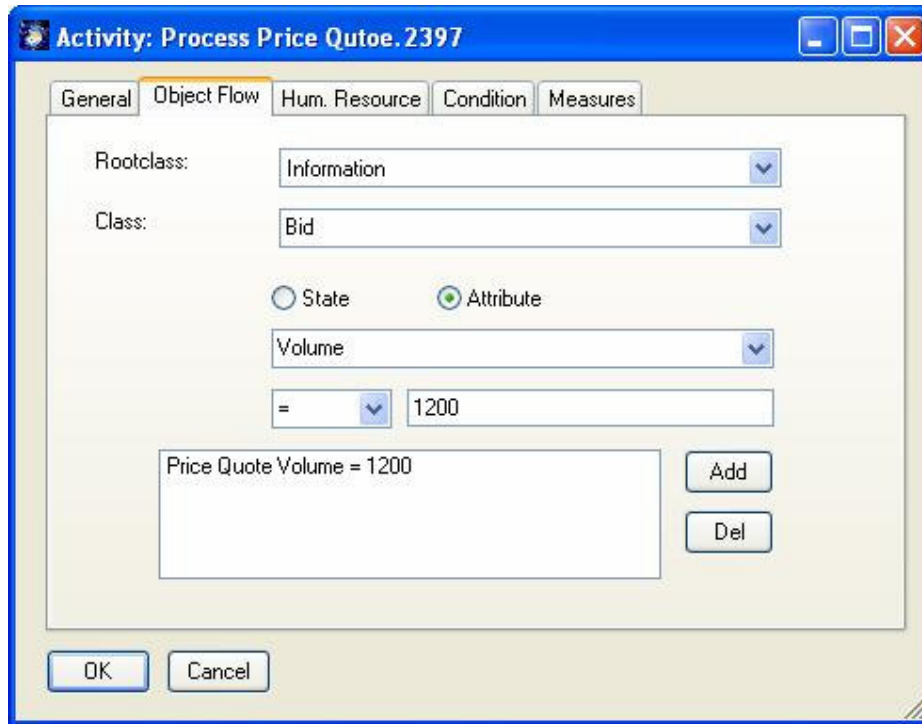


Figure 15: PostCondition Tab

An activity can have multiple post conditions.

On the “Model” tab of an information flow you can also specify attribute values constraints.

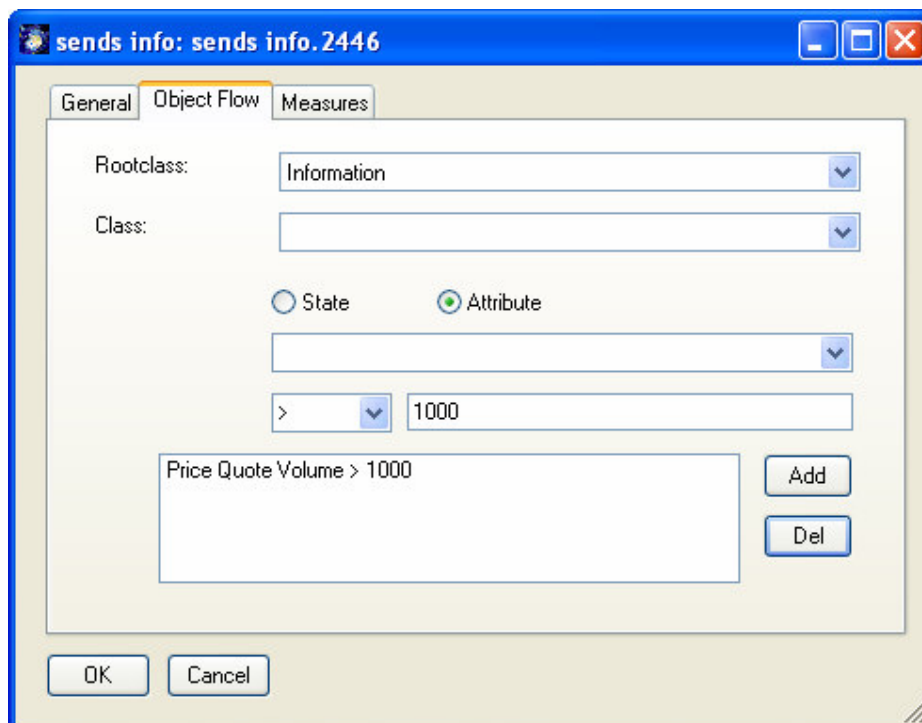


Figure 16: Value Constraint on a flow

If attribute or state constraints are assigned they will only be interpreted if the output condition of the preceding activity is set to INFO. This will overwrite any given probabilities that have been assigned.

Using attribute values you can more exactly specify the dynamic behavior of a process at a much higher level of detail compared to when you only use probabilities.

You also can change attribute values for the purpose of preparing more detailed reports.

