

**Description of the
Rear-Axle Assembly Demo Model
for Tecnomatix Plant Simulation**

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Rear-Axle Assembly Demo Model Description

1. Description

Note that some actions in this description are not available in the Plant Simulation Viewer (in case you run this model from the Plant Simulation Demo-CD), since the Plant Simulation Viewer does not allow any modeling or changes of parameters. Actions which are not allowed in the Plant Simulation Viewer are marked with an asterix (*). In the model for the Plant Simulation Viewer, some of the actions marked with an asterix (*) will happen automatically at the end of the simulation.

1.1 Objective

The objective of this simulation study was to find out how the throughput of an existing rear axle assembly at Mercedes-Benz (now DaimlerChrysler) could be increased. Three different measures were investigated with simulation:

- Varying the layout of the system.
- Testing a different material flow control strategy in the section of the manual workstations.
- Changing the buffer capacity in front of the quality inspection.

1.2 System Characteristics

- Axle transportation and conveyor system on special carriers
- Manual and automated assembly operations
- Very limited space for layout alterations

1.3 Sequence

- Simulate two different layout alternatives simultaneously.
- Evaluate one layout alternative regarding the throughput and the utilization of operators.
- Examine the effects of various buffer loading strategies according to loading rate, and throughput.
- Define the dimension of buffers.

1.4 Results

Planning and implementation of an assembly plant with the support of simulation. As a result, the daily output could be increased to the required number and the utilization of the manual assembly stations could be improved.

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2. Demo Instructions

This model demonstrates the following Plant Simulation features:

- Ability to run two different scenarios simultaneously against each other.
- Doing changes to the simulation model without having to recompile the model.
- Usage of hierarchy
- Advantages of inheritance and re-usability of objects.
- Data exchange with other software.
- OLE embedding of EXCEL spreadsheets into Plant Simulation.

2.1 Study Overview

Open Model1 in Experiment1 and start the simulation by a mouse-click on the Start/Stop icon in the toolbar of Model1. To restart the simulation, click first on the Reset icon left of the Start/Stop icon, then click on the Start/Stop icon again.

