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## Declaration of plagiarism

We, Pankaj Khadse and Desart Bregasi (K1106295 & K1059300), declare that we fully understand the University's definition of plagiarism, other people's work used in this assignment has been properly acknowledged and referenced and that all additional work presented in this assignment is our own. We also agree, in submitting the work, that the school may take steps to authenticate the material submitted.

## Introduction

Simulation is being used in many industries as a tool to aid in production and process planning. It is playing important role in successfully helping simulation of technology for performance optimization and production's planning.

In this study FlexSim Simulation Software is used as a tool for the simulation. FlexSim is Discrete Event Simulation (DES) software which is widely used in many sectors such as airports, supermarkets, banks, health care, manufacturing, real life simulation's etc.

In this paper, three models have been simulated and discussed analytically. It includes the study of FlexSim as a simulation software, along with other simulation softwares and weakness and strengths of the simulation software and their functionalities.

## FlexSim Model 1

### Description of the Model\_1:

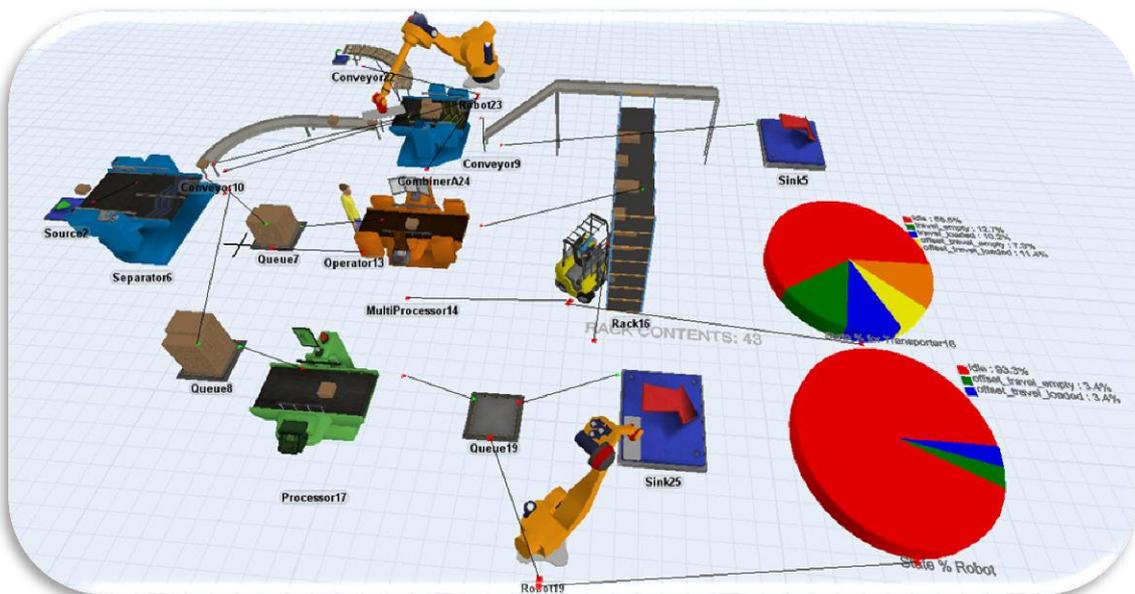
A part enters a Separator where it is split into 3 separate parts. The first part moves via a conveyor to a Combiner where 8 parts are placed on a pallet, the pallet is then placed on a Conveyor that ramps up 4 meters then goes straight for 10 meters then exits the system.

The second part is sent to a Queue where it is then carried by an Operator to a work station where 3 different processes are performed. The first process can complete on its own in 5 seconds. The second process requires the same Operator to be present for 9 seconds, and the third process takes 4 seconds and does not require an Operator. A Transporter then picks it up and takes it to a Rack where it is stored.

The third product moves by itself to a Queue where 10 are collected and are processed together for 120 seconds and then placed in a Queue where a Robot loads one part at a time and transports it to a Sink.

Add two Recorders to show the 'state %' of the Transporter and the Robot. Add a Visual Tool to show the content in the Rack.

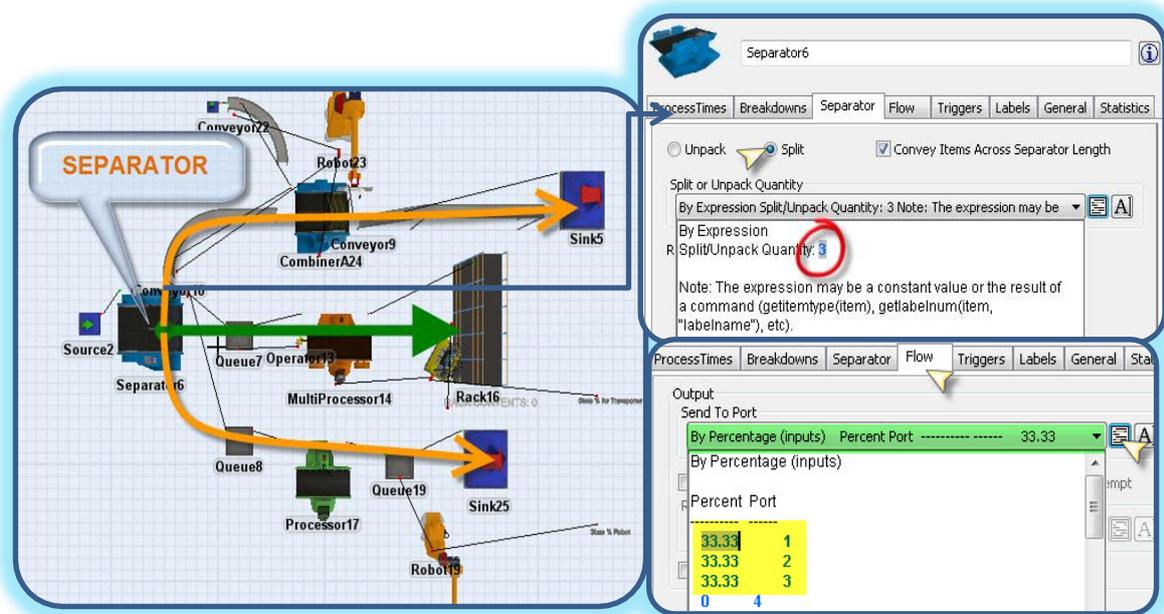
**Save the model to a file Model\_1.** Please include a screenshot of your model. You are not expected to add any extra feature. If you did add some extras, explain what you added in the report.



Picture 1: Completed view of the Model\_1 simulation.

## Following steps to complete simulation Model\_1:

The following simulation will be explained step by step by following the descriptions above. In this case, the part entering the separator is a box. The Separator split it in three types. To start, it is necessary to add a source. To enter the source you need just to drag and drop the icon from the library on the left hand. After drag and dropping the items that are necessary to our simulation, the next step is to link the items by pressing the A-button and clicking on



Picture 2: In this picture you can see the three different parts. Also, in the right hand of the picture you can see the options you should do so that the separator splits the part that it is getting from the source into three separate parts.

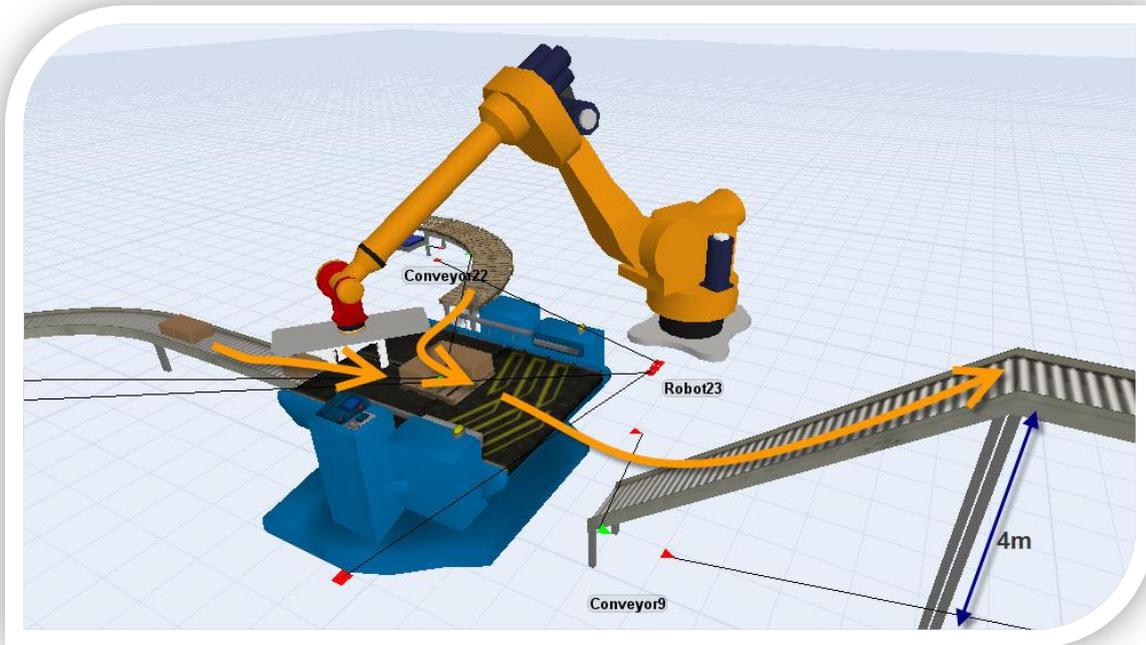
the top of the both items, following the flow of the product. To link an operator, robot or transporter you should use the S-button. To unlink them use the Q-button for the objects that were linked with A and W-button for the objects that were linked with the S.

### First Part

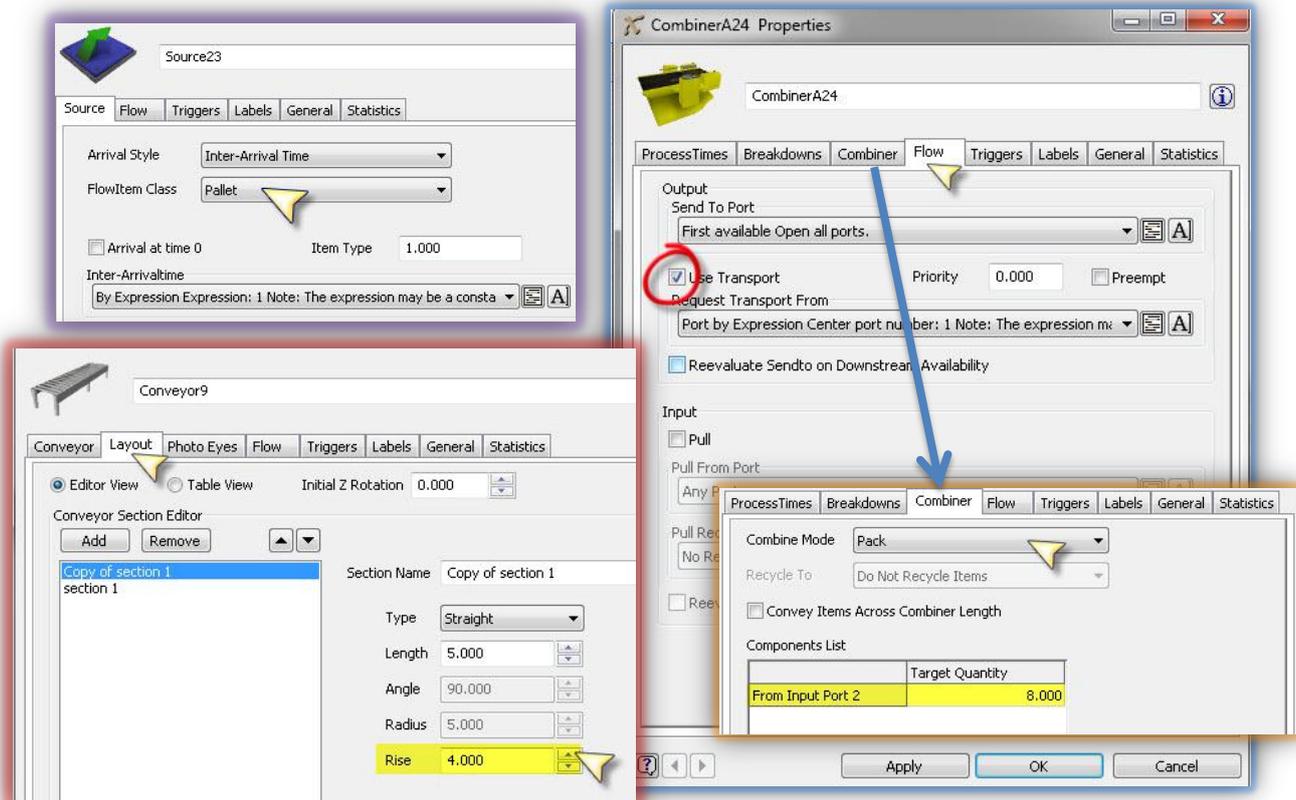
To make the Separator split into three types, double click on top of it or *Right Click* → *Properties*. Then go to *Separator* and click *Split*. In the *Split or Unpack Quantity* select *By Expression* and enter 3 in the quantity (as you can see in the above picture on the right). Then, to make it split equally to all of the ports, you have to go to *Flow bar* and enter 33.33 at the three ports.