Setting post conditions is a simple way to mark the objects and branches of a process. If you run an information instance SemTalk report, you will get a list of objects and their attribute values.

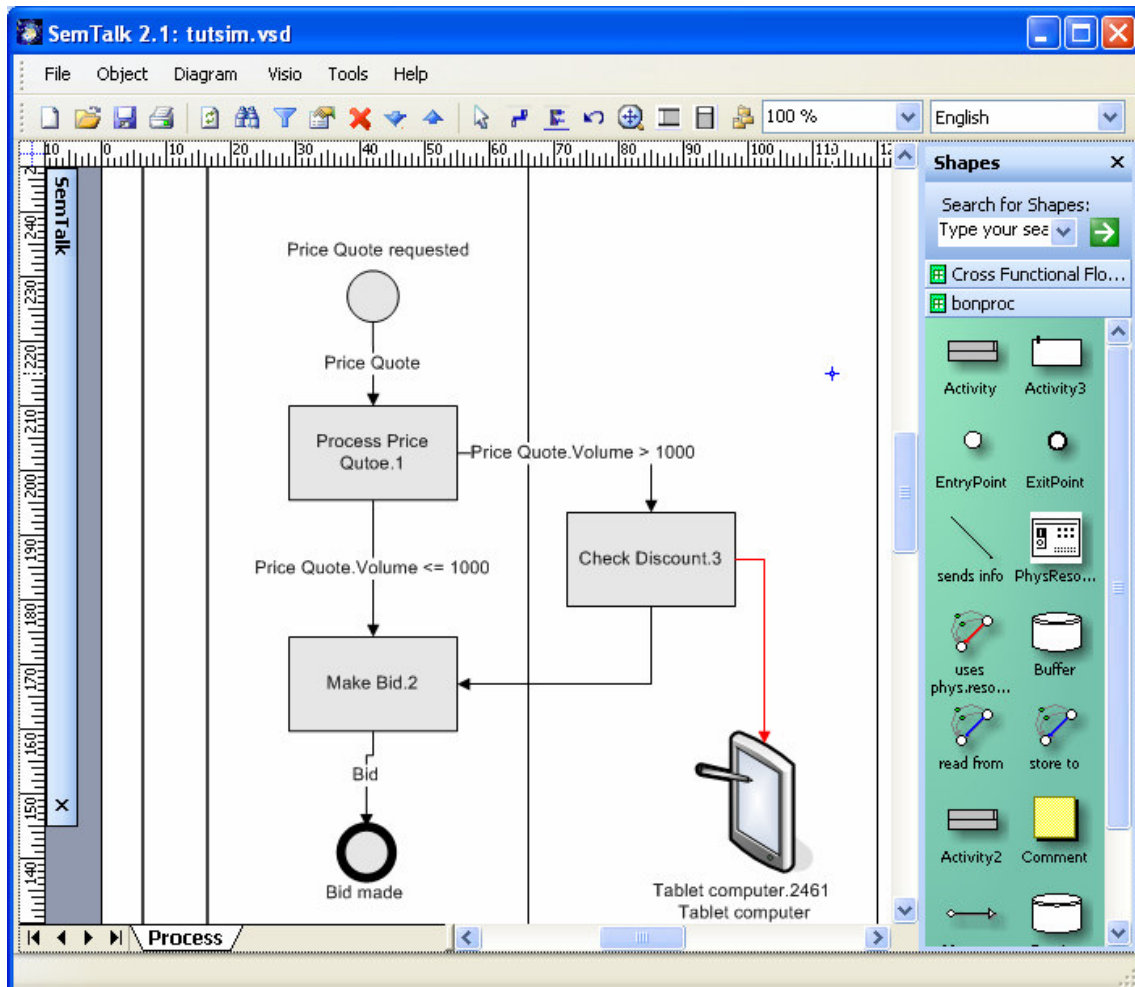


Figure 17: Attribute Constraints

5. Buffers

Buffers are used to store information. Buffers are usually used to read or write information in and out of databases