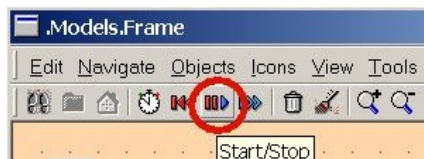


Figure 1: Start/Stop icon in the toolbar

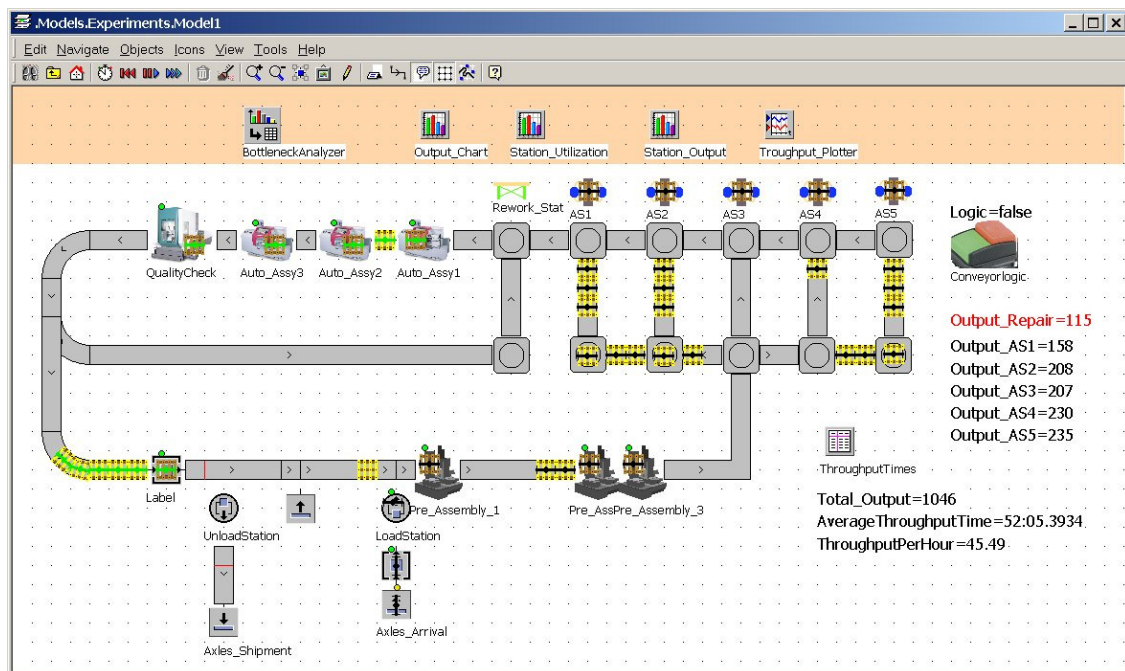


Figure 2: Layout of Model1

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Empty carriers, shown as pallets, arrive at the LoadStation, where the incoming axles are loaded on the carriers. Then, the axles pass three pre-assembly stations. After that, they get distributed to five manual assembly stations (AS1 to AS5) with two workers on each side, which are located in the upper right corner of the system. There is a material flow strategy in place which distributes the axles equally to the five buffer stations before the rotary tables. When an assembly station is available, the respective axle moves to the station using the rotary table before the station. After the manual assembly is finished the axles move towards the three automated assembly stations (Auto_Assy1 to Auto_Assy3) and the quality inspection (QualityCheck) located in the upper left corner. Axles without defects move to the UnloadStation, where the axles leave the system while the empty carriers go straight to the LoadStation. There, they pick up the next axle and the cycle begins once again.

The faulty axles enter the rework buffer, where they wait to be reprocessed by the rework station (Rework_Stat) in the upper middle of the window.

Observe the animation to find out possible material flow problems in the section of the manual assembly stations. You will notice that there is a traffic jam of axles in front of the manual assembly stations. Right-click the chart Station_Utilization and select Show Display Window from the context menu. You will see that the utilization of the stations AS1 and AS2 is very low. The reason is that all axles have to move over the rotary table in front of AS1. Because of the traffic jam, it's difficult to get axles to/from the station AS1.

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2.2 Re-Positioning of the Manual Assembly Stations

Then, look at the first measure the engineers came up with: *re-positioning of the manual assemble stations in front of the rotary table* so that the axles can go directly to the manual assembly stations. Open the Model2 that ran simultaneously with the first one and look at the difference to the first model.

Note, that you can run several different variants of your model with Plant Simulation simultaneously against each other, to find out the differences in the behavior

