Detailed Manufacturability Analysis Test Bench and Tool

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1.0 Purpose

The purpose of the Detailed Manufacturability Analysis Test Bench and Tool is to provide the designer with information on cost, lead time, and design feasibility. This test bench extends the fidelity of the cost, and lead time estimates of the Concept-Level Manufacturability Test Bench by including custom manufactured components and also adds feasibility analysis, i.e. verifies that the design can be manufactured/assembled.

2.0 Procedures

The instructions in this manual assume that the user has installed the latest version of GME and has access to Creo, either locally or via the remote server.

2.1 Installation

Initial installation of this test bench will be provided with the installation of the CyPhy tool suite. Future editions of the tool may be packaged as a standalone or combined test bench installation package.

2.2 Tool

The Detailed Manufacturability Analysis Test Bench is the test bench in GME that the designer uses to interface with, and the Manufacturability Tool, which is a server-based software system that accepts a design, analyzes it, and returns a result.

Manufacturability analysis is an automated process to determine if the design is manufacturable. If the design is manufacturable, the analysis will determine the cost and lead-time to make the design. If it is not manufacturable with the capabilities available in the iFAB Foundry, feedback will be provided as to why it is not. Several analysis tools are employed to determine the feasibility and metrics for the purchase or manufacture and the assembly of the individual components.

Test Bench: Detailed Manufacturability Analysis

Requirements Tested

- **Manufacturing Lead Time (min):** Time required to manufacture the first vehicle, from design release to build completion.
- **Vehicle Unit Cost ($):** Vehicle unit cost based on component costs (purchased and manufactured) and production of one vehicle.
- **Manufacturing Feasibility (true/false):** The design shall be manufacturable.

These requirements correspond to Test Benches: 61 – Manufacturing Cost, 66 – Manufacturing Lead Time, and 67 – Design Feasibility.

Theory of Operation

The system (design) is assembled into a 3D CAD representation, including the customization / generation of any parameterized components. Data about the purchasing and procurement is also assembled together for analysis by the iFAB Foundry. This information is packaged up and sent via remote server to the iFAB Information System for processing.

Test Bench Structure

This test bench contains a system under test that is to be assembled and analyzed for its manufacturability.

Step 1

In the GME Browser, within the “Testing” Test Bench folder, insert a new **Test Bench subfolder** ("Detailed Manufacturing"). Then insert a new **Test Bench model** ("Detailed_Mfg"). Figure 1 shows the new test bench and model.

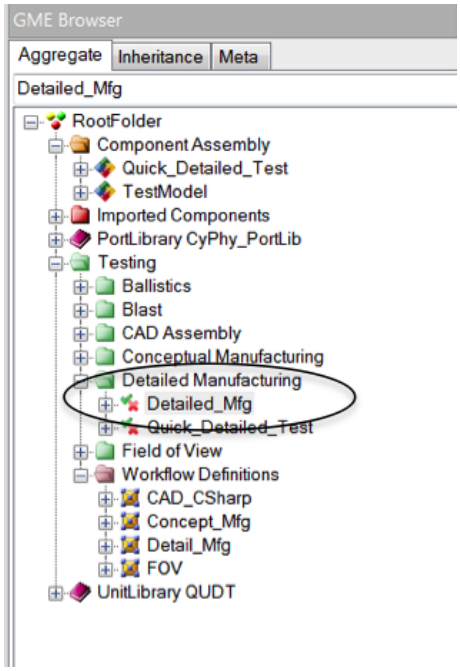

Figure 1. Detailed Manufacturing Test Bench (circled).

Step 2

Now that the test bench container has been created, the design can be added. In the "Detailed_Mfg" test bench, Copy/Paste… As Reference your assembly into the test bench workspace in GME, as shown in Figure 2.