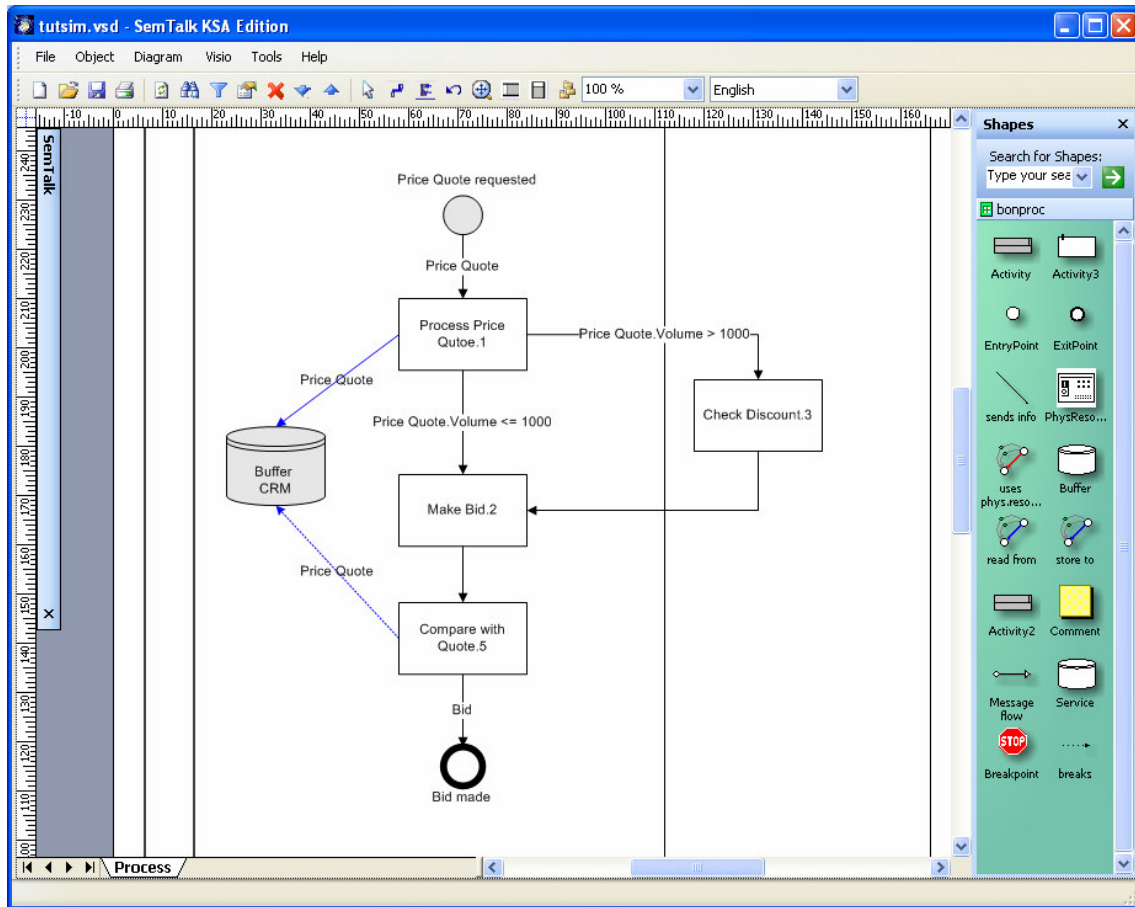


Figure 18: Buffers (Read/Write)

Each time “Process Price Quote” is executed, the information is stored in the CRM system. “Make Bid” reads from this buffer. It can only execute if the required information is contained in the Buffer.

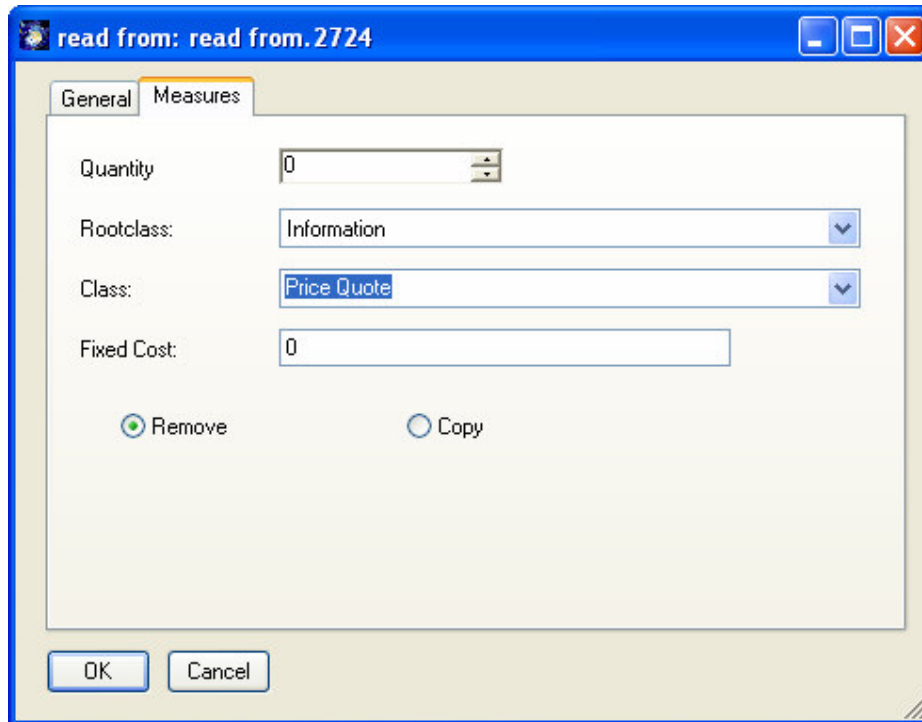


Figure 19: Remove / Copy

If you choose the „Remove“ option the information is removed from the buffer and it will not be available to other activities anymore (e.g. removing a book from the shelf). Use the Copy option if you want the information to remain in the buffer (record in a database) so it will continue to be available for other activities.