To add pallets we need to add a new Source and to select *Source* → *FlowItem Class* → *Pallet*. For this part of the simulation, we have added a Robot to do (you can see from the below picture):

- Loading of the pallet on the *Combiner*.
- Loading of the parts on the pallet.
- Unload of the full pallet (with 8 parts on it) from the *Combiner* to the *Conveyor*.



Picture 3: You can see the Load and the UnLoad that the Robot does.



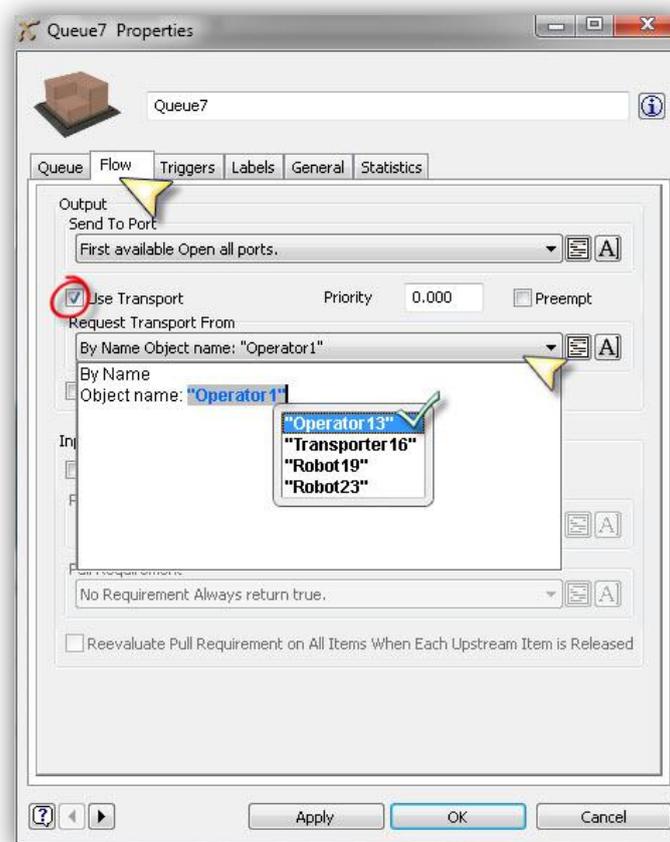
Picture 4: On the left picture up, you can see how to change the FlowItems Class to Pallet, on the left down picture you can see how to setup the Conveyor to ramp up 4m. On the right hand picture you can see the Use Transport option so that the Robot start to work for it and on the lower picture you can see the option to pack 8part in a pallet.

To make the *Conveyor* to ramp up 4 meters, you need to go to the *Properties* of the *Conveyor* → *Layout* → *Rise* and give the value of 4 (you can see from the above picture).

In the end of this line, we need to enter a place where these parts will go. This place will be the sink.

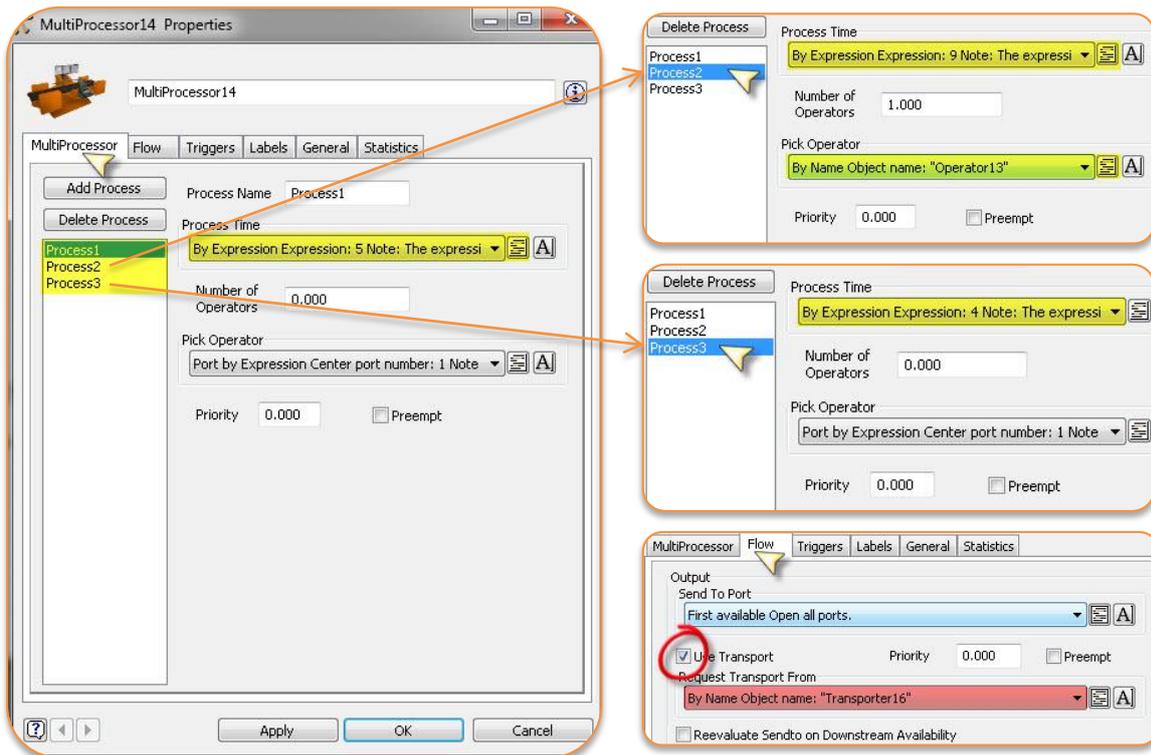
## Second Part

After linking the *Queue*, the *Operator*, the *Work Station (MultiProcessor)*, the *Transporter* and the *Rack* altogether, the next step is to add the setup options for each of them. The *Separator* options were modified from the previous step. The next one is to setup the queue options so that it can use the *Operator* for the transport of the parts from the queue to the *Work Station*. Just Double click at the *Queue icon* → *Flow* → *Use Transport*.

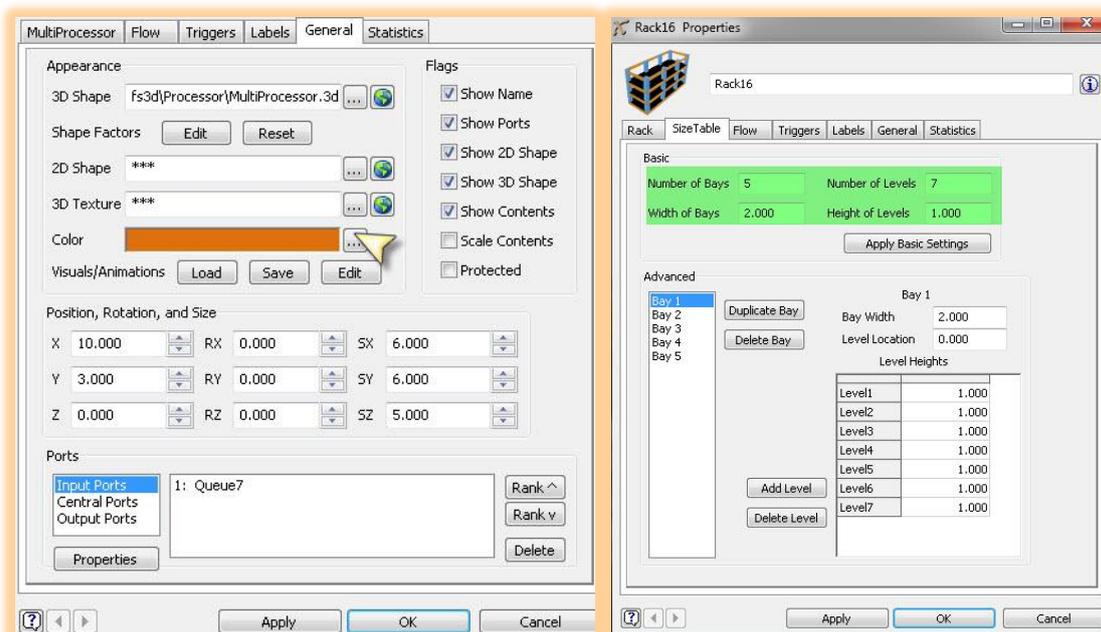


Picture 5: Setup Options: How to select the part that will be carried by an operator.

To do the three different processes that are performed, you need to double click the *MultiProcessor* → *Add Process* (do the same three times). Then *Process1* → *Process Time* → *By Expression* → enter value 5. Next, *Process2* → *Process Time* → *By Expression* → enter value 9, but at this case we need the operator to stay there for 9 seconds, so *Pick Operator* → *By Name* → *Object name* → and we choose *Operator 13* for our case. For the last process, do the same with the first one mentioned but add value 4. But also we need the parts to be carried by the operator, so *Flow* → *Use Transport* → *Request Transport From* → *By name* → *Object name: Transporter 16* (in our case) → *Apply* → *Ok*. In this case, the color of the *MultiProcessor* has been changed.

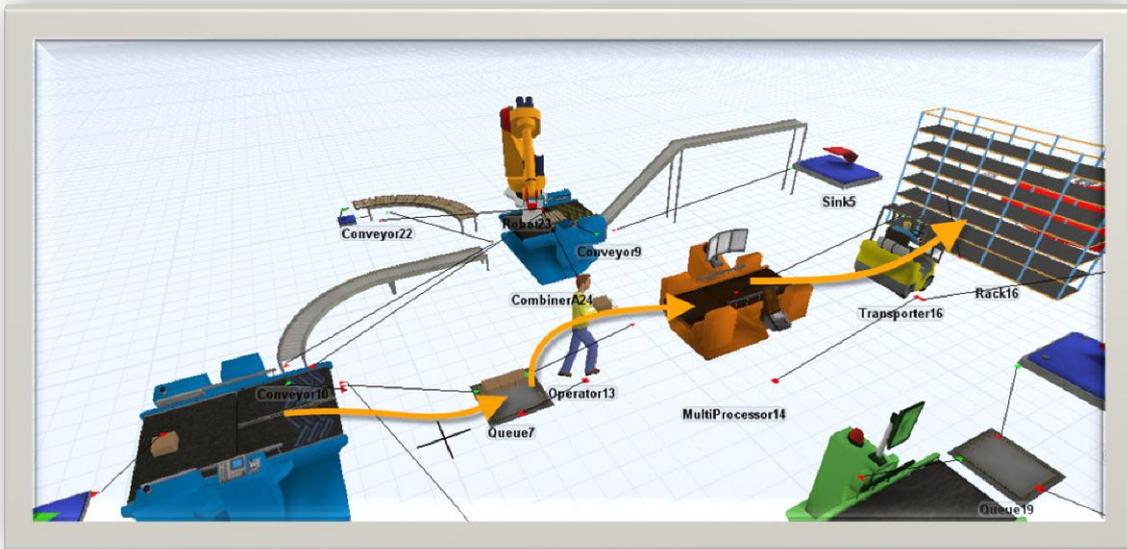


Picture 6: Setting used for the MultiProcessor.



Picture 7: Left picture shows the setting to change the color, shape etc. The right pictures shows the settings to change the Rack size.

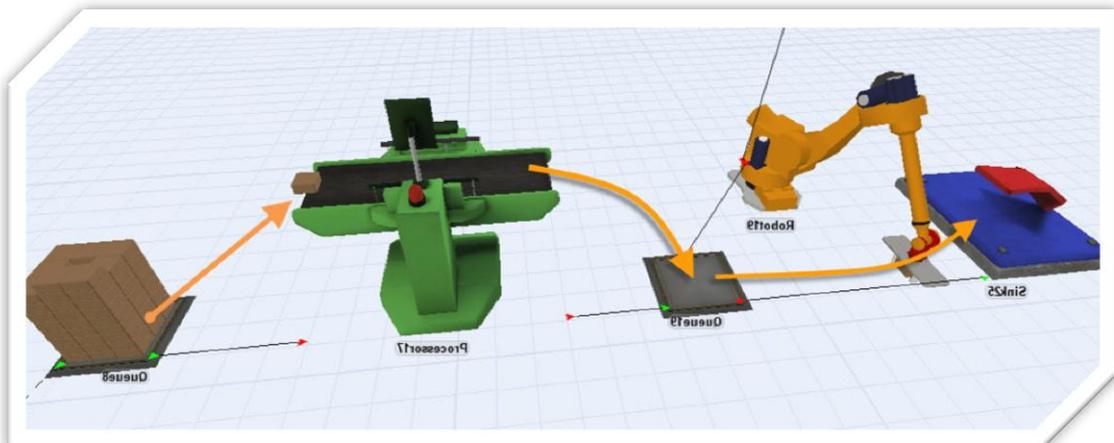
On the left picture in the General tab, you can change the shape of the model, the color of it, you can add visual animations, textures etc. On the right hand in the picture we modified the Rack, 5 Bays and 7 Levels.



Picture 8: The path flow that the second parts follows.