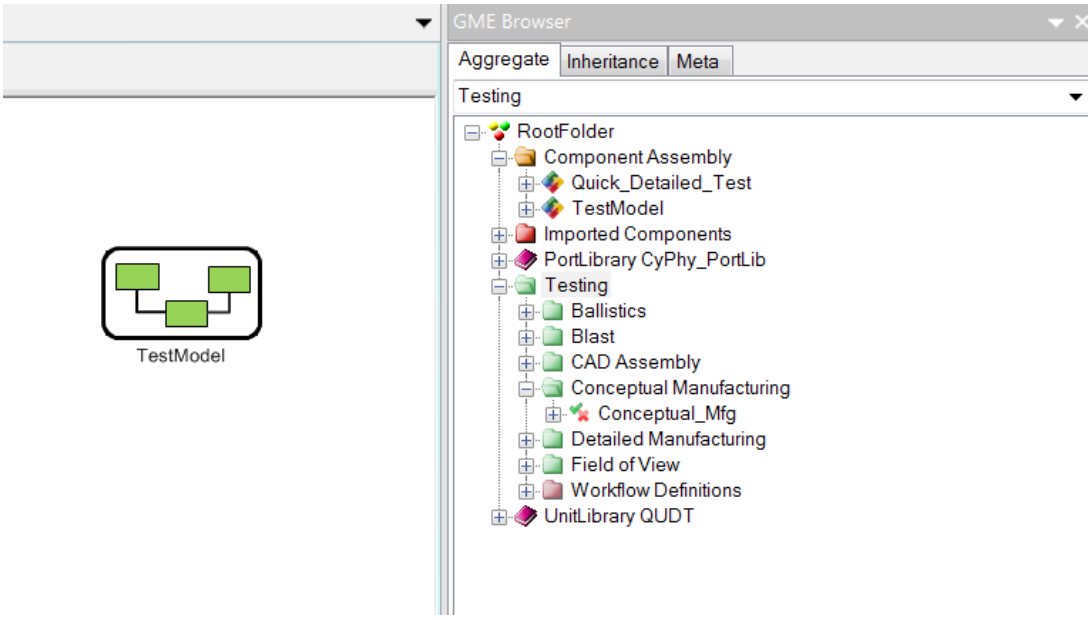

Figure 2: Copy/Paste…As Reference the Design Assembly into Test Bench.

Step 3

In the GME Browser, in the “Workflow Definition” subfolder, create a new **Workflow Model** ("Detail_Mfg") as shown in Figure 3.