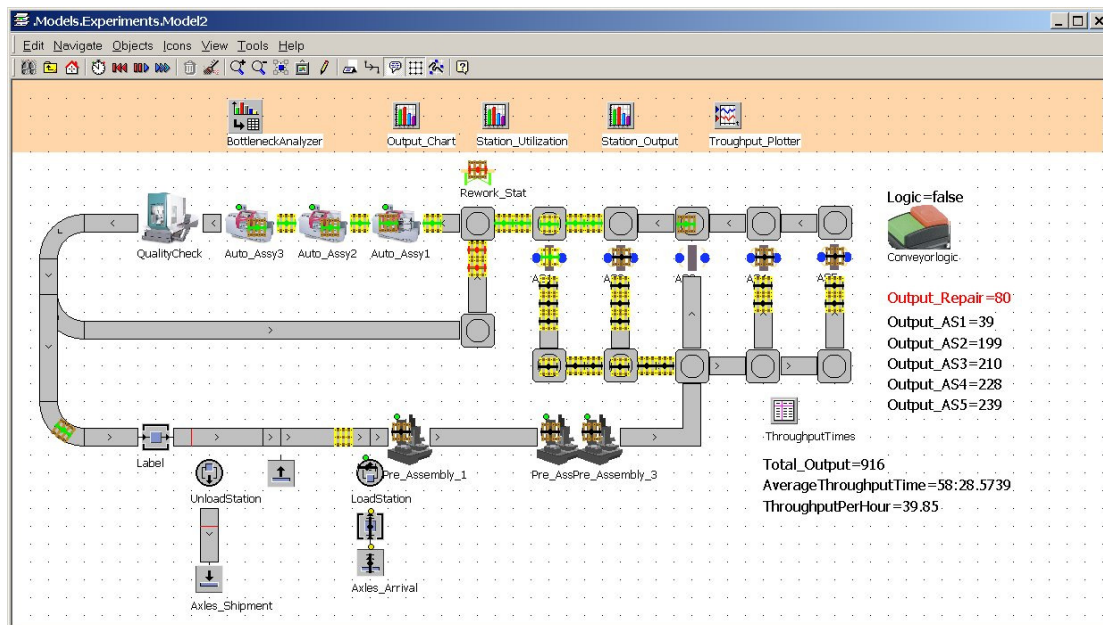


Figure 3: Layout of Model2

Look at the plotter in the main window Experiments (Figure 4) and you will see that the second variant does not show any improvement of the throughput compared to the first one.

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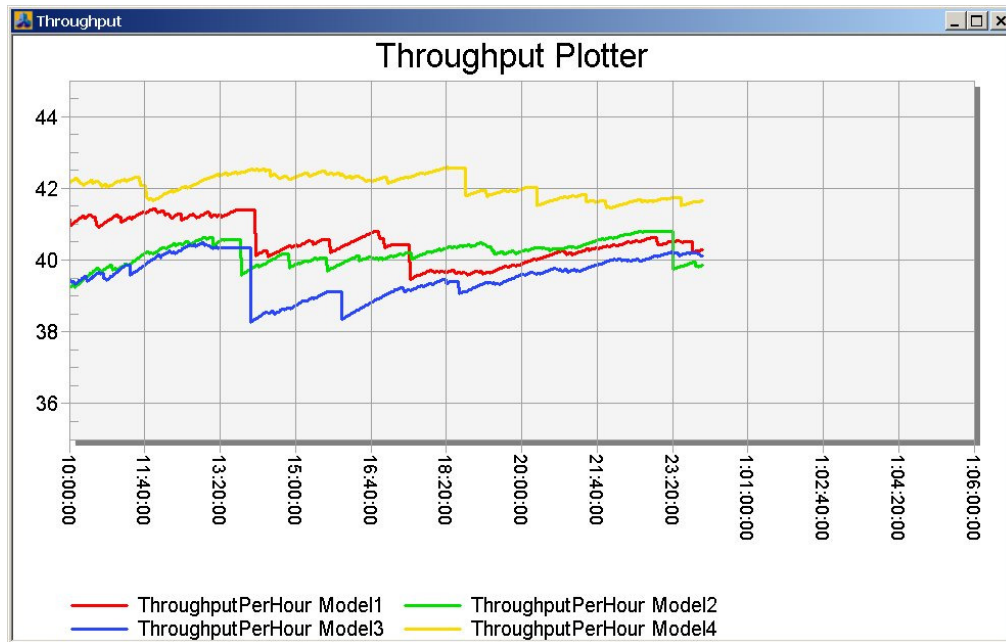


Figure 4 : Plotter with the average throughput of Axles over time

So now the axles can always reach the manual assembly stations, but they can not leave the stations because of the traffic jam at the rotary tables behind the stations.

Besides that, this solution has several disadvantages:

- It's very difficult to access to the workstations (think of emergency exits)
- It's very difficult to supply the workstations with material
- Unacceptable working conditions for the workers

2.3 Changing the Material Flow Control Strategy (*)

Close Model2, open Model3 and look at the second measure that was tested: *changing the material flow control strategy*.

Switch the material flow strategy by a double-click on ConveyorLogic (*). The value of the variable Logic changes from false to true. Now axles coming from the right can only enter a rotary table in front of an assembly station, if the conveyor on the left hand side of the rotary table is free. So an axle coming from the right enters a rotary table in front of an assembly station only, if it can leave the rotary table again immediately. This way, axles coming from the right do not block the axles which should enter an assembly station from below or leave an assembly station.