After or while simulation you can watch the contents of the buffer:

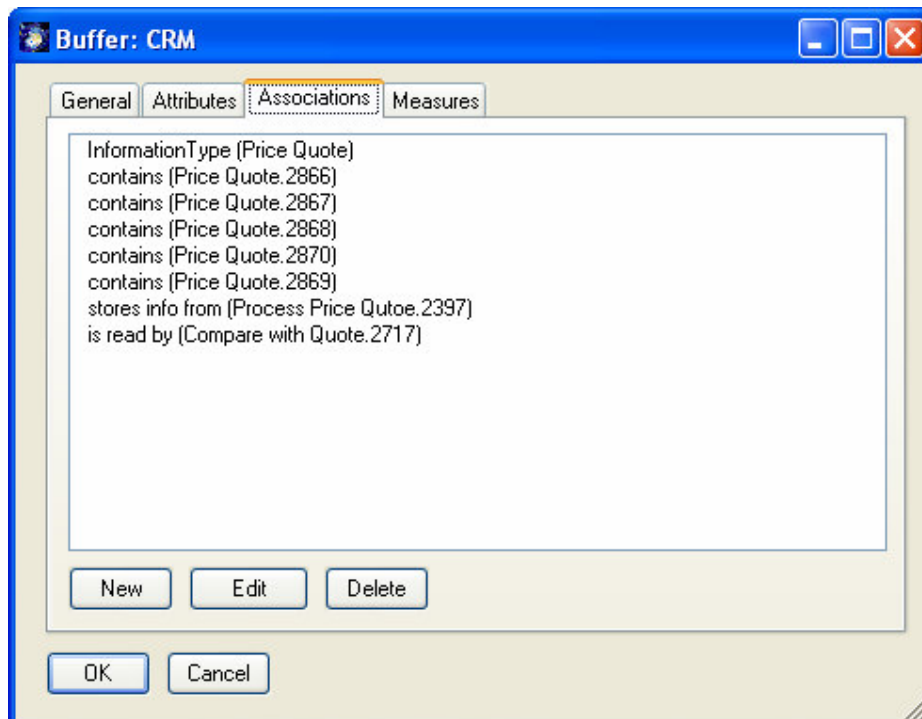


Figure 20: Contents of a Buffer

You can also use “sends info” with buffers. Information can flow from and to buffers and activities.

