Simul8 101

Building Effective and Efficient Simulations

Contents

Getting you to Simulation Success (Fast!)

Congratulations on joining the Simul8 Community! We're delighted to have you onboard and want to provide you with all the help we can to get you to getting value from our software as quickly as possible. We've been making simulation software for over 30 years now, so we've worked with a lot of users! From process improvement projects, to real-time answers to long- term strategy and more, Simul8 has delivered huge impact to the world's leading organizations, empowering them to make confident and impactful decisions. We want to help you do the same!

Our Simul8 101 guide, is filled with our top tips from years of experience helping our users. Whether it's your first simulation project, or you've used simulation software before you'll find some killer time saves. And of course, if you have any questions, or would like additional support, we would love to help! Just reach out at support@simul8.com

 Let's get started and look at some important aspects to consider when building a simulation in Simul8.

Key ingredients of a successful simulation project

✓ Know your process

Before getting started on a new simulation, ask yourself how well you know the process you are wanting to simulate. You should be able to answer the following questions:

- What are the different elements of the system?

- Are there any external elements that may influence the process, and if so, to what extent? Can they be controlled?

- What are the constraints in the system?

- Is the system subject to any seasonal patterns?

- Are there any critical paths in the overall process?

- How efficient are the resources? Does their availability change on a regular basis?

- What do cycle times look like?

The list goes on, but you get the idea. To hit the ground running, consider collecting any data you may need ahead of building your simulation. Don't let that hold you back though, Simul8 has default data built in so you can get started even without data. Our top tip for starting your simulation is to create a flowchart of your current process. Doing that will also help you stay on track while laying out the structure of your simulation model.

✓ Define your objectives

What is **the 'why' behind your simulation**? Clarifying your objectives before creating your simulation will help you keep focused as you go along and keep the scope as narrow as possible. Consider the following:

- If your system has a known issue, what outcome are you trying to achieve with a simulation?

- What question are you asking the simulation to answer? Do you want to maximize throughput, reduce waiting times, tackle bottlenecks, or perhaps all three?

- What scenarios do you want to test? (i.e., will hiring more staff members reduce bottlenecks?)

- How will you know whether you have reached your objectives?

Knowing the answers to these questions will facilitate the structuring of your simulation model, making it easier to collect and interpret the results you are interested in.

✓ Take it one step at a time

Simulation model building is an iterative process. To save you time further down the line, **verify and validate changes at regular intervals**.

Verification: is your simulation doing what you expect it to do?

Validation: does the simulation behave in the same way as your actual process?

When delivering a simulation project, the first thing you will want to do is to create a base "as is" simulation. This should closely reflect what is happening in the real-life process and should be the starting point of any experiments and stress tests that you want to carry out to evaluate how the process is affected under different circumstances.

Creating a simulation model will involve several stages of trial and error before getting it right. Saving versions of your simulation as you go is strongly recommended. If you find after several iterations that the simulation is not quite right, reverting to a previously saved version will be quicker than trying to pinpoint which change needs to be rectified. Similarly, testing changes you make on a regular basis will allow you to spot potential issues early on.

Simul8 hacks: flexible models with minimum effort

Simul8 is the fastest tool on the market, and that's not limited to run speed. Simul8's extensive range of low code and no code features means that you can cut down on modeling time while making your model more flexible.

Internal spreadsheets

Internal spreadsheets are one of the most versatile features in Simul8. A common application of spreadsheets is to use them for storing inputs for your simulation model to allow you and stakeholders to easily experiment with different settings. Spreadsheets can either be created directly within Simul8 or imported from external apps like Excel. There are several benefits to using an inputs spreadsheet:

- If you have many objects in your simulation and need to update their parameters, you can easily access them from a single spreadsheet rather than clicking into each individual object.

- If your simulation is to be used by anyone who is not familiar with Simul8, they will not need to learn how to navigate the software as they can control parameters directly through the spreadsheet.