After a short while the difference becomes obvious by watching the animation.

Note: In Plant Simulation user-interactions may happen while the simulation is running without re-compiling the model.

On the top of the window you will find other valuable analysis tools such as charts that show the output of the manual assembly stations. Activate the charts by right-mouse click and

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selecting Show from the context menu. Also note the global variables on the right hand side that change their value while the simulation is running.

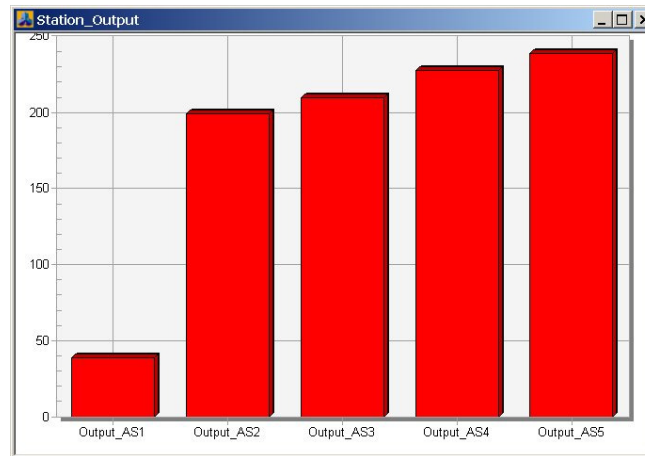


Figure 5: Chart showing the output of the manual workstations

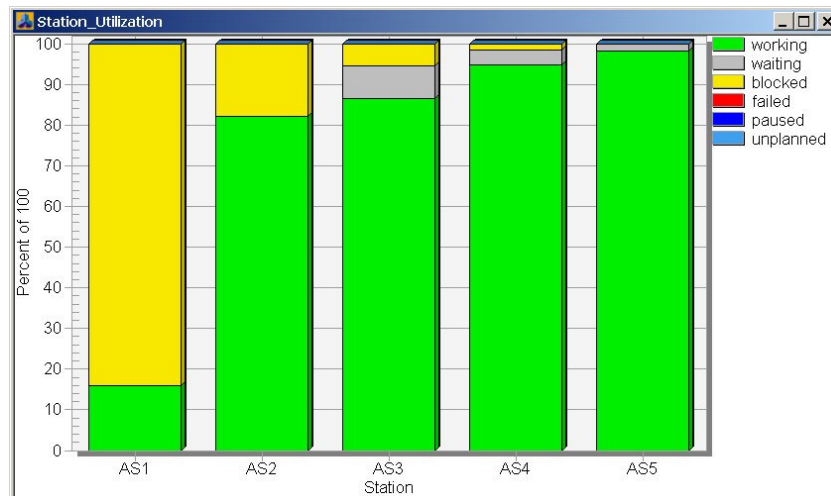


Figure 6: Utilization of the manual workstations over time

When running the two scenarios after each other, you will find that the output with the strategy, where the buffer is NOT kept free, for the different workstations is quite similar to the output of the “Keep the buffer free strategy”. Therefore, the reason for the blocking behavior must be located behind the manual assembly stations.

At the end of the simulation run, right-click the BottleneckAnalyzer object and choose Analyze from the context menu (*). Plant Simulation draws a diagram above each station and each transport system segment. The diagram shows how much percent of time the object was

- Empty (grey)
- Working (green)
- Blocked, which means axles could not leave the object, because the success object was occupied (yellow)

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- Disrupted (red)

You will note that there is blocking behavior even in the area of the automated assembly stations. But after the quality check, there is no blocking behavior any more. Therefore, the quality check is the bottleneck. Open the QualityCheck by double click and go the tab Failures. You will see that the availability is only 90%. So the reason for the blocking behavior is the quality check.

To solve the problem, we enhanced the length of the conveyor before the quality check, this way we increased the buffer capacity of this conveyor.