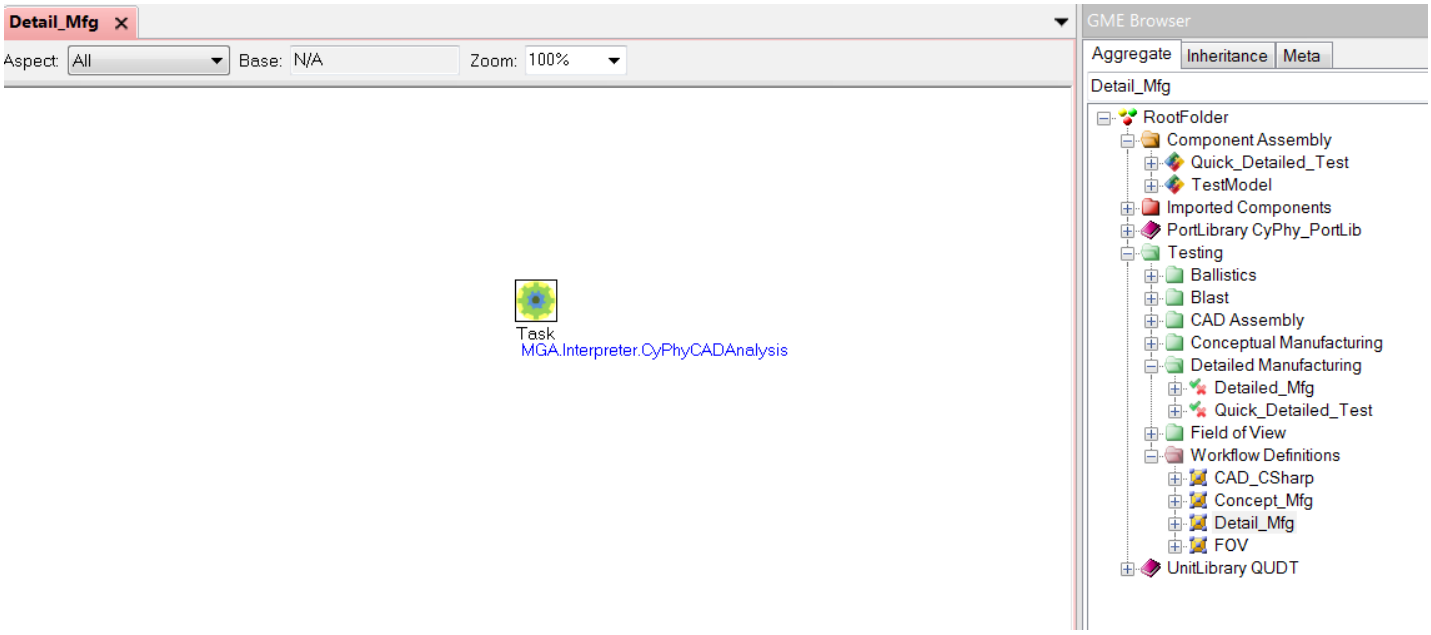

Figure 3: Insert Detail_Mfg Workflow into GME Browser.

Step 4

Open the “Detailed_Mfg” **Workflow Model**, drag a "Task" element into the workspace window and select "CyPhyCADAnalysis" as the interpreter from the pop-up window. Double-click on “Task” and select "Detailed_mfg" as analysis tool. After exiting object inspector parameter should mimic Figure 4.