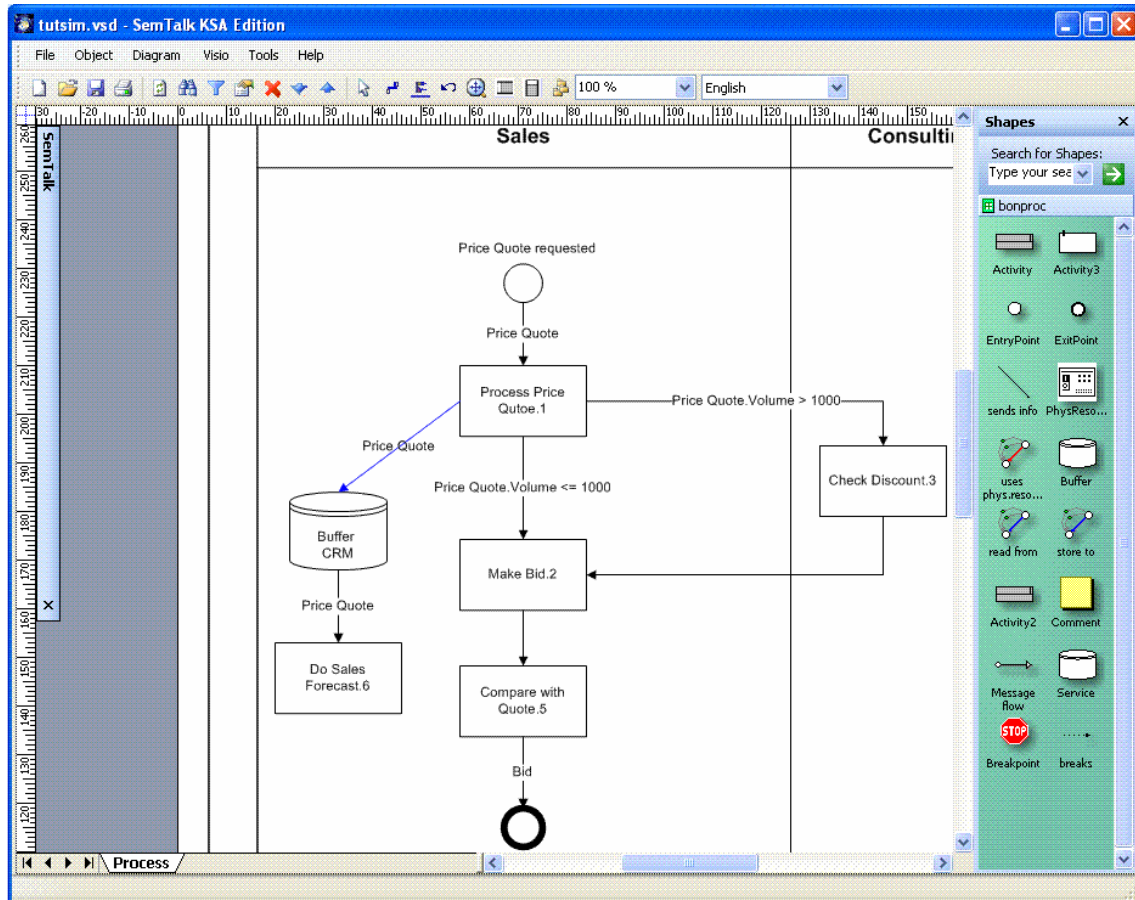


Figure 21: Buffer starting an Information flow

Buffers also may need to be emptied (flushed). If this is the case, please specify at which Flush interval (time) or at which Flush level (count) the buffer should be emptied.

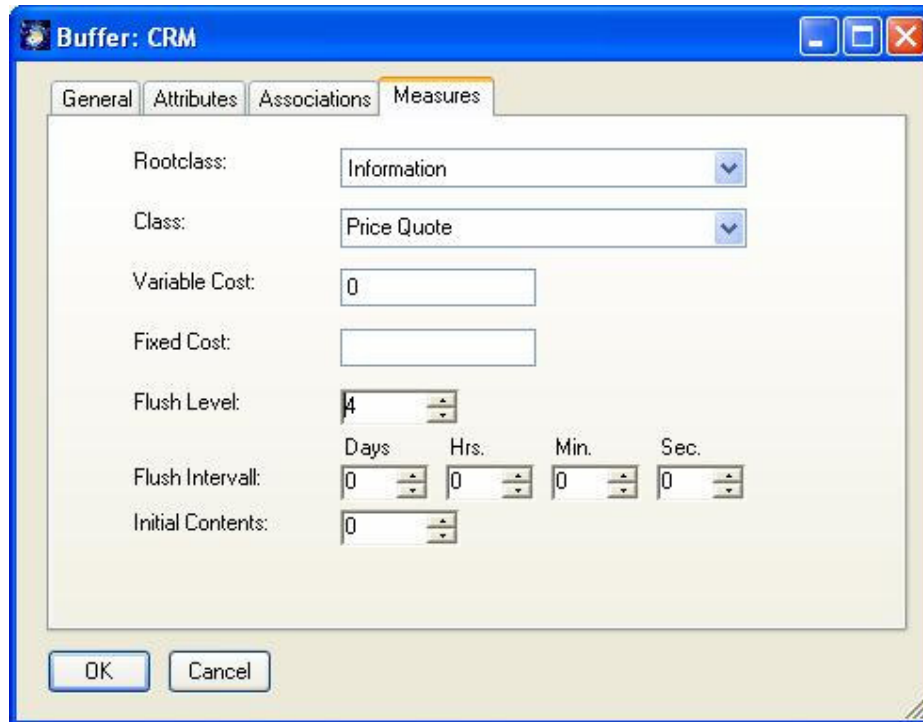


Figure 22: Properties of a Buffer

Flush Level	The buffer sends all contained information into outbound information flows if a certain threshold is reached. e.g. Make a sales forecast after every 5 bids.
Flush Interval	The buffer sends all contained information into outbound information flows if a certain time interval of is reached. e.g. Make a sales forecast every week.
Initial Contents	This is the content of the buffer at the start of simulation run. If the information is being read by a job that has a process ID, the information will be assigned the same process ID as the job that it is processing. Flushing such information instances will actually start a new process with a new ID.

6. Breakpoints

Breakpoints stop a running simulation at a specific activity instead of requiring that you step through the simulation until you reach the desired activity.. Breakpoints are ordinary SemTalk objects which can be navigated, deleted, renamed or listed in a report.