### Third Part

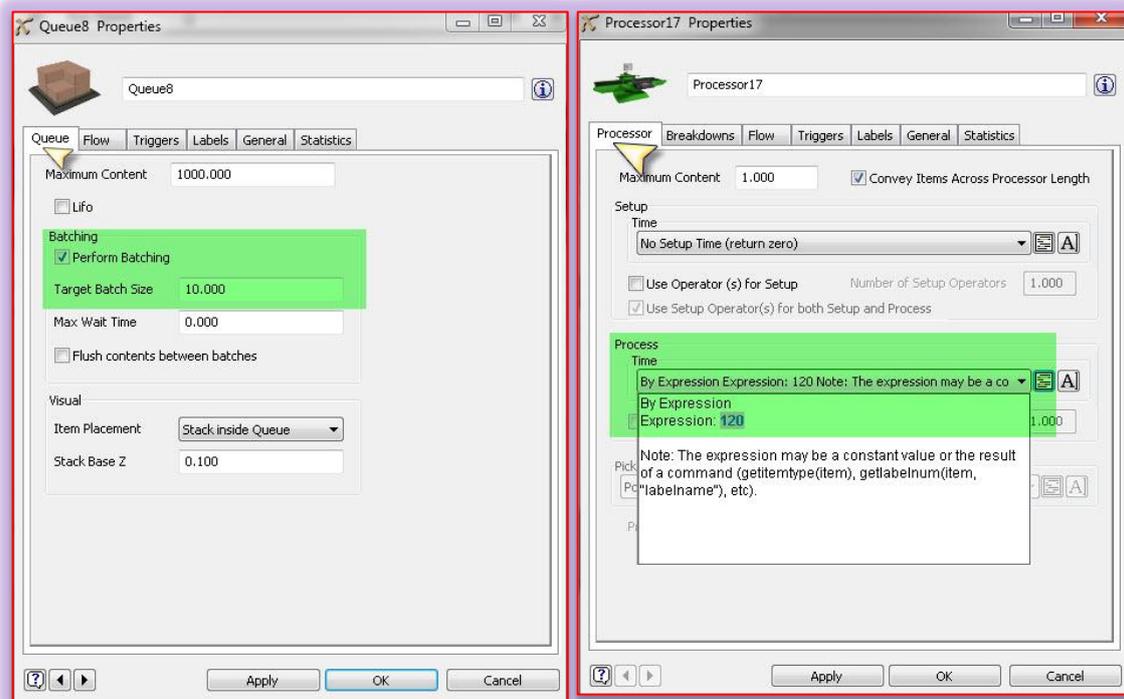
To make the 10 parts collected and processed together, we need to go to the options of the Queue. Double click the Queue → Queue bar → Batching → Select “Perform Batching”. Set “Target Batch Size” value 10.



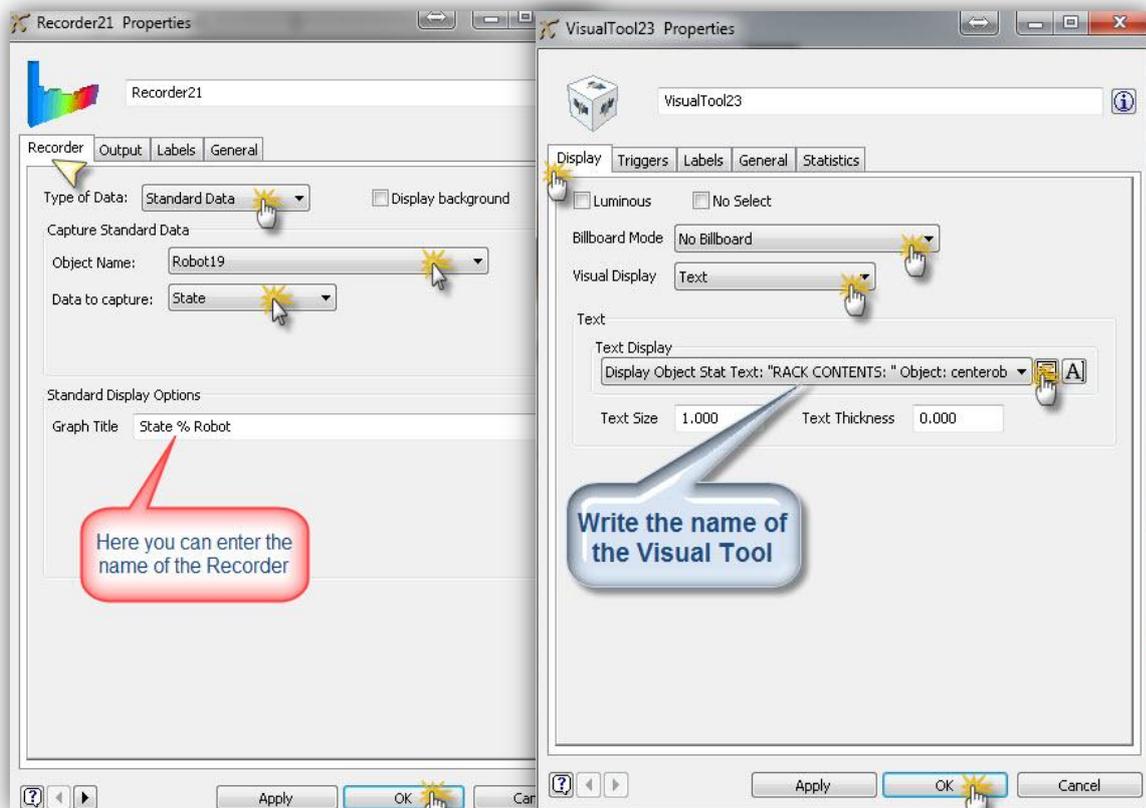
Picture 9: Third part flowing path. The vectors shows the path that the parts follows.

To make the processor process the part for 120sec, double click the Processor icon → Processor → Process → Time → By Expression → Expression: enter value 120. To make the Robot transfer the parts to the Sink, you need to double click the Queue icon → Flow → Use Transport (select it) → Request Transport From → By Name Object: “Robot19” (for our case). You can see these settings in the pictures below.

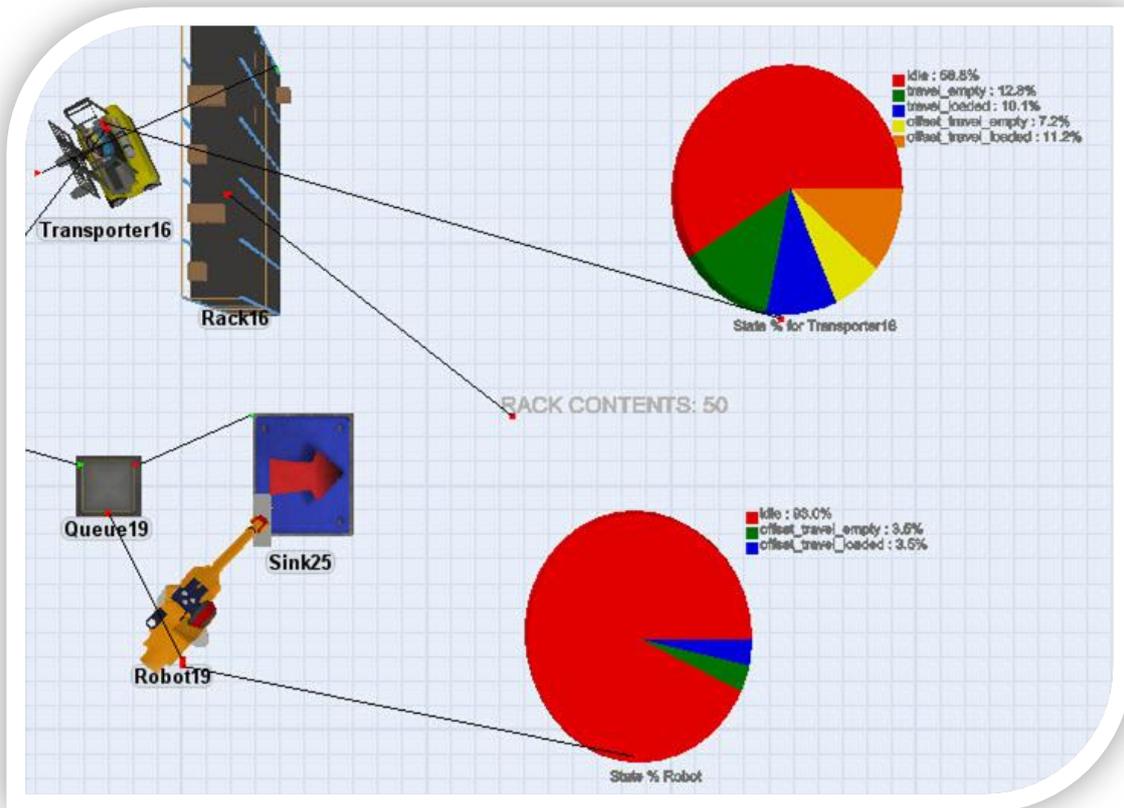
To add the two Recorders you just drag and drop them. After that Double click Recorder → Type of Data: Standard Data → Object Name: Robot 19 (for our case) → Data to capture: State. You do the same for the other Recorder as well. For the VisualTool Double click → Display → Billboard Mode: No Billboard → Visual Display: Text. Statistics → tick the “Record data for Content and Staytime charts”.



Picture 10: On the left: Setting the batching size. On the right: Setting the processor time.

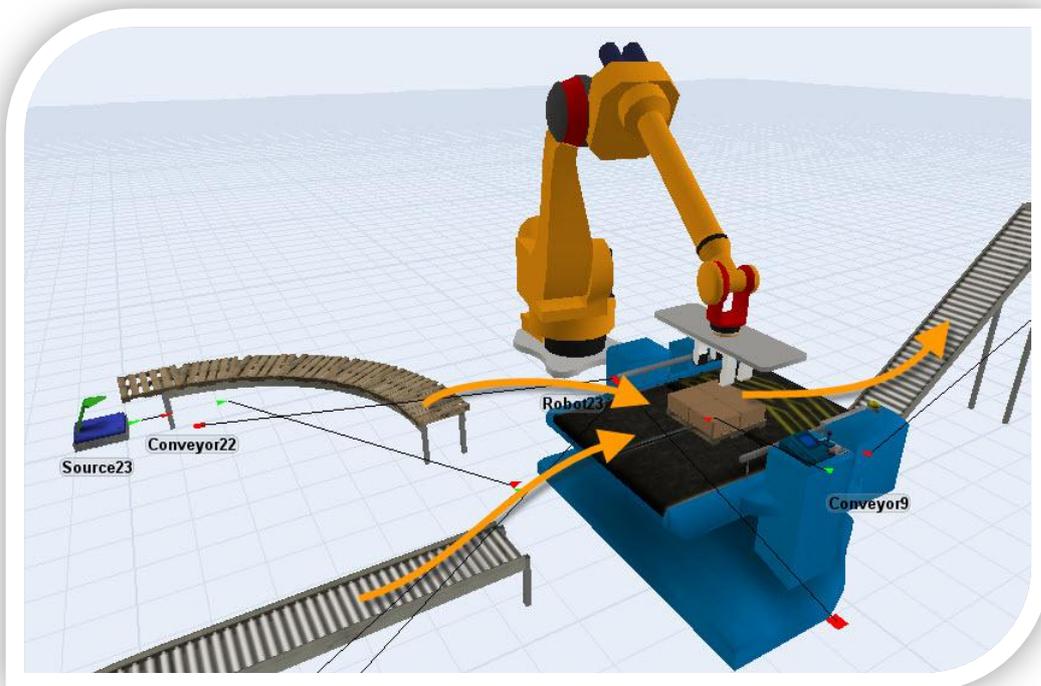


Picture 11: On the left: Settings for the Recorder. On the right: Settings for the VisualTool.



Picture 12: You can see the Recorder (the pie chart) and the Visualization Tool. One Recorder is giving the state for the Transporter, the other Recorder is giving us the State % of the Robot and the visual tool is giving us the Rack Content.

*Extra part added: Robot (First part)*



Picture 13: The extra robot added at the first part. You can see (vectors) the movements that the Robot follows.