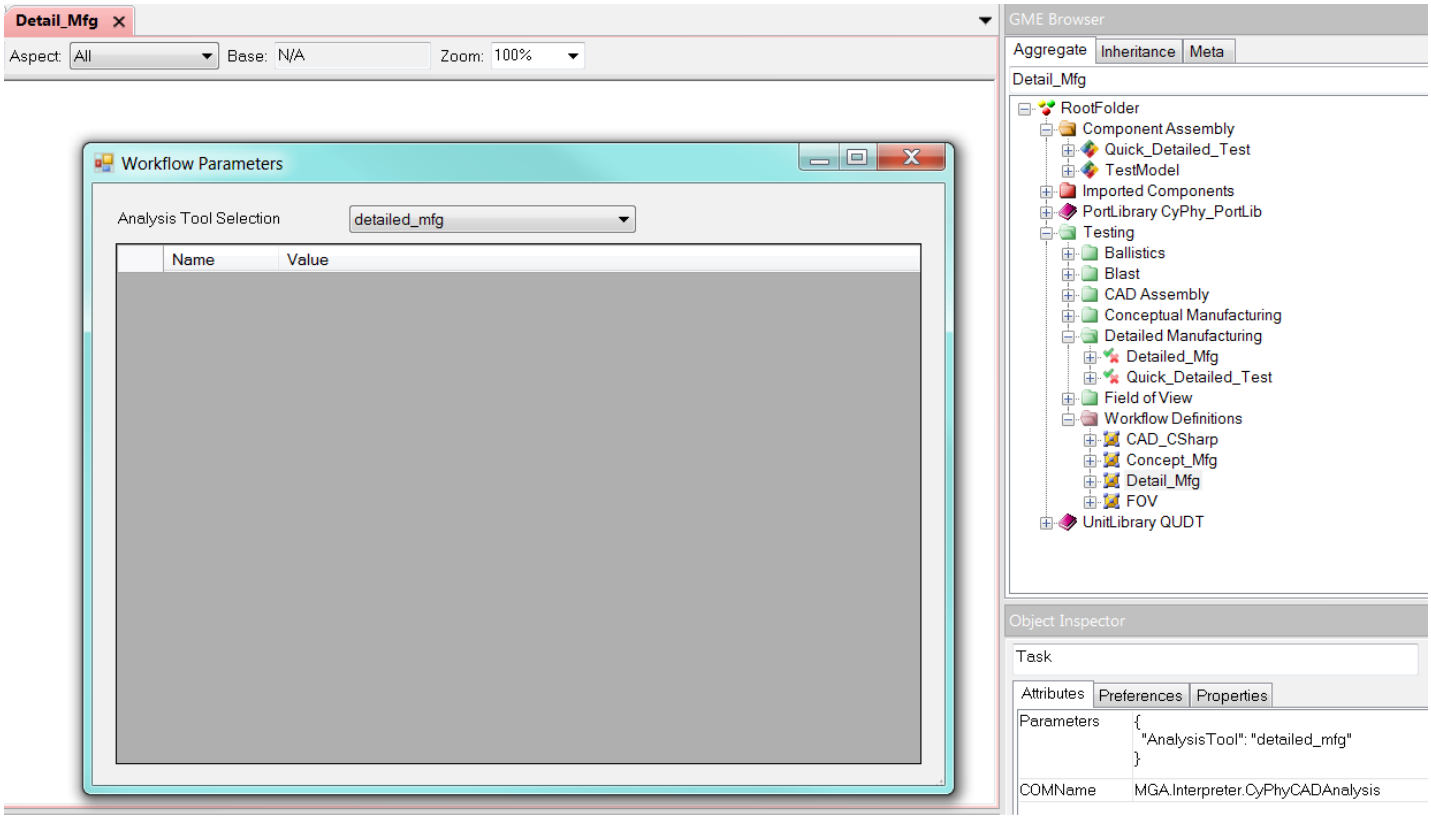

Figure 4: Detailed_Mfg Workflow.

Step 5

Now open the “Detailed_Mfg” test bench and drag/drop the “Detailed_Mfg” workflow definition and 2 metrics (from Part Browser) into test bench. Metrics must be named “Estimated Cost” and “Estimated Lead Time” as shown in Figure 5.

Figure 5: Test Bench Metrics.

Once this step is complete, the main window in GME looks like the graphic shown in Figure 6 below.

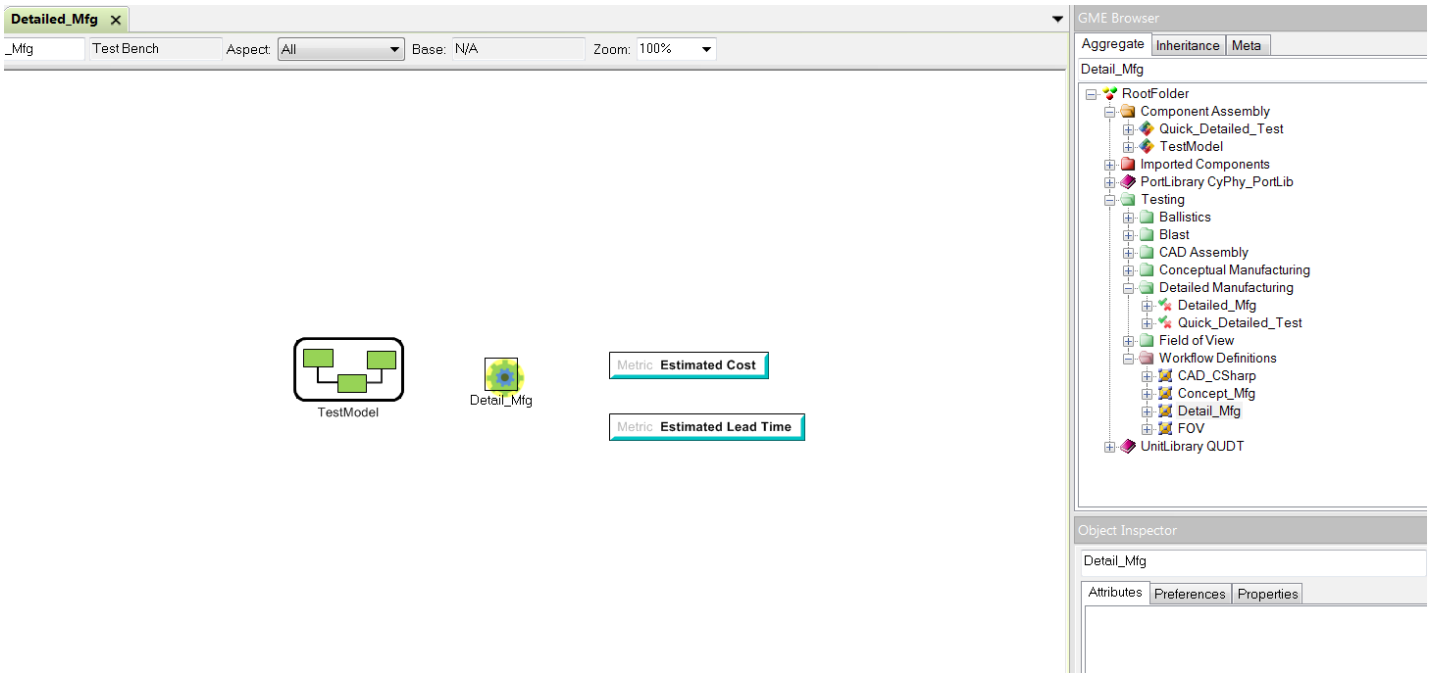

Figure 6: GME Interface with Detailed Manufacturability Test Bench.