Once you have created your inputs spreadsheet, you can access it from your simulation objects wherever you see the Formula Editor button (⋯).

Let's look at the below simulation which represents the application process for obtaining a visa.

If we want to be able to quickly update the timing of Activities, we can do that by setting up an internal spreadsheet which will be used for timing inputs. We can create a new spreadsheet via Data and Rules > Spreadsheets > New.

To link the Activities' timing to the corresponding spreadsheet cell, select the Activity and open the Formula Editor dialog from the timing box under Properties. Then, select Spreadsheets and double-click on the cell which contains the Activity's timing in the spreadsheet preview within the dialog.

In Simul8, cells are referenced with the format
SpreadsheetName[ColumnNumber,RowNumber]
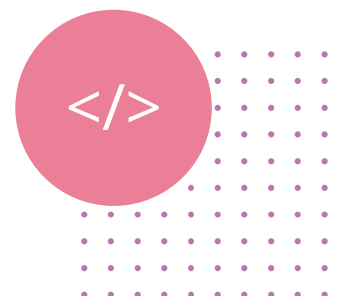
We can now repeat the same steps for all other Activities, so that making changes to the spreadsheet will automatically update the Activity's parameter.
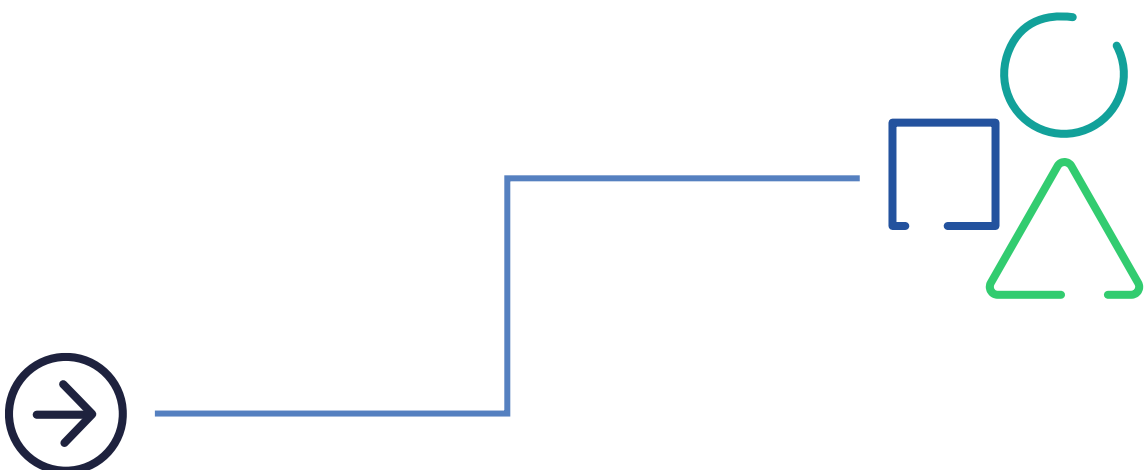
Labels

Now that we have set up the basic structure of the simulation, we can start adding more complexity to it. In many simulations, it is likely that the work items flowing through the system will have different attributes. Think about a manufacturing process for different types of products, or a hospital department treating patients with different conditions. Such differences may influence how the system should operate.

In the visa application process example, we could be dealing with customers who are applying for a visa for the first time, and others who have previously applied and therefore will take less time to complete the steps.

In Simul8, we can capture these nuances with Labels. Labels are a way of differentiating between work items with different attributes. Not only that, but they can be used to control many aspects of the simulation, including routing, timing, resource allocation, and work items' images.

You can create a new Label from the Data and Rules tab. For detailed guidance on creating Labels, check out our online tutorial or the dedicated Academy module.

Let's create a Label in our visa application simulation to differentiate between new and returning customers.