## FlexSim Model 2

### Description of the FlexSim Model\_2 (to use wider types of data distribution, MTBF & MTTR, rework, itemtype increment counter)

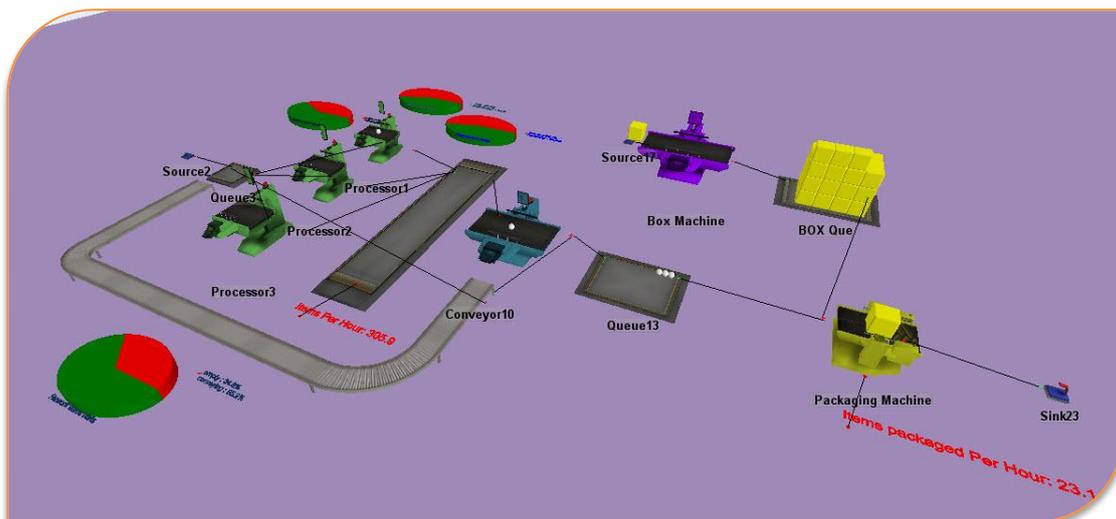
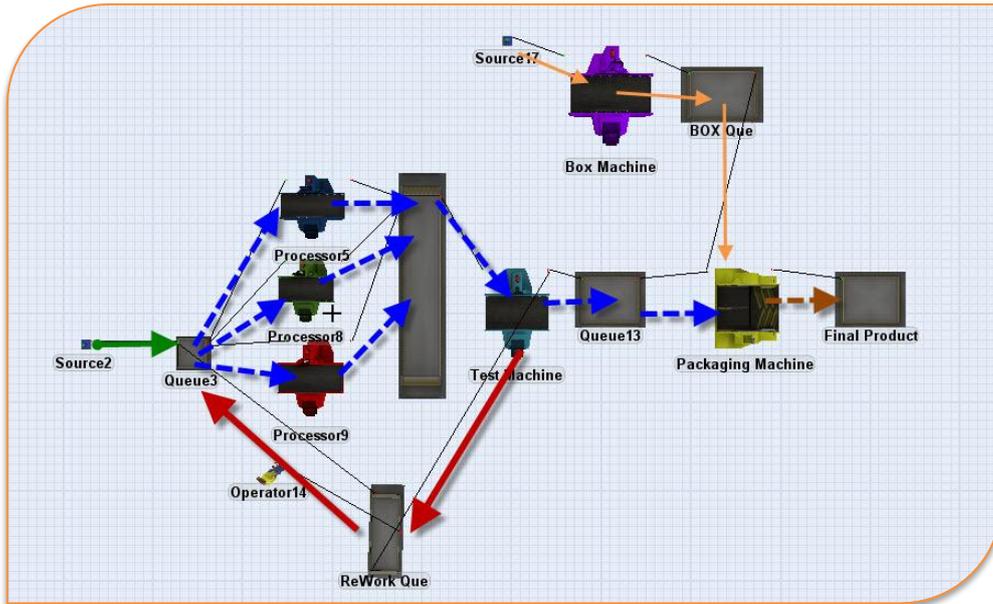
A product arrives in a Queue every 14 seconds exponentially distributed and then routed to any one of 3 machines where it is processed for 20 seconds (24 seconds for rework). Machined parts are placed in a common queue and wait to be tested, 20% are found faulty and must be reprocessed. The test time is a constant 9 seconds. Parts passing test enter another Queue and wait to be packaged at an automatic packaging machine.

The packaging machine accumulates 10 products into a box and then closes, seals, and labels the box in 57 seconds. The supply of boxes comes from a Queue fed by a box forming machine having a cycle time of normal(50,2) seconds. The box former jams regularly per Weibull (151.1,50,24.9) and takes between 20 and 30 seconds to fix uniformly distributed.

- Interarrival time for source is Exponential(0,14,1)
- Send to strategy for tester (Bernoulli (80,1,2) or By Percentage (inputs))
- Cycle time for box forming machine is Normal (50,2)
- MTBF for box forming machine is Weibull (151.1, 50, 24.9)
- MTTR for box forming machine is uniform (20,30)
- Save the model to a file name **Model\_2**

After you have completed the above model, do the following **extras**:

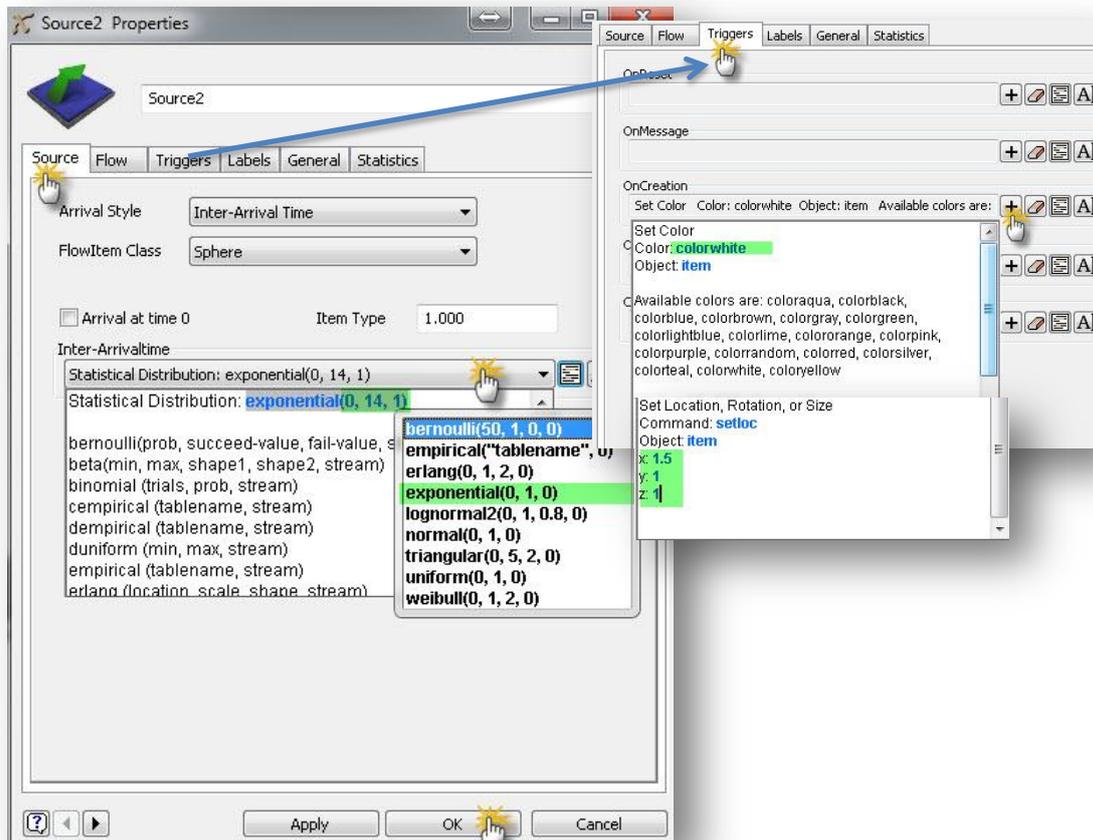
1. Use a conveyor to route failed flowitems back to the queue.
2. Increment ItemType each time a flowitem fails, and change the flowitem's colour according to how many times it fails: 1- green, 2- yellow, 3- red
3. Use Recorder and VisualTool to show some useful data where you think appropriate.
4. Save the model with these extra features to a different file name **Model\_2\_extras**
5. Include some screenshots of the model with these extras.



Picture 14: Top: Model\_2 completed simulation. Bottom: Model\_2\_extras completed simulation.

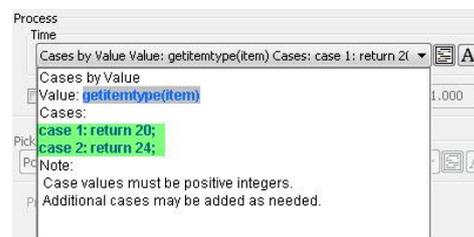
### Following steps to complete simulation Model\_2:

After adding the icons and linking them together, the next step is to do the setting that are required. This simulation requires that the products to arrive in a queue exponentially distributed every 14seconds. To do that, double click at the *Source icon* → *Source bar* → *Inter-Arrivaltime* → *Statistical Distribution: exponential (0,14,1)*. In our case, we have changed products shape to Sphere (you can change it through *FlowItem Class* → *Sphere*).



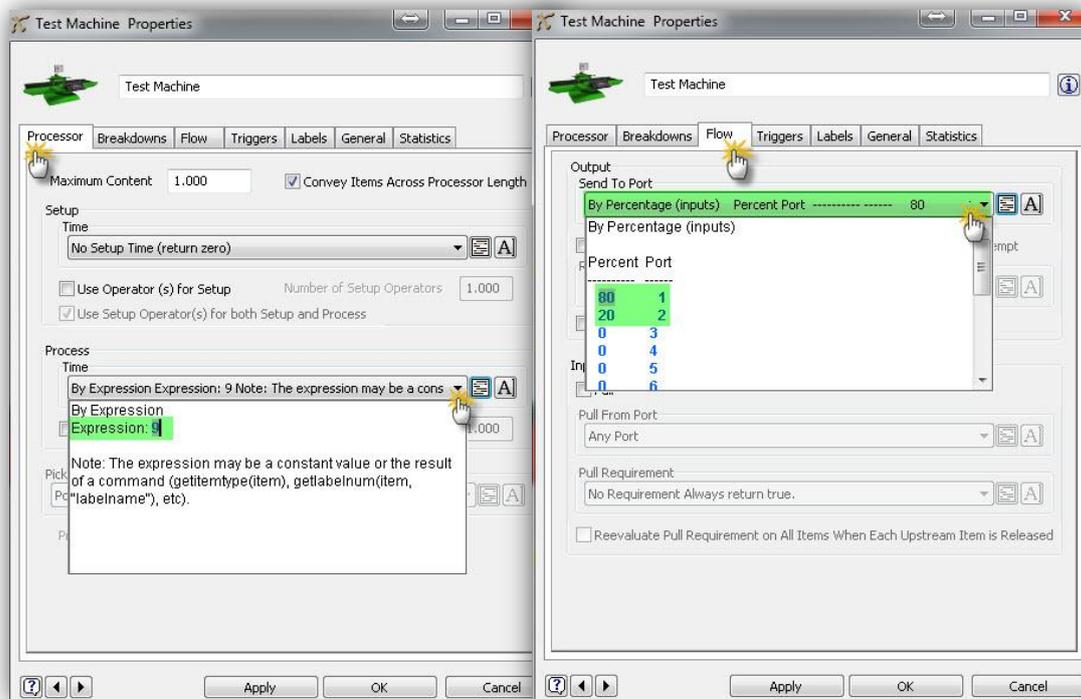
Picture 15: Using the Exponential(0,14,1), changing the color of the sphere and the size of it (right pictures).

To change the processing time, you need to go to the *Processors Properties* → *Process Time* → *Cases by Value*. Then, you have two cases, case1 is the case of the normal processing time, case2 is the rework process:24seconds. This way, case1 are the product that comes from the source and case two the products that come from the Rework Queue.



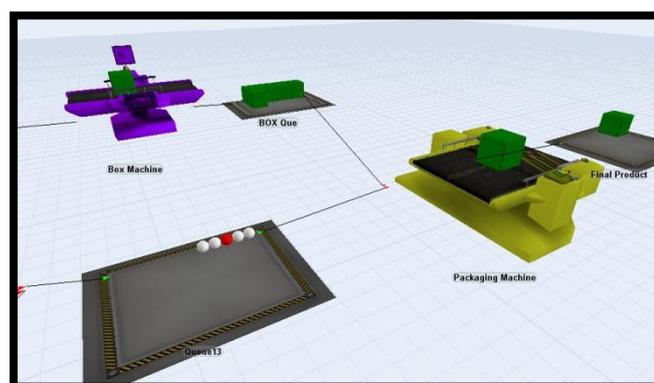
Picture 16: Changing the processing time through the Processor Properties by case, 20seconds for the normal and 24seconds for the rework.

To make the machine to give 20% faulty products, go to the machines (*Processor*) properties → *Flow* → *Output* → *Send To Port* → *By Percentage* → *Percent Port*: Enter value 80 for *Port 1* and 20 for *Port 2*. To setup the test time go to the *Processor bar* → *Process Time* → *By Expression* → *By Expression*: give value 9.

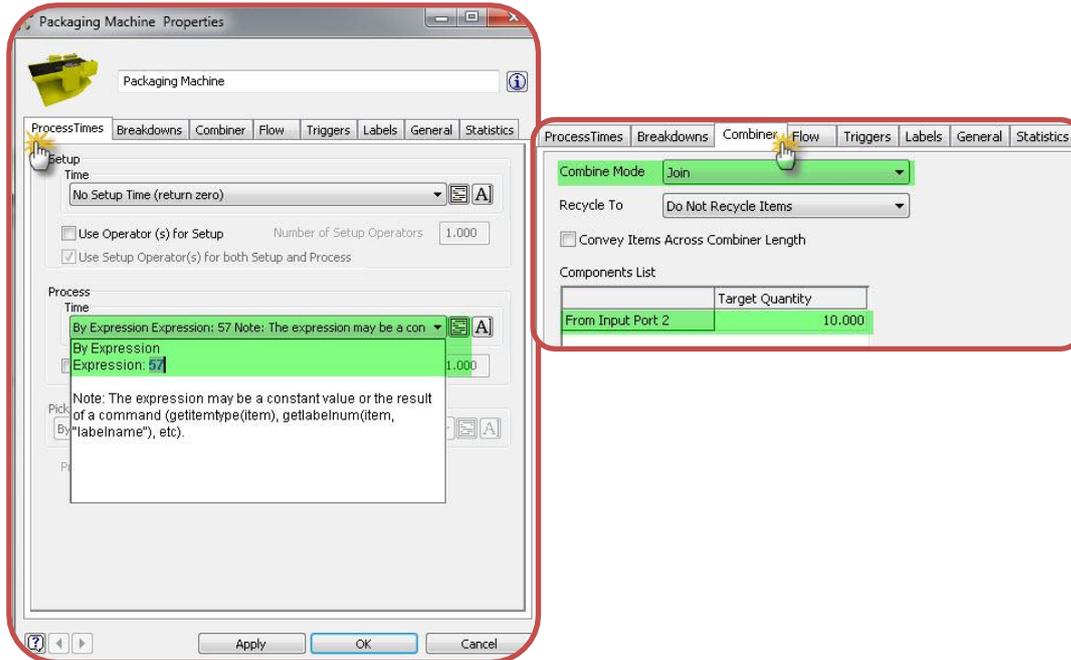


Picture 17: Setting up the test time and the faulty products.