Step 6

To exercise the test bench, run the Master Interpreter (highlighted in task bar). Check the “Post to META Job Manager” and “Use Project Manifest” boxes as well as the “AP203_E2_Single_File” and “AP203_E2_Separate_Part_Files” as shown in Figure 7. Also point to the Creo file location for the “CAD Auxiliary Directory:” field.

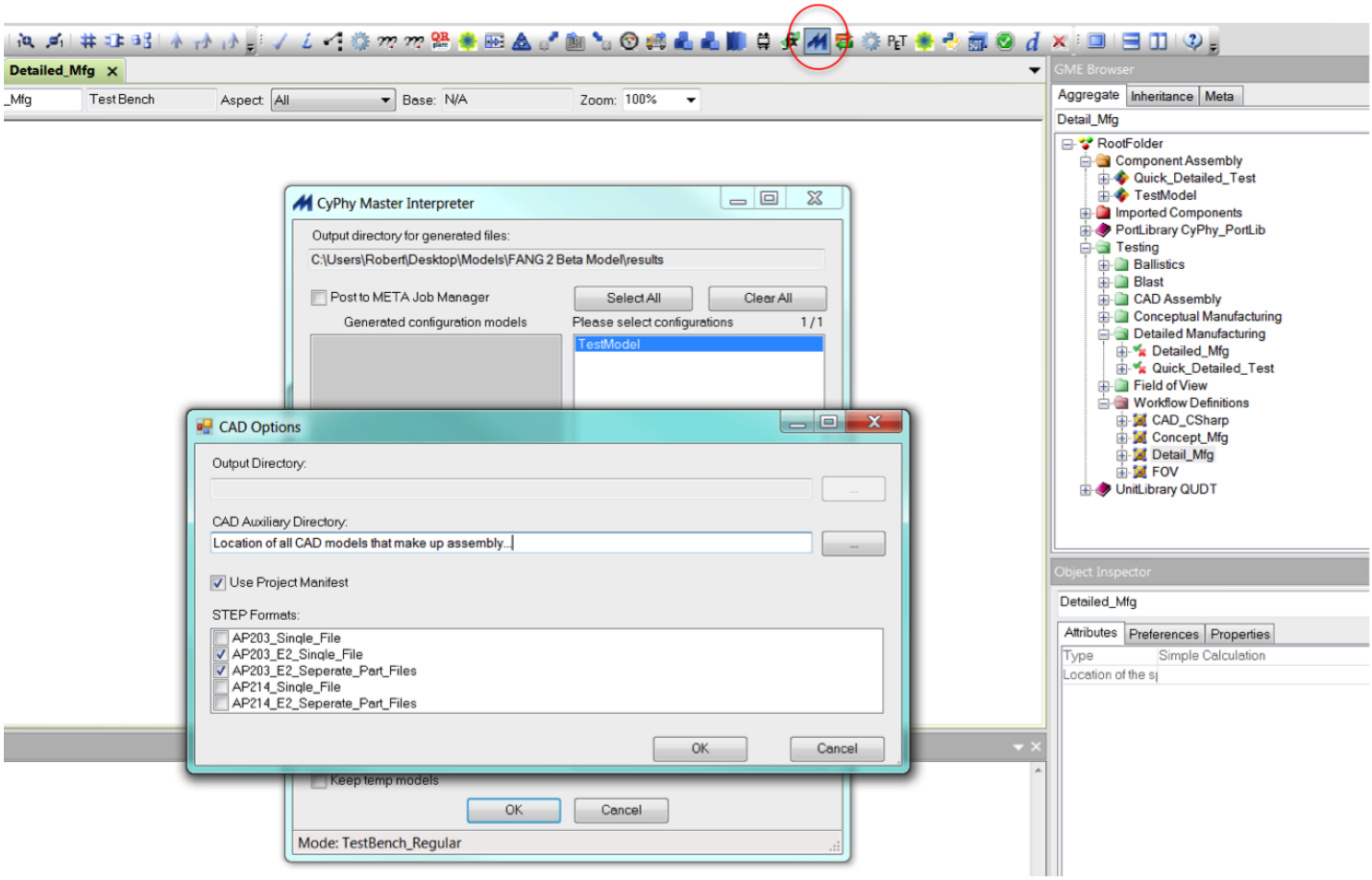

Figure 7: Running the Test Bench./center>

Step 7

Once the job has posted to the Job Manager, the design information will be uploaded to the server, the analysis will be run, and the results will be downloaded to the results folder. In results folder, there will be two output files that contain manufacturing analysis information about the design: summary.testresults.json and iFAB.ManufacturabilityResults.json. The information in these files can be used to modify the design to improve cost and lead time.

Typical analysis times are between 0.5 and 1 hour and increase with the number of components in the design.

The Detailed Manufacturability test bench is a server only test bench and cannot be run on the designer's machine because the analysis tool is instantiated on a server.

Description

Detailed Manufacturability analysis is an automated process to determine if the design is manufacturable. If the design is manufacturable, the analysis will determine the cost and lead-time to make the design. If it is not manufacturable with the capabilities available in the iFAB Foundry, feedback will be provided as to why it is not. Several analysis tools are employed to determine the feasibility and metrics for the assembly and the purchase or manufacture of the individual components.

The System Under Test is assembled in CREO and then each component making up the system is saved as an individual step file. Data about procurement for each component is also gathered. This information is packaged and sent (via remote server) to the iFAB Foundry information system for post-processing.

Results are returned in two files, "summary.testresults.json" and "iFAB.ManufacturabilityResults.json", containing summary results and more detailed results, respectively. The summary results can be viewed in the dashboard and shortly after, the detailed results can be viewed in the Vehicle Forge manufacturability visualization tool.

Metrics

- **Manufacturing Lead Time (min):** Time required to manufacture the first vehicle, from design release to build completion.
- **Vehicle Unit Cost($):** Vehicle unit cost.