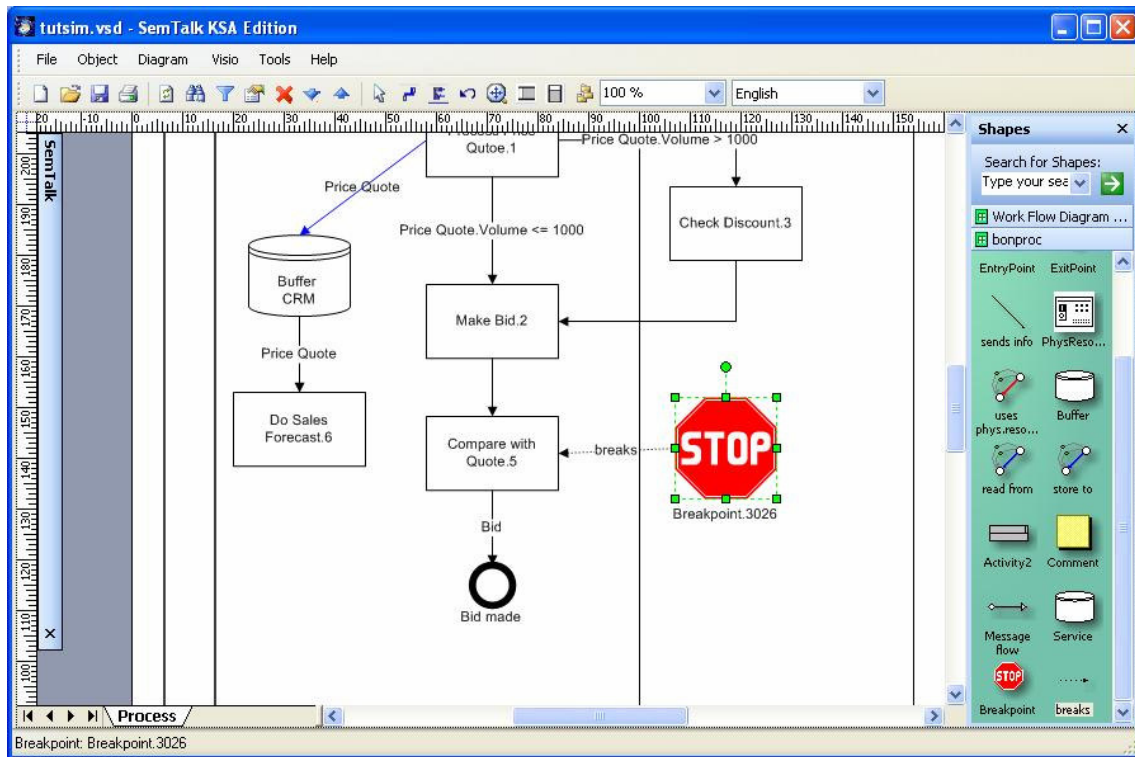


Figure 23: A Breakpoint

To add a Breakpoint just use the Breakpoint (STOP sign) shape available in the process stencil and connect it to one or more activities using the “breaks” connector.

7. Probes

Probes are tracking the actual usage of a resource, buffer or activity. In order to open a probe window use Tools->Probe in the simulation window. Select an object to watch in the following dialog :

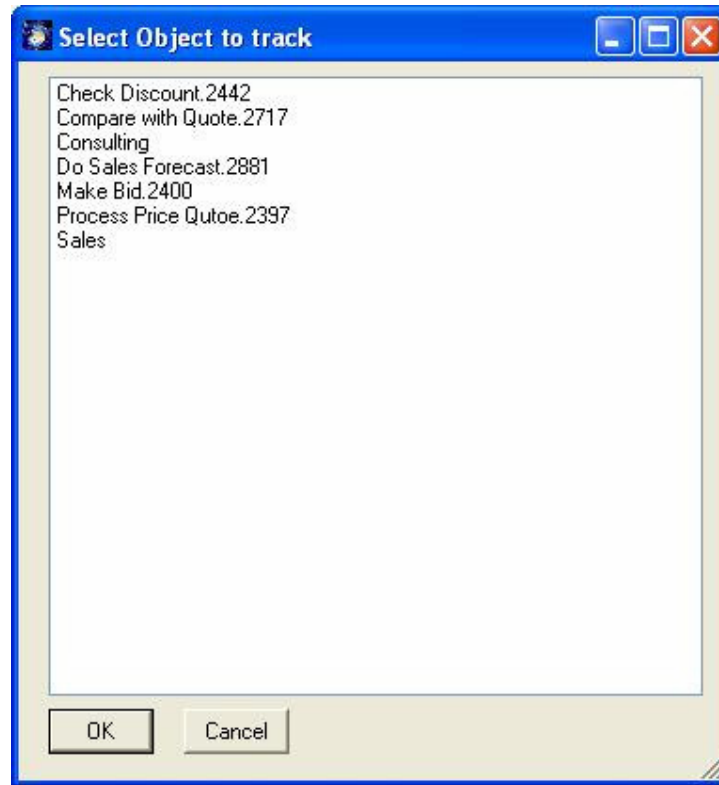


Figure 24: Selection of an object for a Probe

Probes show the actual usage of a resource, activity or buffer during simulation. They can give you hints on how to better optimize your process. Please note that probes show real time and NOT simulation time.