To make the packaging machine to accumulate 10 products into a box and then closes, seals and labels the box in 57 seconds, we need a combiner. Go to the *Combiners Property* → *Name it "Packaging Machine"*. After that *Process Times* → *Process Time* → *By Expression* and enter the value 57 and *Combiner* → *Target Quantity: 10*. (From *Input Port 2*) and *Combiner Mode* → *Join*.

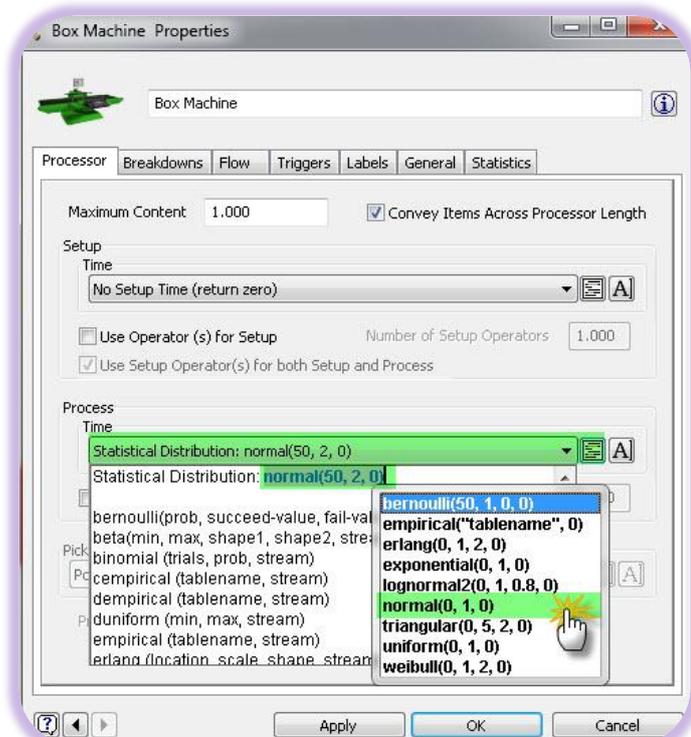


Picture 18: Products waiting in the line till the packaging machine finish its processes.

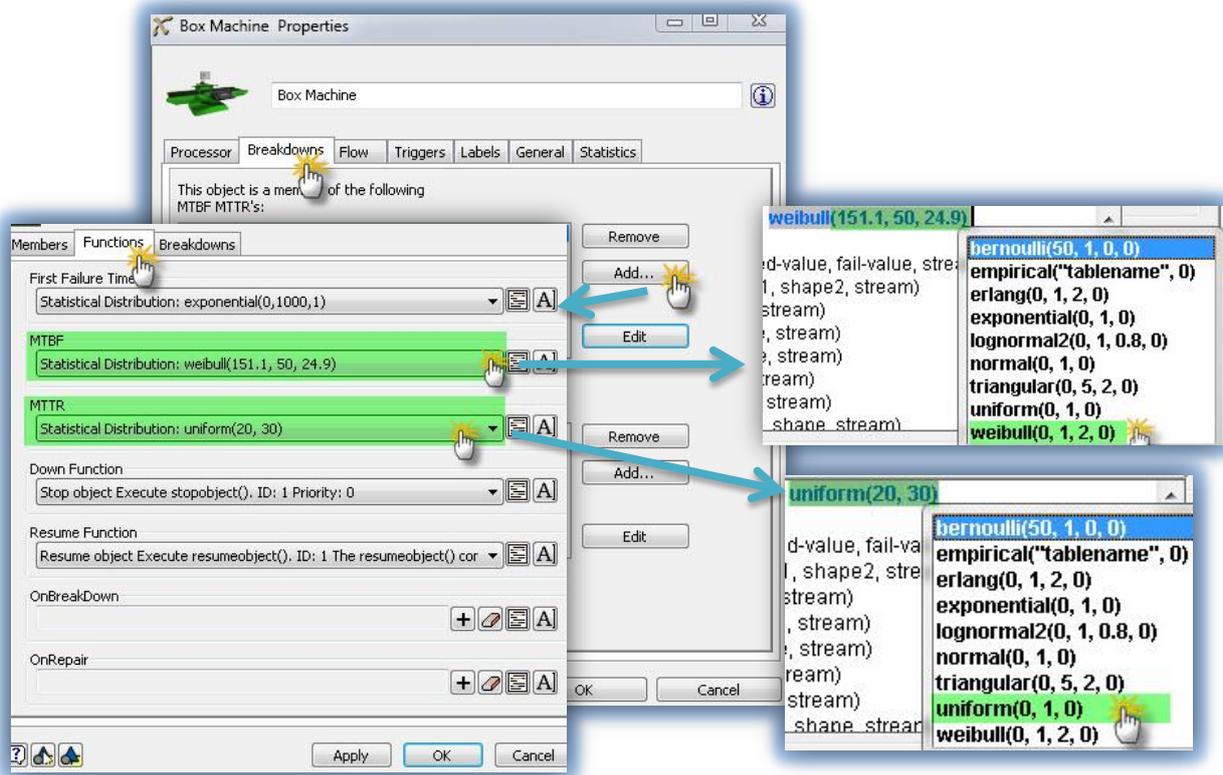


Picture 19: Packaging Machine setup windows. Left: you can change the processing time. Right: Join the products together.

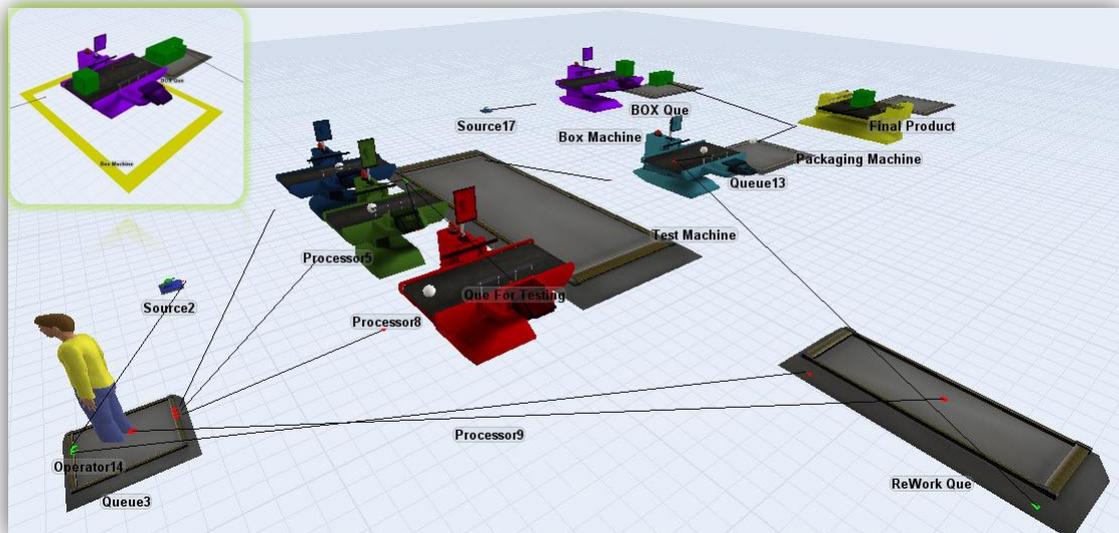
To add the cycle time at the box forming machine, you need to go at the properties of the *Box Machine (Processor)* → *Processor bar* → *Process Time* → *Statistical Distribution: normal (50,2,0)*. To make the box former to jams regularly per Weibull (151.1, 50, 24.9) and to take between 20 or 30 seconds to fix uniformly distributed, you need to go from the Box Machine Properties at the *Breakdowns bar* → *Add* → *Add New MTBF MTR*. Then a new window will appear. At this window, go to *Functions bar* → *MTBF* → *Statistical Distribution* → *weibull* and enter the values (151.1, 50, 24.9). Then go to *MTR* → *Statistical Distribution* → *uniform (20,30)* → *Apply* → *OK*. Then *Apply* → *OK* at the Box Machine Properties windows as well.



Picture 20: Settings for the Cycle time for box forming machine as normal (50, 2)



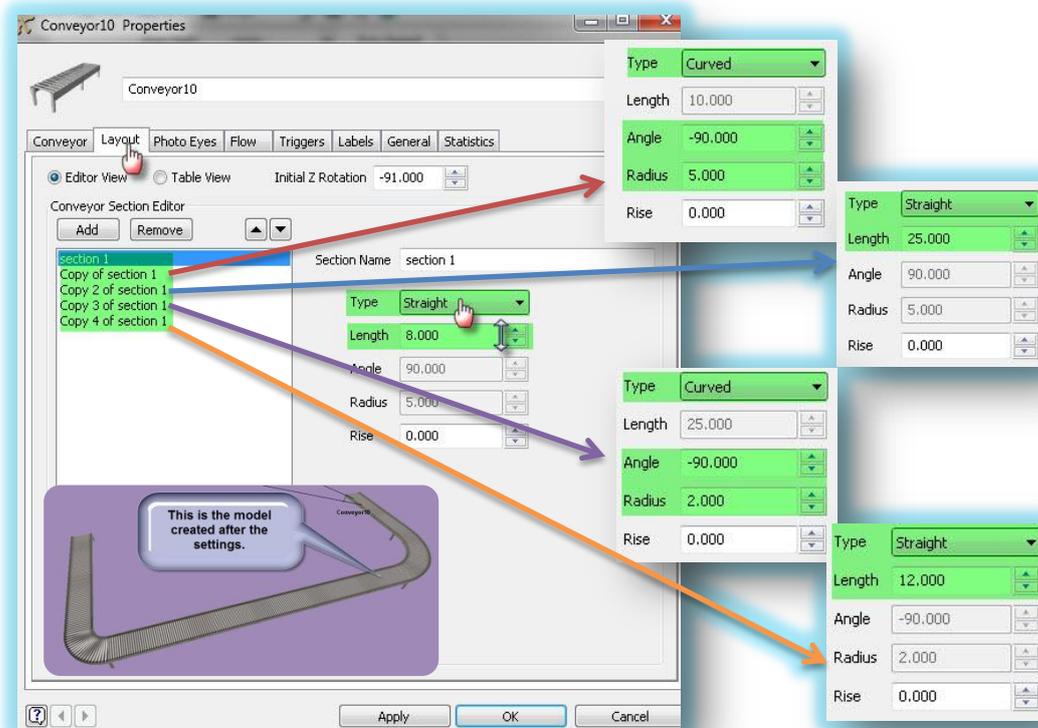
Picture 21: Setting the box former jams per Weibull and fix the uniformly distributed time between 20 and 30 seconds.



Picture 22: Simulation of the Model\_2. On the left of the picture you can see the machine jams.

### Following steps to complete simulation Model\_2\_extras:

For this case, we are using the same model using previously (Model\_2) and extra things will be added. To add the conveyor to our simulation, drag and drop the icon from the left. After linking it, double click the icon to go to the Conveyor Properties→Layout→Conveyor Section Editor→Add and add four more sections. Below you can see the settings for each of them.



Picture 24: Settings for the Conveyor length and parts.

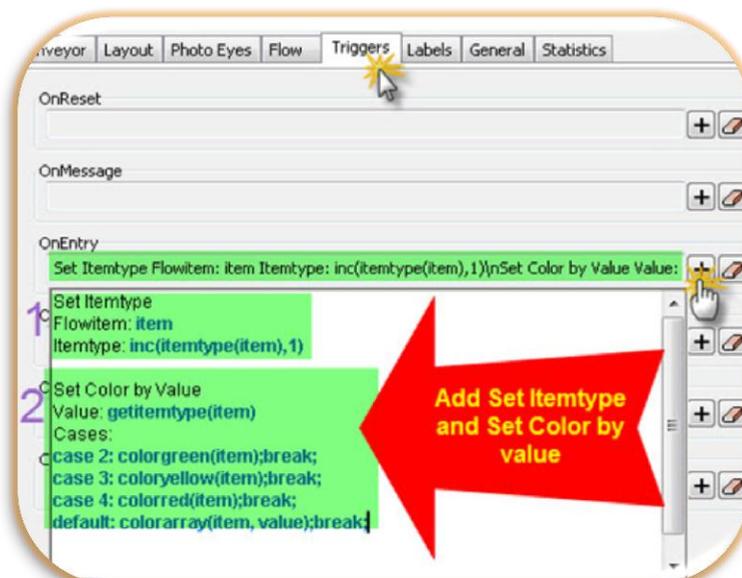
After you finish these settings, the next step is to set the *Increment ItemType*. We need to change the flowitem's color according to how many times it fails: 1-green, 2-yellow, 3-green. To do that, from the same window (Conveyor Properties) you need to go at the *Triggers*

bar → *OnEntry* → Click the Add (+) button → from the window that will appear select *Set ItemType*, then write

`inc(itemtype(item),1)`.

After that click again at the Add (+) button and select *Set Color by Value*.