- **Manufacturing Feasibility (true/false):** The design shall be manufacturable.

Required Connections to System Under Test

NONE

Outputs

The output of this test bench is two results files, “summary.testresults.json” and “iFAB.ManufacturabilityResults.json”. The summary results summarize the cost, leadtime, and manufacturing feasibility and can be viewed/interpreted in the dashboard. A portion of the summary results is shown in Figure 8.


```
"AnalysisStatus": "OK",
"TestBench": "Detail_Mfg",
"DesignName": "PowerPack_Hierarchical_Suspension_Adapters_cfg1",
"Metrics": [
    {
        "Name": "Estimated Cost",
        "DisplayedName": null,
        "GMEID": "id-0067-00000473",
        "Value": "2194385.95485",
        "ID": "ebce3eea-713b-44fa-b6ec-d7487f843fe2",
        "Unit": "USD"
    },
    {
        "Name": "Estimated Lead Time",
        "DisplayedName": null,
        "GMEID": "id-0067-00000472",
        "Value": "38.0",
        "ID": "7028f7f1-3da7-4b0a-bdcf-80d8a97ddbca",
        "Unit": "Day"
    }
```


*Figure 8: Portion of Summary Results.8

The summary results can be seen and compared with other system metrics in the Dashboard.

The detailed results file contains information about the overall design, including detailed information about each component in the design. It also includes the schedule of the manufacturing and assembly of the components in the design. Shortly, the detailed results can be viewed in the VF manufacturability visualization tool.components in the design. The detailed results can be viewed in the VF manufacturability visualization tool.

Notes on Authored Components

If you have created custom components that you would like to submit for manufacturability analysis, a few things need to be included in the CyPhy component:

1) Make sure the component has a directory in the 'components' folder of your project directory. This is similar to all current C2M2L components. This is where the "CAD" & "Manufacturing" folders and ComponentData.xml are housed. Place the manufacturing xml associated with the part in this component's folder.

2) A ManufacturingModel block. Leave all attributes for this part blank.

3) A Resource block that is then connected to the ManufacturingModel. For the "Path (URI)" attribute, enter the path to the manufacturing xml relative to the specific component's folder created in (1). An example: If the manufacturing xml is located at "\components\Engine\Manufacturing\<xml>", the Path (URI) would be "Manufacturing\<xml>".