Go to Data and Rules > Labels > Add Label. We will call it lbl_CustomerType and use a number Label. In the second panel, we select the object in which the Label will be attached to the work item. In the third panel, we assign values to the Label using the "Set to" option. Assuming we have a 50/50 split of new and returning customers, we can use a Rounded Uniform distribution between 1 and 2, where 1 will denote new customers and 2 returning customers. If none of the existing distributions fit your data, you can also create your own probability profile distribution.
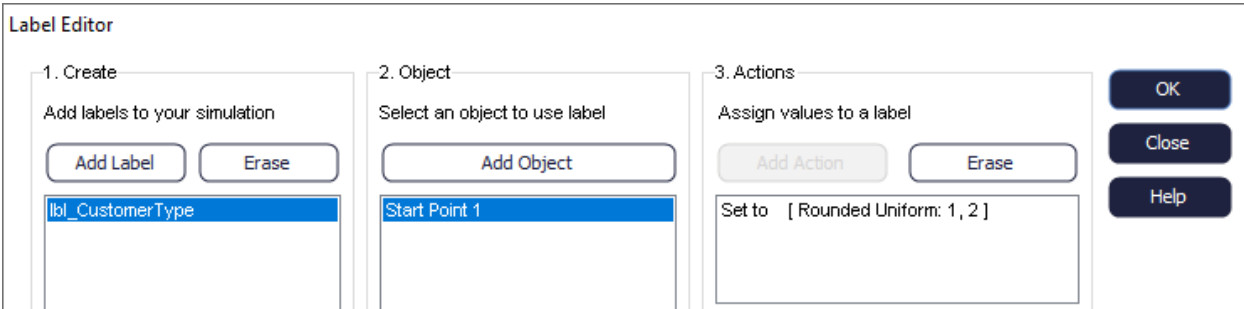

Dynamic referencing

After setting up the Label, arrivals will now follow the distribution used. To adjust Activities' timing based on the work item's Label value, we could use Timing By Label. However, if we want to control timing directly through the spreadsheet, we will need to implement dynamic referencing.

Firstly, update the spreadsheet with all the timing data.

	A	B	C
	Activity Name	New Customers - Processing Time (minutes)	Returning Customers - Processing Time (minutes)
1			
2	Reception	4	3
3	Fill out application	17	11
4	Interview	20	16

Select the Reception Activity and launch the Formula Editor dialog from the timing value box. Select the Spreadsheets option and double-click on ssTiming. Both values for the Reception's timing are recorded on row 2, so we can replace the *r* in square brackets with a 2. However, we want to make sure that Simul8 will read from column 2 when a new customer is at the reception, and column 3 when it is a returning customer.