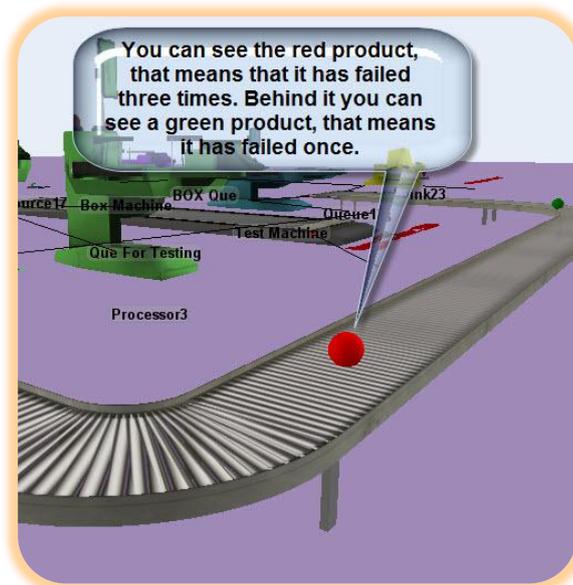
As Value: `getiitemtype(item)` and



Picture 23: Changing the color according to how many times it fails.

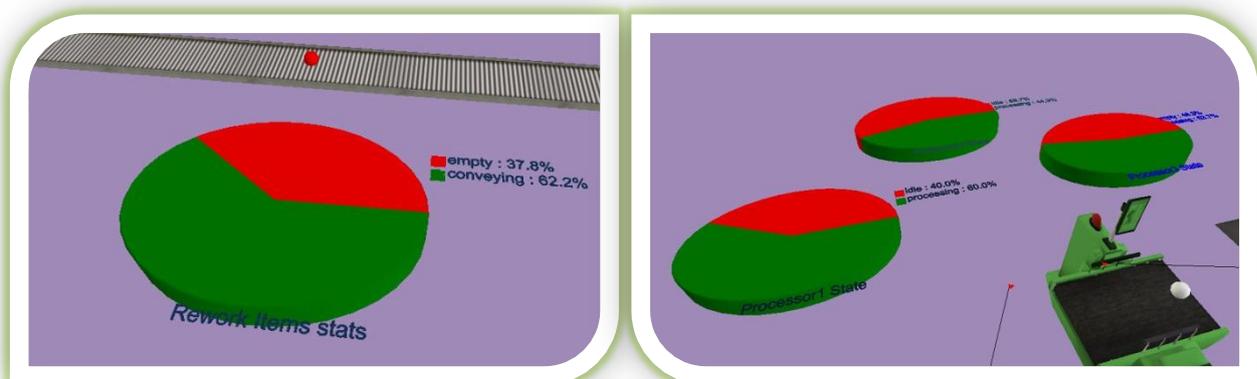
cases:

- *case 2:colorgreen(item);break;*
- *case 3:coloryellow(item);break;*
- *case 4:colorred(item);break;*
- *default: colorarray(item,value);break;*

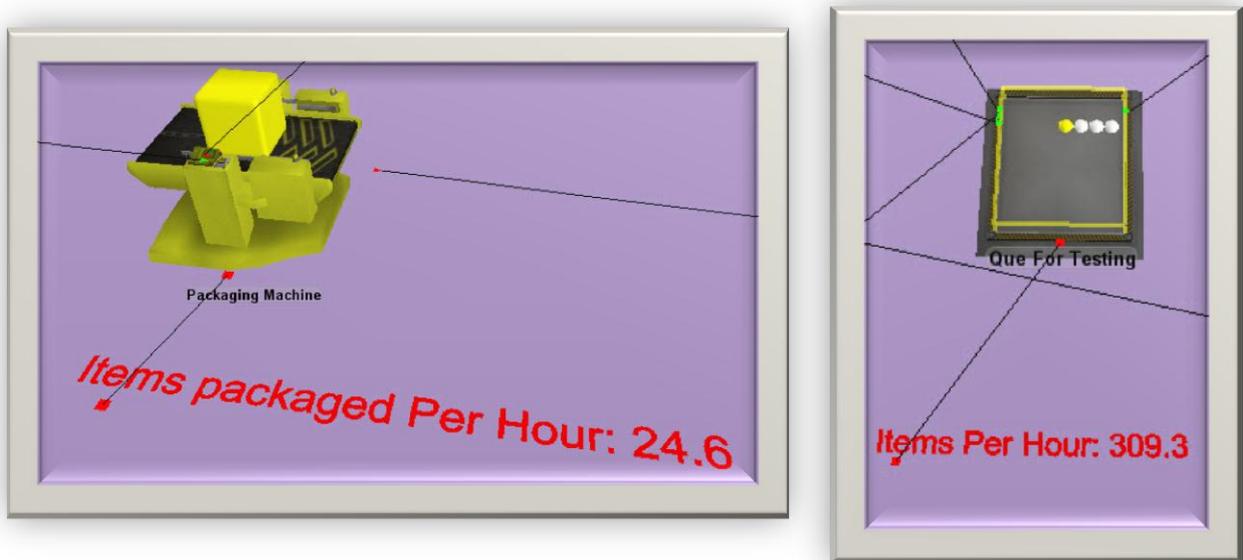


Picture 25: Red item product after failing three times the test. Behind the red you can see a green item coming.

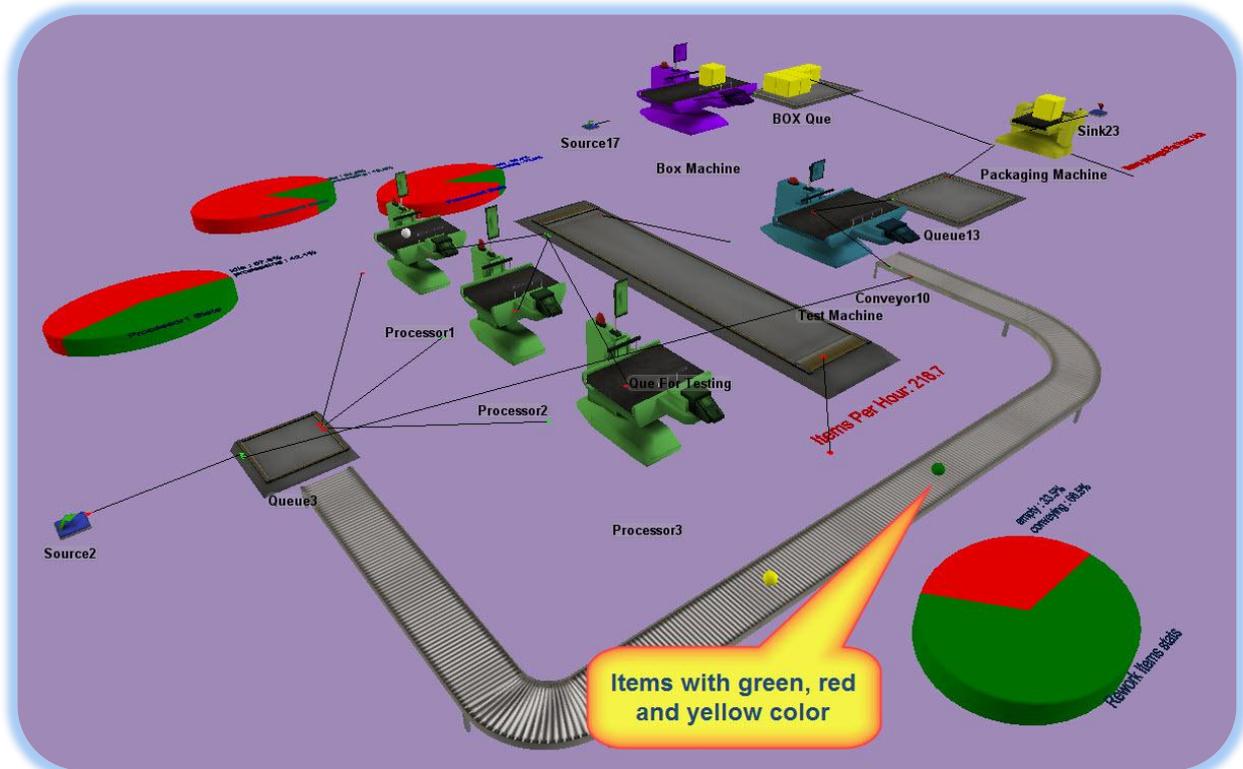
At Model\_1 we had explained how to add a Recorder and a VisualTool. In Model\_2\_extras we have added Recorder for each Processor and for the Conveyor so that we can have a better view of their State (idle time and processing time by %, empty or conveying for the conveyor). Also, a VisualTool is showing the *Items per Hour* for the testing common queue and another VisualTool is showing the *Items packaged per Hour* from the Packaging Machine. A VisualTool has also been used to give the floor a purple color.



Picture 26: Left:showing the idle percentage of the Conveyor. Right: Showing the Processing time of the three Processors.



Picture 27: VisualTool for the "Queue for Testing" and the "Packaging Machine"



Picture 28: General view of the Model\_2\_extras simulation.

## FlexSim Model 3

### Description of FlexSim model 3

Background:

- Four types of customers arrive at a service centre, one every Exponential (0,30) seconds.
- 20% of customers are type 1, 30% type 2, 40% type 3, 10% type 4.
- Assign unique colours to each type of customer.
- Customers wait in queues until they are able to see a service agent.
- Four separate agents can only service one specific customer type.
- Service times are all between 100 and 120 seconds uniformly distributed.
- Use flow paths to show serviced customers as they exit the model.
- Add Recorders and VisualTools where appropriate to show useful statistics
- Save the above to a file name **Model\_3**

Make these discussions in your report:

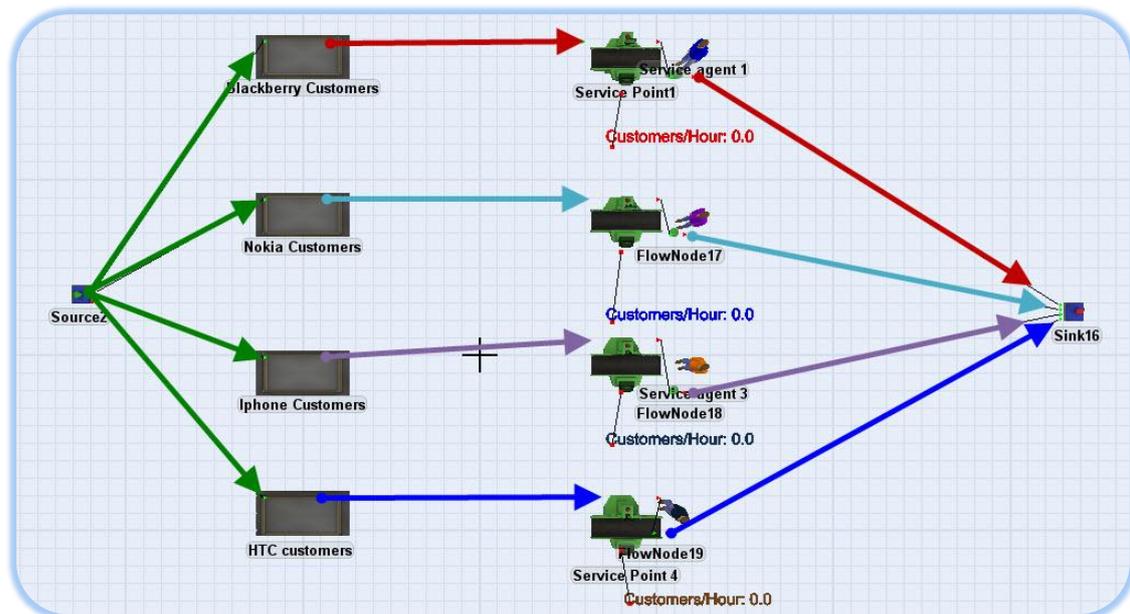
1. Are all agents equally utilised? Discuss.
2. Add animation to show customers moving to the desks themselves. Now, Agent 1 can only handle customer type1, likewise Agent 2 can only handle customer type 2. The other agents can handle any type of customer. Save this to a different model name **Model\_3\_1**
3. How can we improve this current situation without adding additional agents? Discuss in the report. Make these improvements to your model, and save this to a different model name **Model\_3\_2**

### Following steps to complete simulation Model\_3:

To make the Simulation more understandable, it was supposed to name the customers as as:

1. Blackberry Customers
2. Nokia Customers
3. Iphone Customers
4. HTC Customers

The next step is to add a source, four queues, four service Points (center) and one sink. As you can see in the picture below, we have added four operators as well, close to the Service Centre of each item. The path that they will follow is described by the vectors in the pictures below.