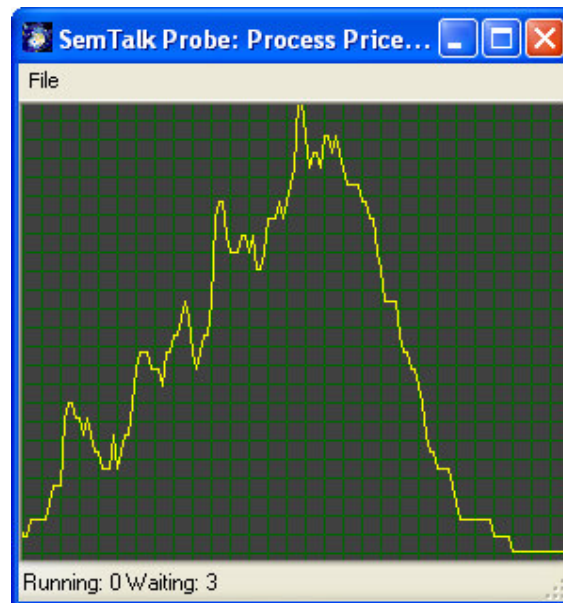


Figure 25: A Probe on an activity

8. Simulation Reports

The SemTalk Simulation reports are opened the same way as other SemTalk process reports.

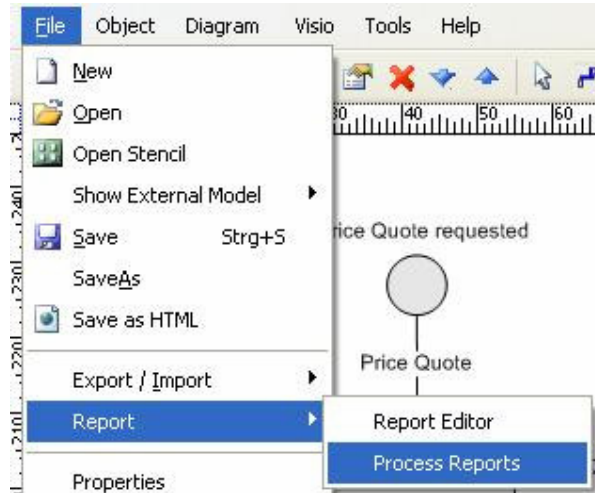


Figure 26: SemTalk Process Reports

If simulation data is available, the simulation dialog will show a tab having the simulation reports.

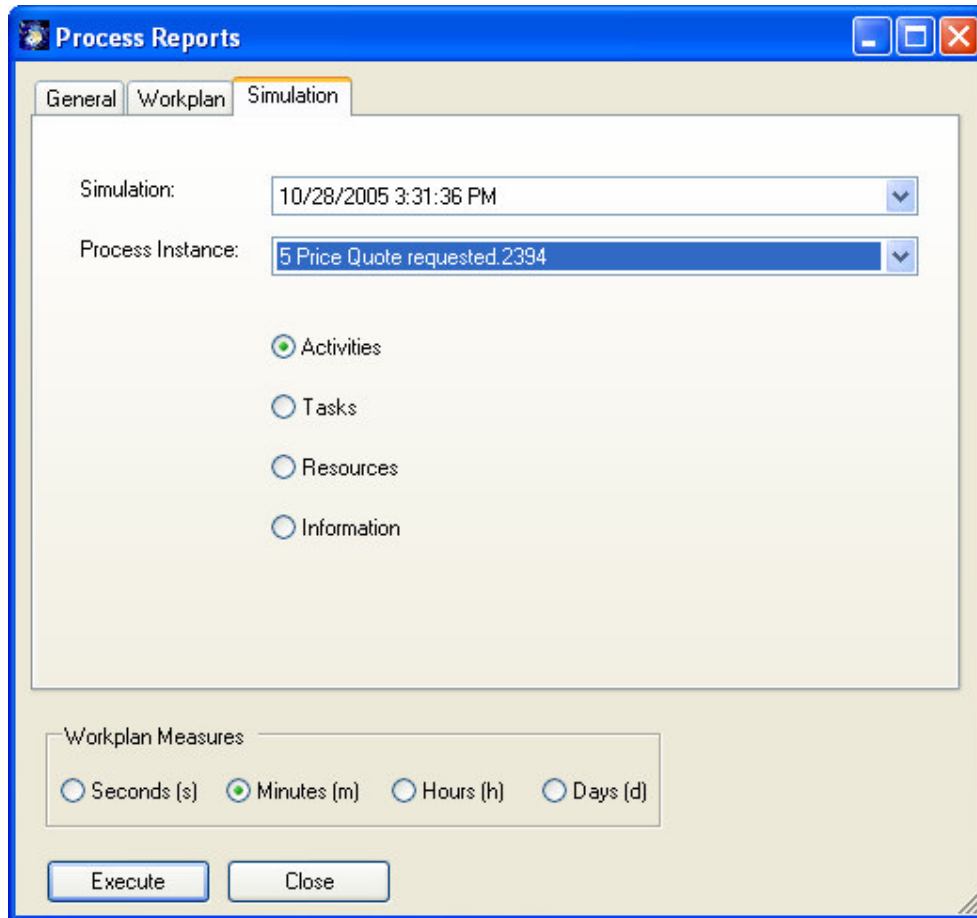


Figure 27: Simulation Reports

You can select a report that covers a single process instance or you can select all process instances together.