To make the cell reference dynamic, we can use the Label lbl_CustomerType. We know that lbl_CustomerType = 1 denotes new customers and 2 is for returning customers, so if we want the column reference to update according to the Label value of the current work item, we can substitute the *c* with *lbl_CustomerType+1* (+1 is used to offset by one column, as the first one contains Activities' names).
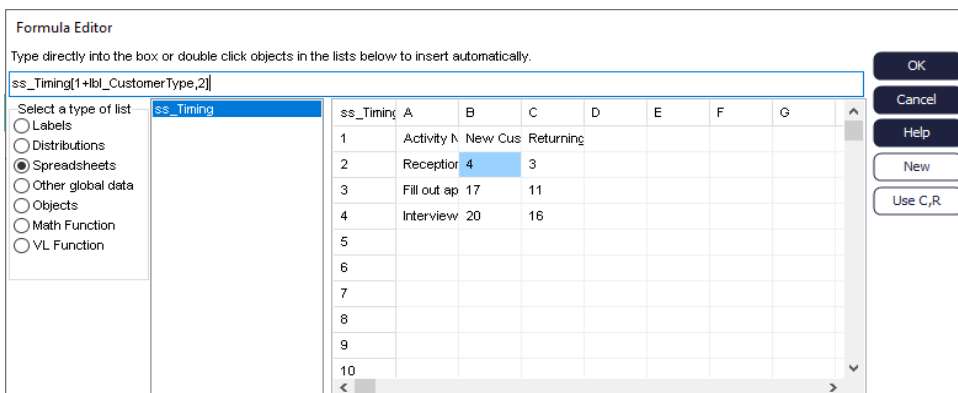
We can now apply this to the remaining Activities, making sure to amend the row reference to 3 for "Fill out application" and 4 for "Interview".
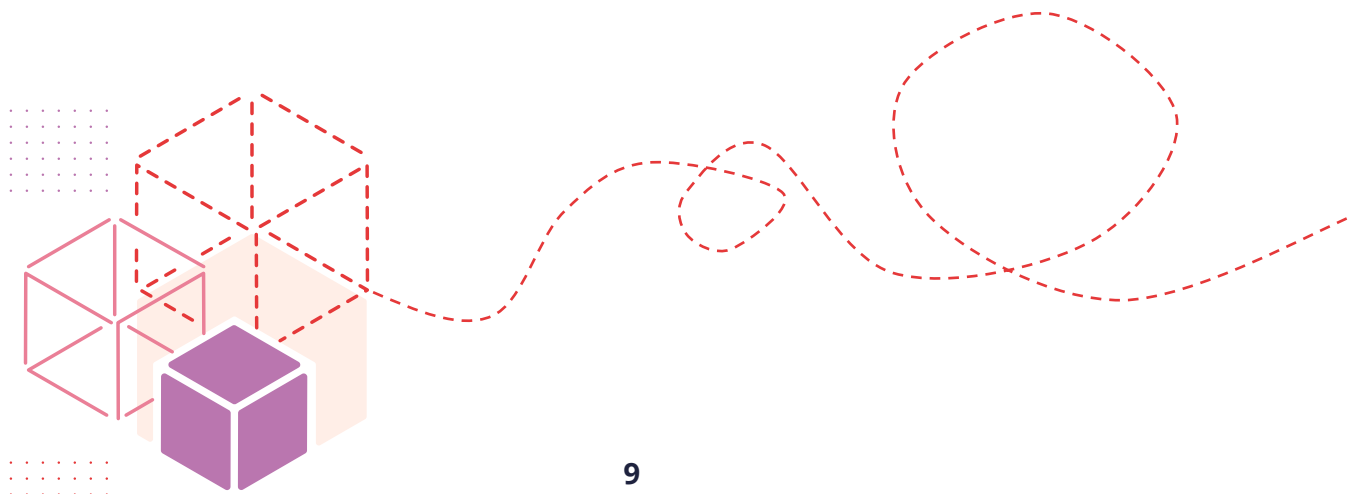
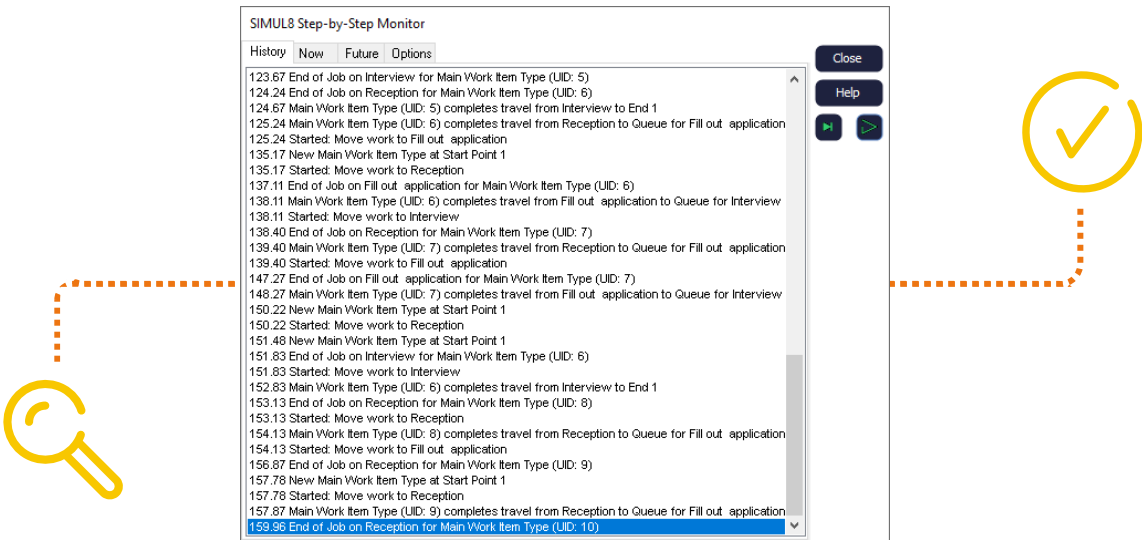# Validating and debugging your simulation model