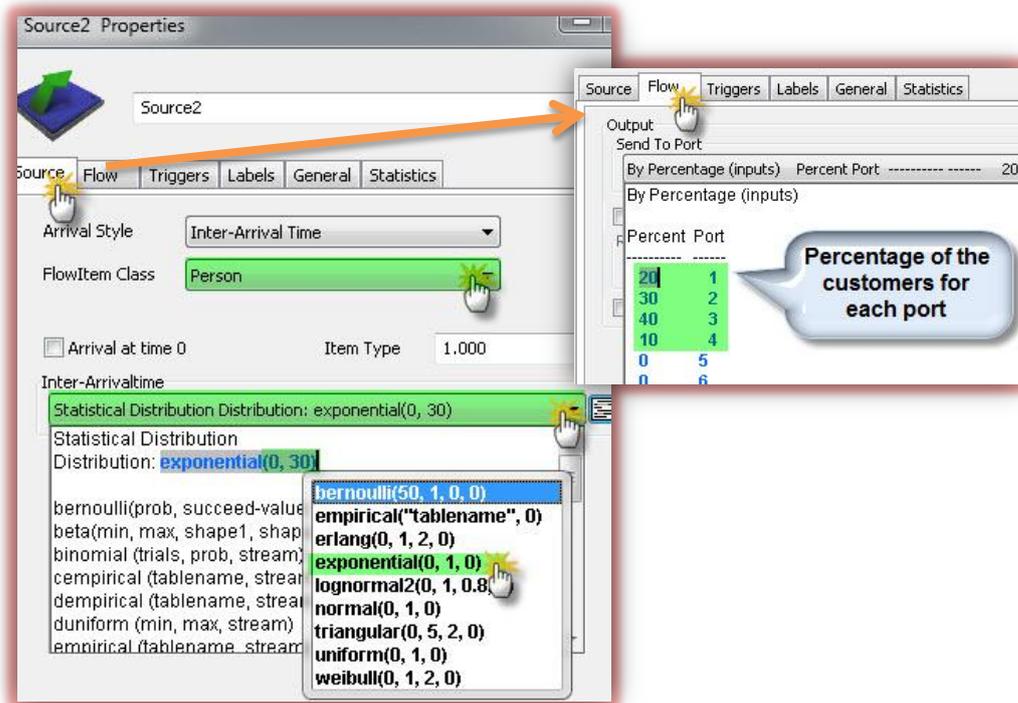


Picture 29: After adding the icons and linking them together.

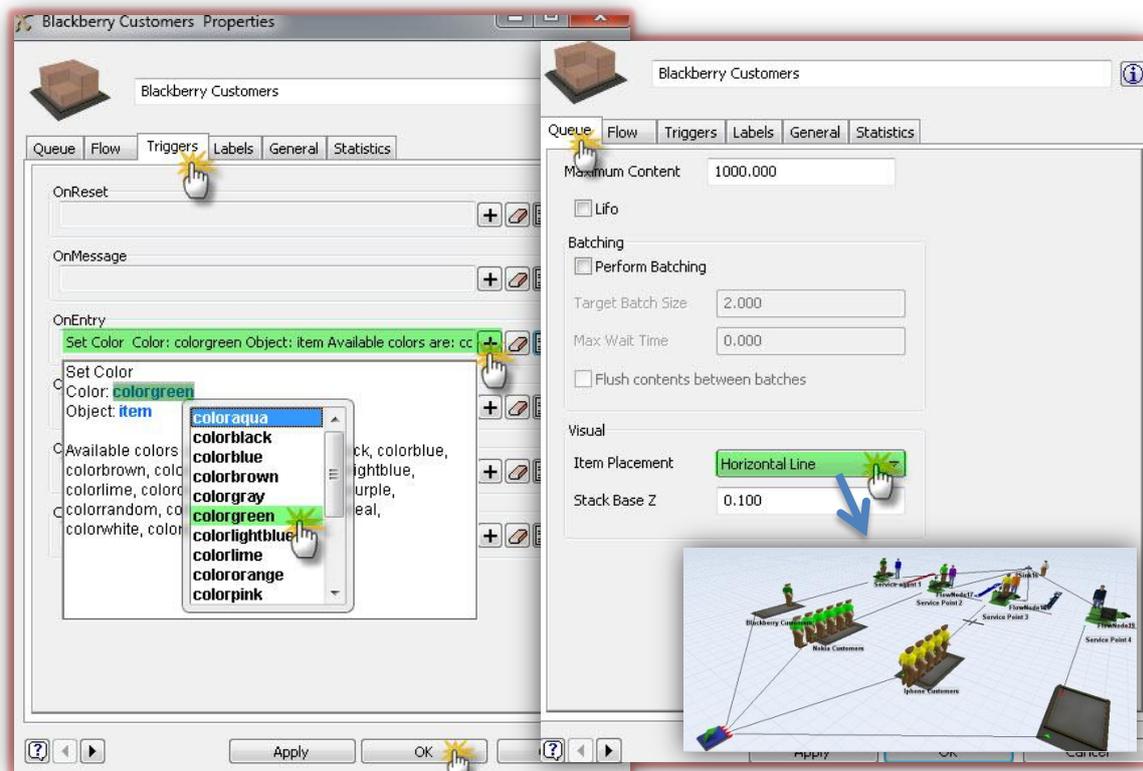
We first need to change the FlowItem, so that we have people coming instead of products. This can be done at *Source Properties* → *Source* → *FlowItem Class* → *Person*. To make the customers arrive one every Exponential(0,30), you need to go at *Source properties* → *Source* → *Inter-Arrival* → *Statistical Distribution* → *Distribution (0,30)*. To change the percentage of the customer types going to each Queue, you need to go to the *Flow bar* → *Output* → *Send to Port* → *By Percentage* → *Percent Port:* and enter the values: 20% for port 1, 30% for port 2, 40% for port 3, 10% for port 4.

To assign unique colors to each type of customers, can be done by going to the settings of the Queues, *Queue Properties* → *Triggers* → *OnEntry* → *Set Color: Color:* and select the color you desire. By the same way you can change the colors in the other queues as well. In our case the following colors have been used: *Blackberry Customers* → *Green color*, *Nokia Customers* → *Lime color*, *I-phone Customers* → *Yellow color* and *HTC customers* → *White color*.

To make the customers wait in queues, go to *Queue Properties* → *Queue* → *Visual* → *Item Placement* → *Horizontal Line*. Every queue is linked only with one Service Point, so that they can service only one specific customer type.



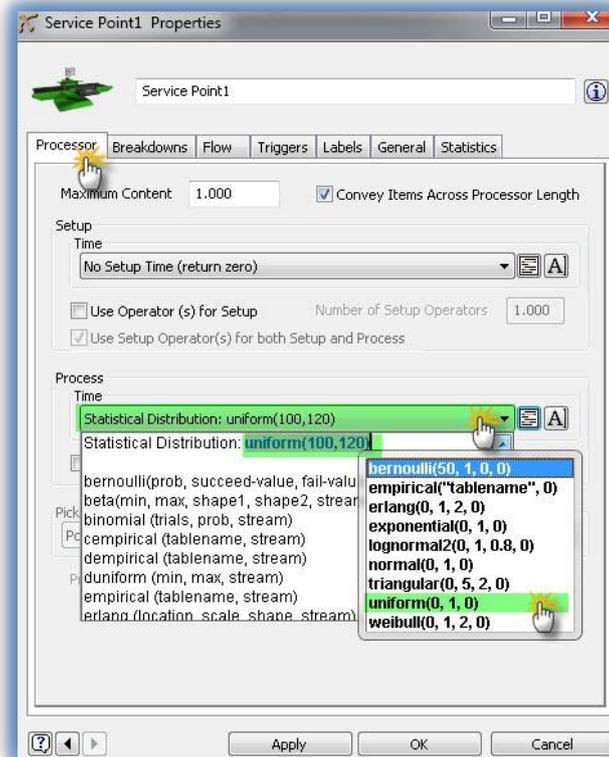
Picture 30: Setting the percentage for each customer type and the time that the customers arrives (Exponential)



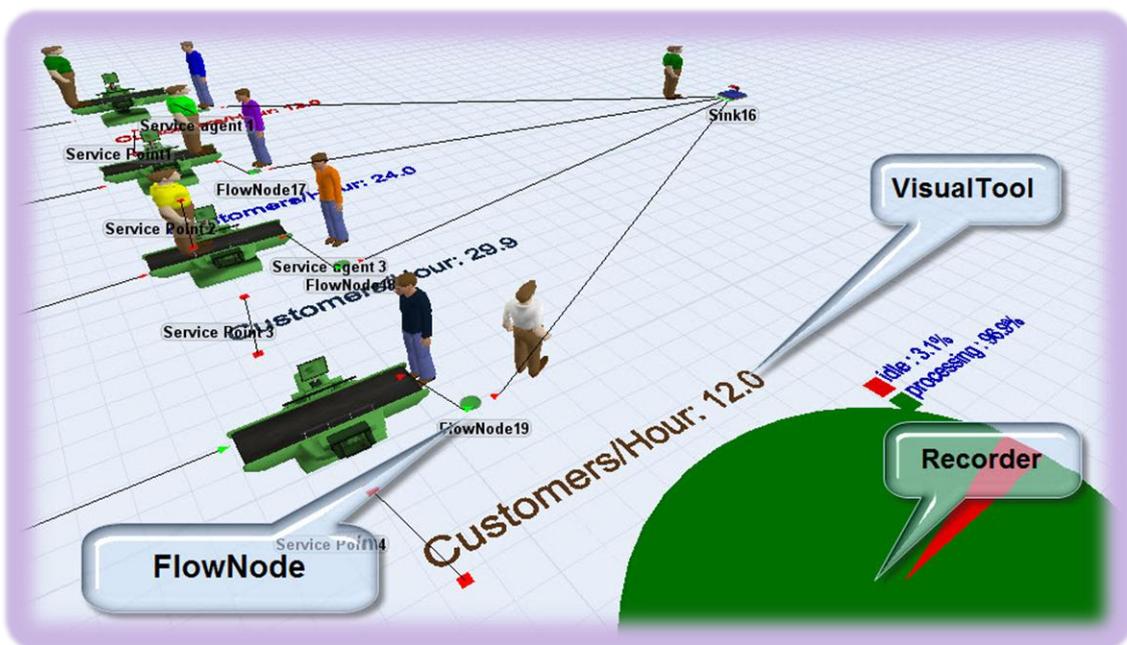
Picture 31: Left: Changing the color of the customers OnEntry. Right: Customers wait in queues in Horizontal Line.

To make the service times all between 100 and 120seconds uniformly distributed, go to *Service Point Properties (Processor)* → *Processor* → *Process Time* → *Select Statistical Distribution* → *uniform* and enter the values *uniform (100,120)*.

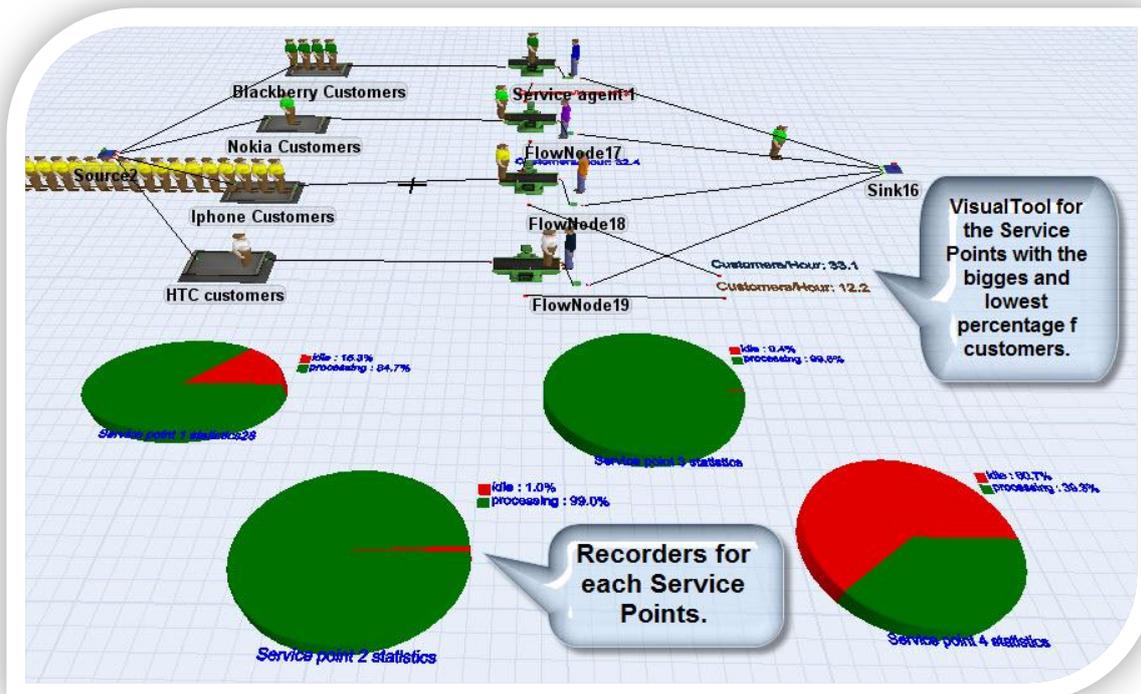
To use the FlowNodes, you just drag and drop them and then link them with the between the Service points and the sink. The Flownode should be close to the Service Points so that it looks more realistic as they exit from the Service Point straight away to the Sink (Exit).



Picture 32: Setting the Service time between 100 and 120seconds uniformly distributed.



Picture 33: Showing the FlowNodes, VisualTool and Recorder.



Picture 34: In this picture you can see the VisualTool and Recorders used. The Iphone customers are making the biggest line and Customer Service 4 is the most idle (ServicePoint 4 Statistic)

### Are all agents equally utilized?

To answer this question, we need to see the statistics that we get from the Recorders and from the Visual Tools, but also and from the simulation.

**The Recorders:** Trying to understand the Recorders, we can see that the Service Point 3 hasn't got at all idle time, which means that it is working in full time. Also, we can see that Service point 4 has a quite big amount of idle time; this means that in mostly this Service point is empty and waiting for customers.