2.4 Modeling in Plant Simulation

Before we look at the buffer capacity in front of the quality inspection, let's take a look at the way we model in Plant Simulation.

Open the manual assembly stations AS1 and AS2 by double-click and make sure both windows do not overlap each other.

Note, that Plant Simulation allows working with hierarchies of objects. This enables you

- **to develop your own intelligent objects and to build up your own application object libraries**
- **to handle large models efficiently using compound objects for certain sections of your system**

Then, open the *class* object by selecting any of the manual assembly stations and choosing Navigate > Open Class from the menu of the assembly station window. Move any object in the class object around and watch the changes in the windows of the *instances*. Every object you insert in a model (instance) inherits all its properties from a class object.

So if an object appears multiple times in your system (stations, transport systems, buffers etc.), you develop this object only once in Plant Simulation (developing the class object) and insert this object multiple times in your simulation model. If you have to add or change parameters in your object, you change it only once in the class object and all objects in your simulation model immediately inherit those changes.

Note, that the concept of classes and instances helps to save a lot of time and increases the productivity developing and maintaining your simulation model. In addition, any object in Plant Simulation can be built and tested separately before you use it in combinations with others, allowing modular model development.

Note, that you can save and load any class object from/in Plant Simulation to exchange them between libraries, so that concurrent engineering is supported very effectively. Thus, people can work in teams on large projects and that way significantly reduce project times.

2.5 Increase Buffer Capacity of the Quality Inspection

Now let's look at the third scenario. Open Model4 in the Experiments frame and look at the conveyor. Note, that we increased the buffer capacity of the conveyor in front of the quality

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inspection. This way, the automated assembly stations can continue to work even when the quality check is not available.

Compare the results of the variants in the throughput diagram in the main window Experiments.

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Using Plant Simulation, you can easily create an HTML report of the results of your simulation. Right-click the object Report in the main window Experiments and select Show Display Window from the context menu. Click on the different pages in the tree on the left hand side of the report. Click on the Save icon of the report to save it as an html file.

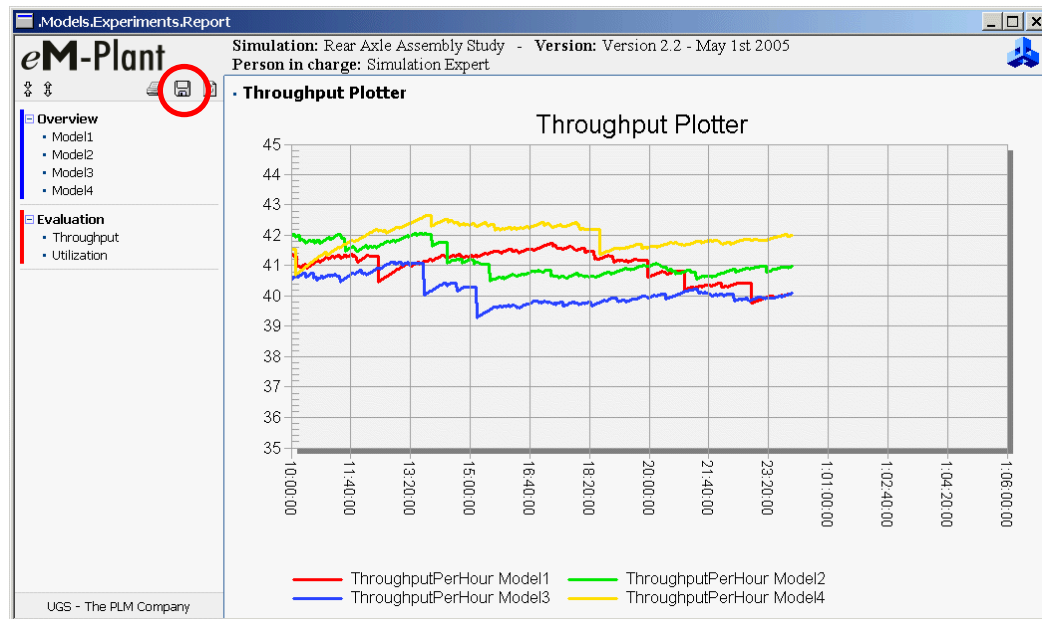


Figure 7 : Plant Simulation HTML report

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2.6 Exporting data from Plant Simulation to Microsoft® EXCEL® (*)