Activities	A list of process steps plus working times, waiting times (simulation) and costs taken from the resources
Tasks	A list of process steps aggregated by activity class (task) with working times, waiting times (simulation) and costs taken from the resources
Resources	Process steps by resource with activities, working times, waiting times (simulation) and costs
Information	All – All information types with the number of instances Single process - A list of the information objects with their attribute values

You can select from all available simulation runs (each simulation run is listed as a time). For each simulation run you can run a report on a single process instance or on all process instances together.

	A	B	C	D	E	F	G	H	I	J	K	L
1	PID	JID	No	Name	Worktime in min	From	To	Ress.	Sync.	Waittime	Cost	
2	5	52	1	Process Price Qutoe	54.8	5:5:0:0	5:5:54:50	60	0	60	0	
3	5	55	2	Make Bid	0	5:5:54:50	5:5:54:50	0	0	0	0	
4				Total	54.8						0	
5				Durance	54.8							
6												
7												
8												
9												
10												

Figure 28: Results of the "Activities" Report

The resulting Excel Sheet contains detailed information for each job such as start time, end time, waiting time for resources, synchronization time. Duration time is the difference between the start time of the first job and the end time of the last job.

9. Scripting

The use of post conditions opens up some very powerful opportunities, but even more sophisticated solutions are available using scripting. VBScript is one of the most popular scripting environments.

Before and after the execution of an activity it is possible to call a function. Inside these macro you have read/write access to process and simulation data. You can modify SemTalk objects, popup dialog boxes or even call up SAP R/3 transactions.

You can add any scripting code to activities. A procedure named "Before" is executed before the activity starts and one called "After" is executed afterwards.

SemTalk Simulation is binding the variable "base" to the SemTalk Object engine. The current simulation is bound to the object "sim". The variable "job" is bound to the current job which is being executed.

Programming scripts requires a user to have basic knowledge about the SemTalk API. Some samples of how to use this API are in the MS Excel interface to SemTalk.

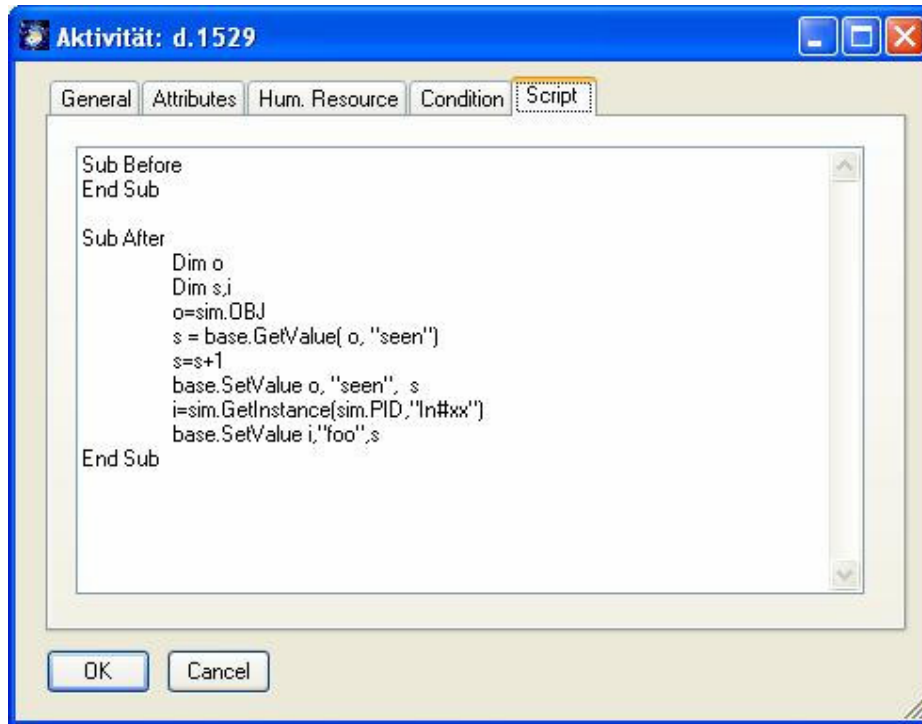


Figure 29: Before and After Macros

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