Simul8 comes with several built-in tools to help you verify, validate, and debug your simulation. Let's look at some of them.

Simulation Assistant

Accessed by clicking on the ⑧ icon at the top of your simulation window, the Simulation Assistant will monitor your simulation as you build it and will flag any potential issues. We recommend reviewing the Simulation Assistant on a regular basis and address any advice if appropriate.
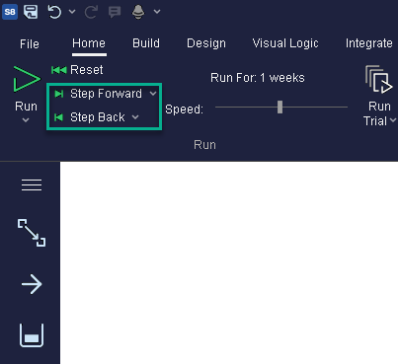
Monitor Simulation

Using the Monitor Simulation under the Advanced tab can help you spot mistakes in your model. The Monitor Simulation will record all events in chronological order, so you can have an overview of what is happening in your simulation. If you are interested in specific events, you can also type in a keyword under "Stop if step text contains" within the Options tab and the Monitor Simulation will pause when the keyword is detected. For example, if you type in "Breakdown", the start or the end of a breakdown in any of the Activities will cause the Monitor to pause.

Step and Current Contents

If you want to verify that your simulation is behaving as it should be, you can use Step. The Step button is found under the Home tab. You can simply click on it to step to the next scheduled event or expand the drop down to access more options like stepping forward 1 or 10 minutes, stepping back 1 or 10 minutes, or back 1 event.

Using Step is particularly useful if you want to 'follow the journey' of a Work Item through a simulation with lots of routing options.

When using Step, you may also want to consider using the Current Contents dialog to inspect specific objects in your simulation. Current Contents can be accessed by selecting any Activity or Queue in your simulation and going to the object's Properties tab. It will show any Work Items that are currently in the selected object. The Current Contents dialog consists of three sub-tabs:

1. Labels
This is where you can check the Label and corresponding value of each Work Item in the object. Select a different Work Item in the Work Items list on the left to display its Label values.

2. Resources

If the selected object is an Activity that uses Resources, you will be able to see which Resource has been assigned to that Work Item in the Resources tab.

If you are using [Resource Moves With Work Item](#) and you are inspecting the Current Contents of a Queue, you will also be able to see which Resource is with a given Work Item, provided that the Resource has not yet been released.

3. Other

Within the Other tab, you will be able to see the following information:

- Unique Identifier of the Work Item
- What time the Work Item entered the simulation
- Work Item's current location
- What time the Work Item entered the current object
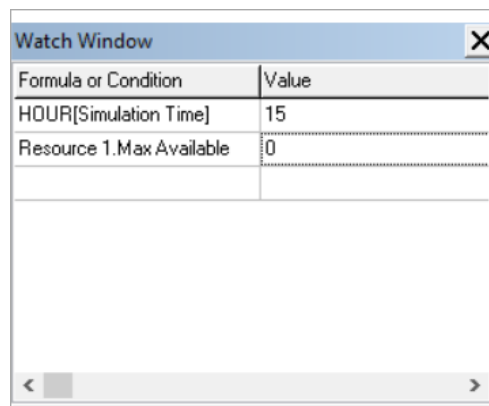- If it is an Activity, what time the Activity will finish processing the Work Item