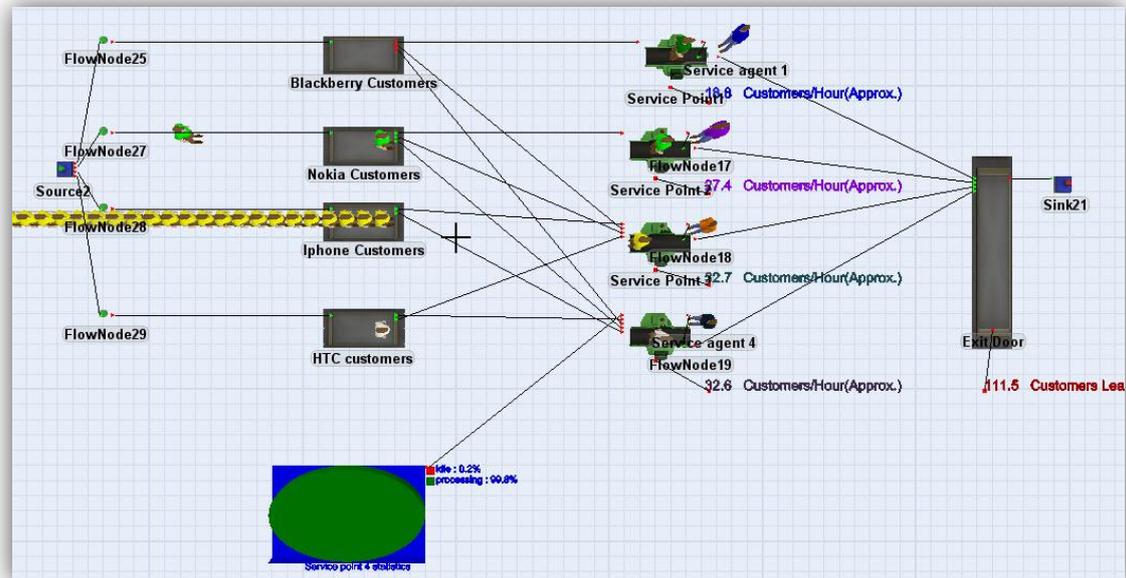
**Visual Tool:** From the Visual Tool, the information we are getting, is that Service Point 3, that had no Idle time at all, has served 33.1 Customers/hour. Service Point 4, with the lowest percentage of customers, is serving 12.2Customers/hour only.

**Simulation:** When we run the simulation, we notice that there is a big queue at the IPhone customers. Smaller Queues can be seen and at Nokia and Blackberry customers as well.

After reading all the above information's, the conclusion is that the agents are not equally utilized. The agent 4 is working less than all the others and agent 3 is working more than all the others.

### Following steps to complete simulation Model\_3\_1:

To show the customers moving to the desks themselves, firstly we need to add Flow Nodes for each customer and link them with the Queues.

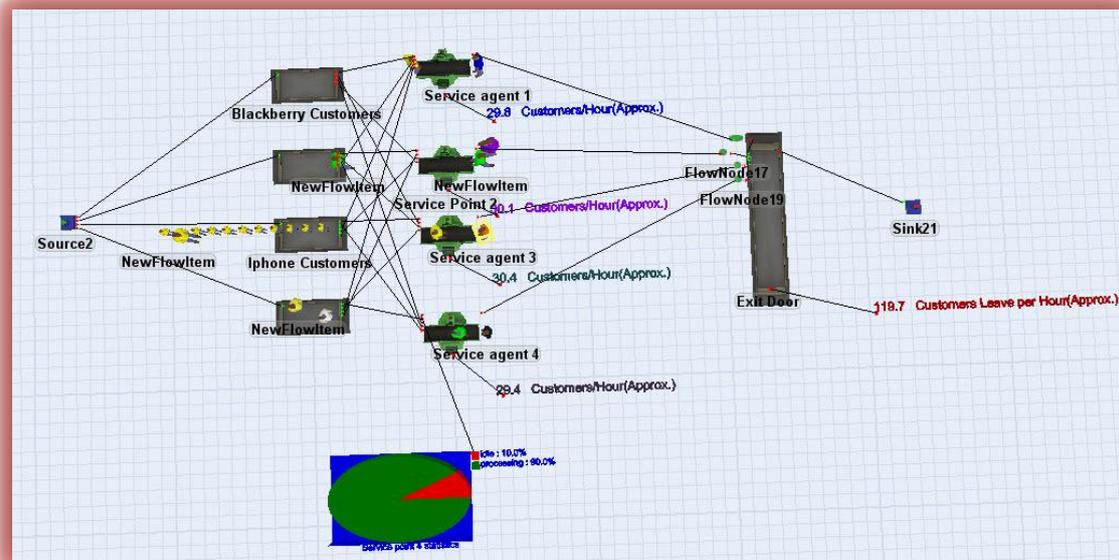


Picture 35: Customers moving to the desks themselves. Agents 3 and 4 are accepting customers from other companies as well.

As you can see from the picture above the situation now is better, the Agent 4 is very busy and hasn't go idle time at all. Agent 3 and 4 are servicing nearly the same amount of Customers/hour, nearly 32, and 6. Also, we can see from the simulation the big queue that iPhone customers are making. Agent 1 and 2 are not so busy.

### Following steps to complete simulation Model\_3\_2:

After a few test done, without adding additional agents, we can improve the situation by training the other agents, so that they can service the other customers as well. As you can see from the picture below, the customers leave per hour has been improved, from 111, 5 to 119, and 7. Also, the service that the agents do have been improved and they are all between 29.4 to 30.4. It means that they are all equally utilized comparing it with the previous model\_3\_1



Picture 36: The improved model. Agents are equally utilised.

## Strength and weaknesses of FlexSim 5

### Strength:

1. Easy to model. Because of the inbuilt library objects and extended downloadable library on FlexSim website.
2. Logistics are a key strength, easy to connect with Excel and other tools.
3. Proper documentation and helpful forum on FlexSim website.
4. Friendly interface using drag and drop tool for inserting 3D models.
5. Easy to code changes, using C++, Flexscript and DLL, which are basic programming languages.
6. Statistics are readily available, which can be used for presentation purpose.
7. Saving animation which can be used for other entities as well.
8. It is able to show different views using the cameras.

### Weaknesses:

1. Very expensive, only big companies can buy it.
2. Old version FlexSim files cannot be opened in newer versions of the software. This is the big weakness.
3. Difficult to add a new 3D Model from other 3D Design software.
4. Sometimes it is very hard to design a system just the way it looks like in real.

## Other Software's (Functionality – Prices – Application)

In the global market there are many Discrete Event Simulation software's which are used widely. These are the list of some softwares that are there in the industry:

Open Source Softwares:

- PowerDEVS .
- SimPy
- Tortuga .
- Facsimile
- Galatea
- MASON
- SharpSim

Commercial Softwares:

- AnyLogic
- Arena
- Enterprise Dynamics
- ExtendSim
- Flexsim
- GoldSim
- WITNESS
- L-SIM
- NetSim -
- Plant Simulation .
- Renque
- SimEvents of MathWorks
- SIMUL8
- Simcad Pro

## WITNESS Simulation Software –

It is a software which uses discrete event simulation environment, with graphical 2D & 3D and scripting interfaces, for modeling processes and experimentation. Witness was developed by Lanner group in 1987 (The Lanner Group, 2011).

### Functions:

Witness is mostly used in strategy validation, operational planning and process improvements. The industries in which witness is widely used are manufacturing, aerospace engineering and defence. It is even used in federal homeland security, pharmaceuticals, health and IT (The Lanner Group, 2011). In model building, it has functions like drag and drop of items; it has runtime debugging enabled and access to programming modules. Witness Easily link to existing Spreadsheet, Database or CAD files. *No replication of effort is necessary in WITNESS*. It helps in accurate animation, 3D flythroughs, and dynamic graphical charting. It is a good decision making tool because it has functions like KPI, energy usage & cost reporting, scenario management, process optimization (The Lanner Group, 2011). The cost of witness software is quite high. It is around \$10000 depending on the package (Ball, 2001).

### Required Hardware and Software

Witness requires min 256MB of RAM to be installed in the computer. It works on operating systems such as Windows NT 4 (SP3 and above), Windows 2000, Windows XP, Windows VISTA and windows 7 (Lionheart Publishing, Inc., 2010)

## 2. ExtendSim Simulation Software

ExtendSim is discrete event simulation software developed by Imagine That Inc. in year 1987 (Imagine That Inc., 2010).

### Functions:

In ExtendSim models can be modeled drag and drop of icons for model construction. It even gives access to run-time programming and run time debugging. There are many probability distributions that we can put in for separate entities. The models developed can be reused and even imported into other softwares (which lack some features). Tool to support packaging is available for free. Other features are costing, animation, real time viewing, animation export in MPEG version and 3D animation. The CAD model parts can be imported to model into the software.

The standard industry versions is priced from \$995-\$4500, the educational discounts are available as well. Student version is also available which is of importance for research purpose and it is priced at \$100 (Imagine That Inc., 2010).

### Required Software and hardware:

ExtendSim works on operating systems such as windows 7, Windows xp, Windows servers and Macintosh. It requires minimum 512Mb of RAM and for more 3D capabilities it requires a video card as well.

## 3. AnyLogic Simulation Software

AnyLogic is developed by XJ Technologies (XJ Technologies, 2010).

### Functions:

It has prebuild library which can be used to model the scenario. The objects can be reused.

The object libraries show how to build the models and it's really helpful. It has agent-based, system dynamics, discrete-event, continuous and dynamic system models, in any combination, with one tool. It supports the seamless integration of discrete and continuous simulations

It has excellent statistical distributions available, which helpful in putting different probability scenarios.

AnyLogic's simple yet sophisticated animation functions allow the development of visually rich, interactive simulation environments.

Automatic applet creation allows users to quickly build simulations that can be broadly disseminated — they can even be placed on a website.

The most interesting part of AnyLogic is that the model can be run stand alone. That means, it does not necessarily require software or license installed. The model itself is created as a java application and when we run the model it automatically runs the model.

Price of software ranges around £4000 for advanced version, £11000-£12000 for professional version and £300 for educational purposes. AnyLogic is quite expensive though.

#### Required Hardware and Software

It runs on operating systems such as windows 7/Vista/XP, windows servers 2005. It requires minimum 256Mb of RAM installed on the computer.

## FlexSim and Industries

Flexsim already has wide range of clients using it for simulation and other purposes. If we go to flexsim website (<http://www.flexsim.com/company/clients/>), we can see some of the largest worldwide companies use flexSim as a simulation tool to solve their problems. Some of these companies are: NASA, FedEx, Coca-Cola, Siemens, Ford, Goodyear...Etc.

If we see the types of clients the flexsim has got, it has almost all manufacturing and public sectors using the tool. Flexsim can be used more in **healthcare** for simulating the Patient check-up or managing the operations in hospital. It can be used in **Rail industry** to simulate the train timings, crowd movements and entry/exit of customers. The simulation can be helpful in **shipping industry** for parking of boats and movement of vehicles and people.

**Governments** can use the tool for simulating the government offices, where citizens come for information or for any other purpose (Offices are crowded most of the times like in developing countries). The **Construction** companies can use it for simulating complete construction scenario and get the time reduced by working on the model.

It can be used by smaller industries for reducing the time and for finding lowest working costs for the company. It can even be used for simulating the usage of mobile phones by users. Supply chain management industry can be benefitted as well.

Simulation can be used in service centres such as car service centres or customer services in public sectors to facilitate the easy handling of customers.

In all we can see there is a huge possibility of flexSim as simulation software, which can be used by every industry for one or the other reasons.

## Conclusion

FlexSim as a simulation software is very user friendly. Working on the assignment, helped to understand the way it works. It helped to familiarize with library elements and overall simulation environment. Using of regular tools such as recorders, visual tools and components such as conveyors, robots, operators, transporters helped to get better statistical analysis and results from each part of model. We could judge the optimum solution of the model by changing the parameters. The animations can be done with the software and it is a good tool. It will be nice to work on the future versions of the FlexSim.

The understanding of FlexSim helps in understanding the basics of simulation modeling which is helpful in working on other simulation software's which have the same basic concepts.

Discussion on three simulation softwares helped to gain the simulation industry insights, like different functionalities these software have, the kind of market they have and the price ranges of them.

## Bibliography

- Imagine That Inc. (2010). *Pricing for ExtendSim simulation tools*. Retrieved may 15, 2011, from ExtendSim simulation software by Imagine that Inc.:  
[http://www.extendsim.com/prods\\_pricing.html](http://www.extendsim.com/prods_pricing.html)
- Ball, P. (2001). *Introduction to discrete event simulation*. Retrieved may 15, 2011, from Masters Portal-Donetsk National Technical University:  
<http://masters.donntu.edu.ua/2006/kita/kondrakhin/library/art6.htm>
- Imagine That Inc. (2010). *ExtendSim User manual*. San Jose, CA: Imagine That Inc.
- Lionheart Publishing, Inc. (2010). *Simulation softwares survey*. Retrieved may 15, 2011, from Informs Online:  
<http://www.lionhrtpub.com/orms/surveys/Simulation/Simulation1.html>
- The Lanner Group. (2011). <http://www.lanner.com/en/witness.cfm>. Retrieved May 15, 2011, from Lanner: <http://www.lanner.com/en/witness.cfm>
- XJ Technologies. (2010). Retrieved May 15, 2011, from XJ technologies:  
[http://www.xjtek.com/anylogic/why\\_anylogic/](http://www.xjtek.com/anylogic/why_anylogic/)