With Plant Simulation, data can be exchanged very easily with databases or other software applications, e.g. with Microsoft® EXCEL®. Start EXCEL from Plant Simulation by just double-clicking the EXCEL sheet in the Experiments window (*). Confirm that you want to update the data in this EXCEL sheet when EXCEL opens. Now you can watch in EXCEL, how the values of Plant Simulation variables change online while the simulation is running.

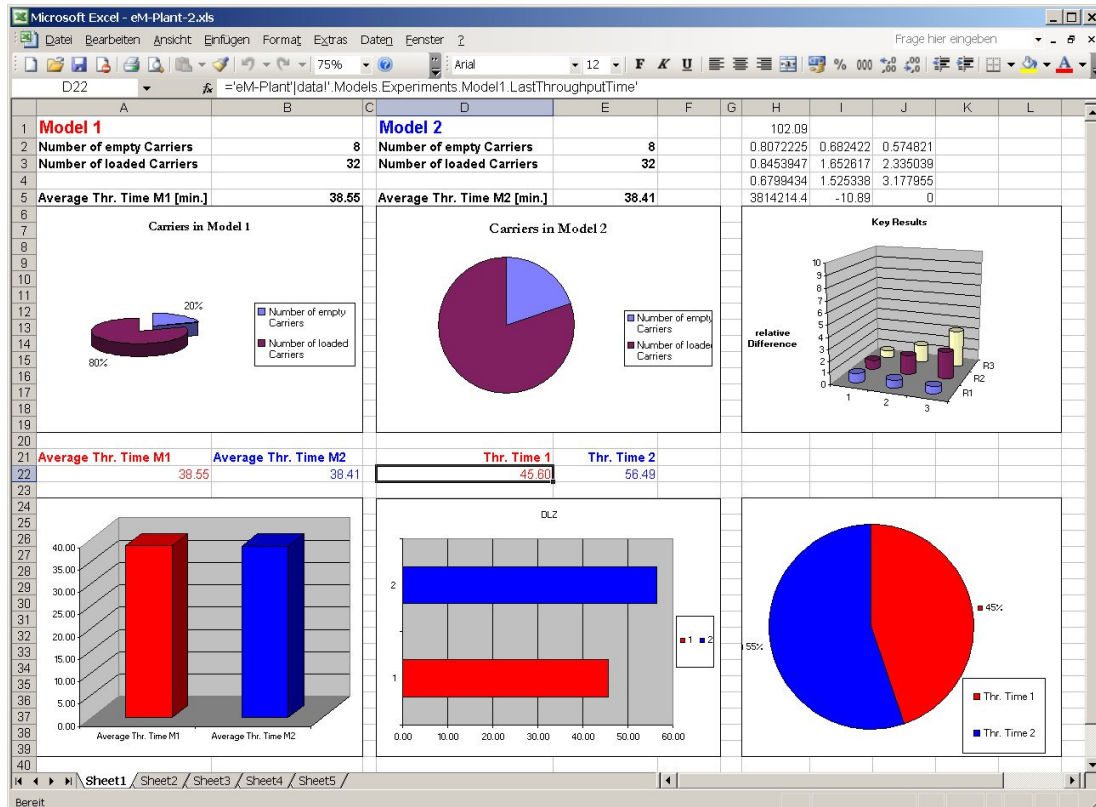


Figure 8 : Spreadsheet embedded in Plant Simulation for on-line data transfer

Note, that with Plant Simulation, data exchange with other software is easy and straightforward. Data can be exchanged even bi-directionally while the simulation is running. Because of that reason, Plant Simulation is used not only for strategic systems planning, but also for monitoring, forecasting and scheduling of production systems to support decision-making in daily operations.

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