Current Contents can help you ensure that the Work Items are moving correctly through your simulation, that Resources' settings are being obeyed, and that distributions are being applied correctly.
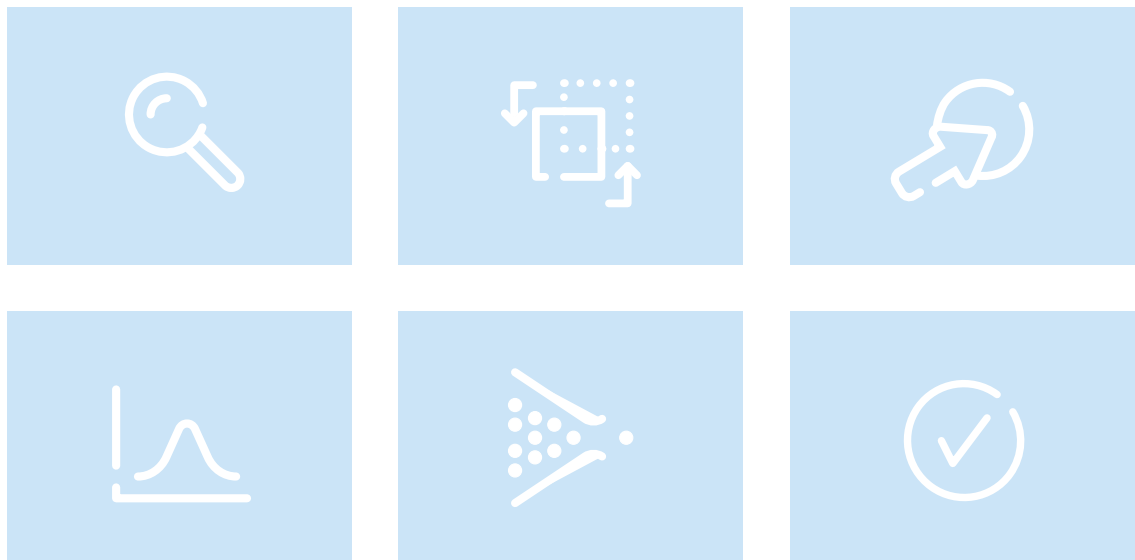
Watch Window

You can access the Watch Window under the Advanced tab. This feature lets you monitor parameters in your simulation as it runs. To add a parameter, double-click anywhere on the Watch Window dialog. This will bring up the [Formula Editor](#), where you add parameters.

For example, if your Resources are shift-dependent or change based on the Resource Schedule, you may want to check that their numbers are indeed changing at the correct time. In that case, you can add HOUR[Simulation Time] and Resource 1.Max Available to the Watch Window so you can keep an eye on the respective values during the simulation run.

Break Points

Using Visual Logic? Debugging your code is really easy with Break Points.

If you want to make sure that a specific line in your code is getting triggered, simply place your cursor over the line and hit F9 on your keyboard. This will add a red circle next to it. When you next run the simulation and the line gets triggered, you will get a pop-up message informing you that a Break Point has been reached. You can then step through your code line by line to check it's behaving as you intended.

Common pitfalls

Simul8 comes with a lot of features and techniques to learn, so let's look at some of the most common beginners' mistakes to look out for when you are building your first simulations.

Not including Queues in your simulation

Although your real-life system may not come with buffers between each process step, we strongly recommend adding Queues between the different Activities in your simulation as this will allow you to immediately spot any bottlenecks. Additionally, unless you are using the Unlimited Arrivals feature, connecting a Start Point directly to an Activity (instead of a Queue) may mean that some Work Items will be prevented from entering the system when the Activity is working.

Connecting passive-passive or active-active objects

In Simul8, Start Points and Activities are considered active objects because they can push and pull-push Work Items respectively. On the other hand, Queues and End Points are passive objects, as they do not control the movement of Work Items.
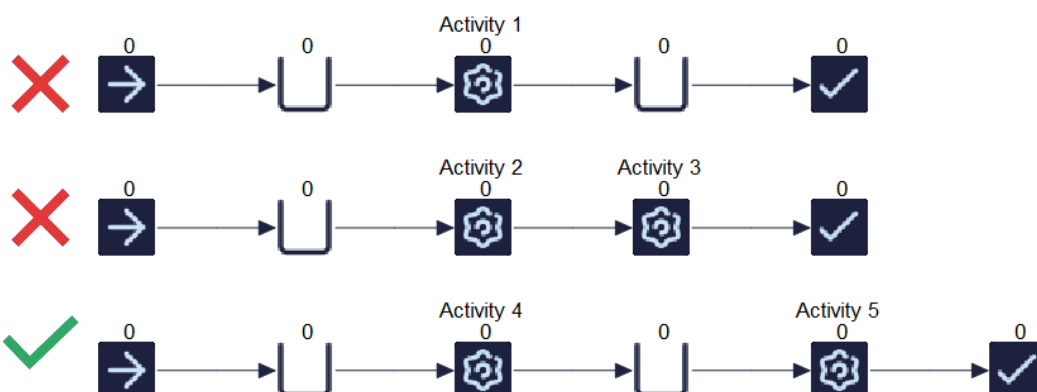
Avoid connecting two passive or two active objects together as this will affect the behavior of your system. For example, if you connect a Queue to an End Point (both passive objects), Work Items will never be able to leave the system. On the other hand, if you connect two Activities together, routing rules on the second Activity will override any of the routing conditions of the preceding one. You may connect two Activities together as long as one of the Activity's Routing In discipline is set to Passive, which means that said Activity will behave like a Queue.

Creating unnecessary Labels

In Simul8, you can use Labels to set apart different types of work in your process. In a healthcare setting, you may want to use Labels to distinguish between different types of patients (emergency versus non-emergency, young versus old etc.). Similarly, in manufacturing you may wish to differentiate between different products or materials. As long as they fall under the parent category (i.e., patient types, product types, color types), you only need to create a Label and assign it to a distribution to represent each type.

For example, if you are simulating a car paint line and there are 6 potential colors, you can simply create a Label called "lbl_Color" and set it to a rounded uniform distribution with a lower bound of 1 and an upper bound of 6 (assuming each color has an equal chance of being selected).

Not using Warm Up Time

Warm Up Time is used to get your system to its normal running conditions before results are collected. In some cases, using Warm Up Time is not necessary. For example, if you are simulating a process that starts and ends the day empty (such as a call center, airport, or supermarket), there is no need to use Warm Up Time.

On the other hand, in situations where there might be work-in-progress left from the previous day/week/month (think of a hospital's emergency department or a factory), then using Warm Up Time can allow you to get a more accurate overview of your system and any metrics that are of importance to you.

To find out more about using Warm Up Time, check out this help file.

Overusing "Before Selecting" Visual Logic

Depending on the code you have written, using "Before Selecting" Visual Logic may not provide enough time for the changes to be reflected in Simul8. Not only that, but because "Before Selecting" is called whenever an Activity can take in a work item, overusing this VL section can slow down your simulation.

If appropriate, consider placing your "Before Selecting" VL code on the previous Queue's On Exit to optimize the code and the speed of your simulation.
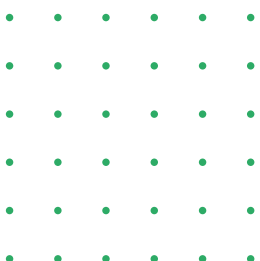
Not using Reset logic

Visual Logic is extremely useful to have your simulated process behave exactly as it does in real life. For this reason, you may be using it to make structural changes (linking or unlinking objects, assigning or removing Resources from Activities) or to modify certain parameters (Activities' timings, batching out sizes, Queues' capacities, variables, etc.) at different points during the simulation run.

In all the above cases, you will need to make sure that you are using "On Reset" Visual Logic so that when you hit the reset button, the original model is reinstated. Failing to do so can you lead you to make decisions based on the wrong data, so it's good to keep this in mind when writing your Visual Logic code.
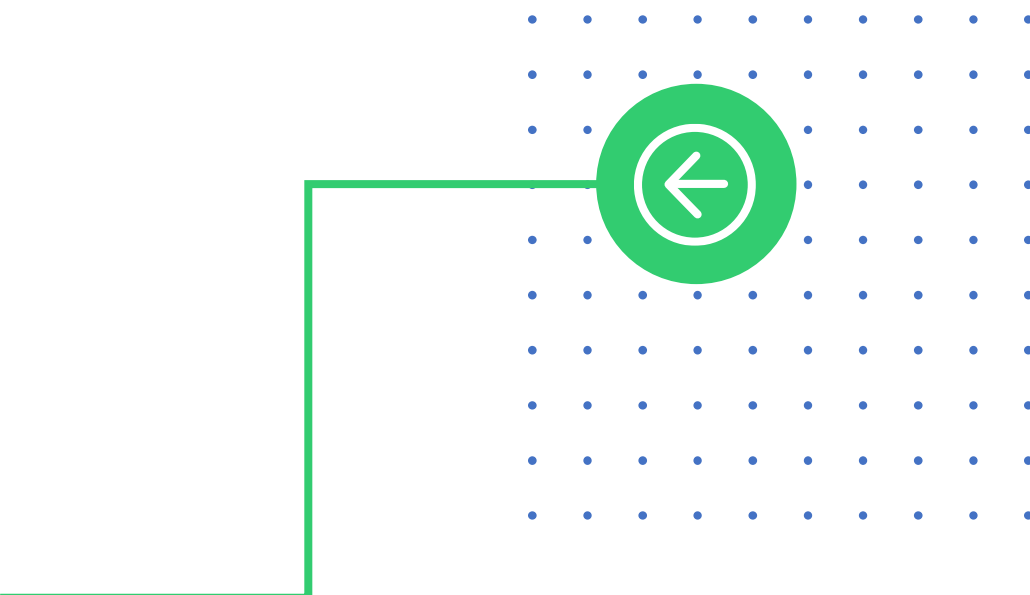
The next step in your Simul8 learning journey

That's just some of our best tips from 30 years of building simulations. Below are some additional resources to help you as you build your first simulation. Happy Simul8-ing!

Simul8 Academy
Access our e-learning platform anywhere, anytime.

Onboarding Call
Receive modeling tips from our friendly team. Delivered through a 1-hour session to get you up to speed quickly.

Drop-in Sessions
Take your Simul8 knowledge further by deep-diving into features and industry applications during our drop-in sessions.

Online Help Files
Browse our extensive online resources for feature guides, tutorials, and example simulations.

Simul8 Support
Get help from our dedicated Support team via email, chat, and telephone.

Need a bit more help?

Coaching
Collaborate with our expert Simulation Consultants to achieve your project goals and take your Simul8 knowledge to new heights.
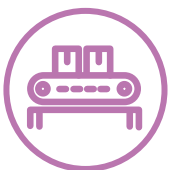
Advanced Modeling Support
Looking for 1-2-1 advice to rapidly progress your simulation? Schedule an Advanced modeling Support session with our Support team today!

Training Classes
Learn the fundamental concepts, features and techniques of Simul8 in a few days through our interactive online classes.

Conveyors Module
Explore the ins and outs of the Conveyors feature and make your simulations more intuitive with this ad-hoc Academy module.