Concept-Level Manufacturability Analysis Test Bench and Tool

Table of Contents

1.0 Purpose

The purpose of the Concept-Level Manufacturability Analysis Test Bench and Tool is to provide the designer with information about cost and lead time of the design. This test bench is a fast alternative to the detailed manufacturability test bench, but it does not analyze the design for feasibility or provide support for custom manufactured components.

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 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 Concept-Level Manufacturability Analysis Test Bench is the test bench in GME that the designer uses to interface with the Concept Level Manufacturability Tool, which is a software application that accepts a design, analyzes it, and returns cost and lead time results.

Manufacturability analysis is an automated process to estimate the cost and lead time of a design. Specifically, the tool collects cost and lead time information about each component in the design and aggregates that information into overall design cost and lead time metrics. In addition, it analyzes the geometry of the hull to calculate a cost estimate at the various levels of design completeness of the hull.

Test Bench: Concept-Level Manufacturability Analysis

Requirements Tested

- **Manufacturing Lead Time (days):** Time required to manufacture the first vehicle, from design release to build completion.
- **Vehicle Unit Cost ($):** Vehicle unit cost based on component costs and production of one vehicle.

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

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 analyzed to estimate the cost and lead time of the design.

Test Bench Structure

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

Step 1

In the GME Browser, within the “Testing” **Test Bench folder**, insert a new **Test Bench subfolder** ("Conceptual Manufacturing"). Then insert a new **Test Bench model**

("Conceptual_Mfg"). Figure 1 shows the new test bench and model.

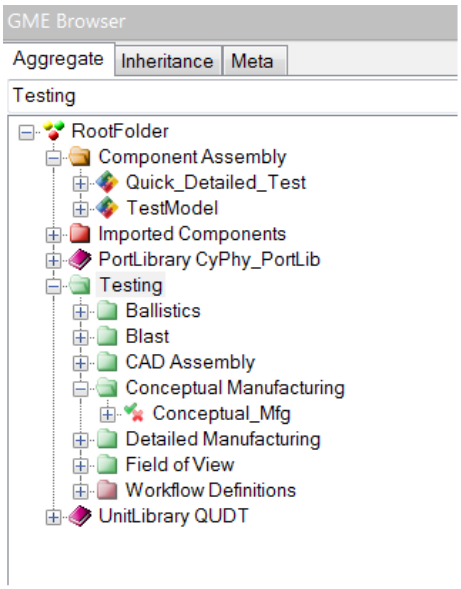

Figure 1: Conceptual Manufacturing Test Bench and Model (highlighted).

Step 2

Now that the test bench container has been created, the design can be added. In the "Conceptual_Mfg" testbench, Copy/Paste… As Reference your assembly. Figure 2 shows the test model in the test bench.

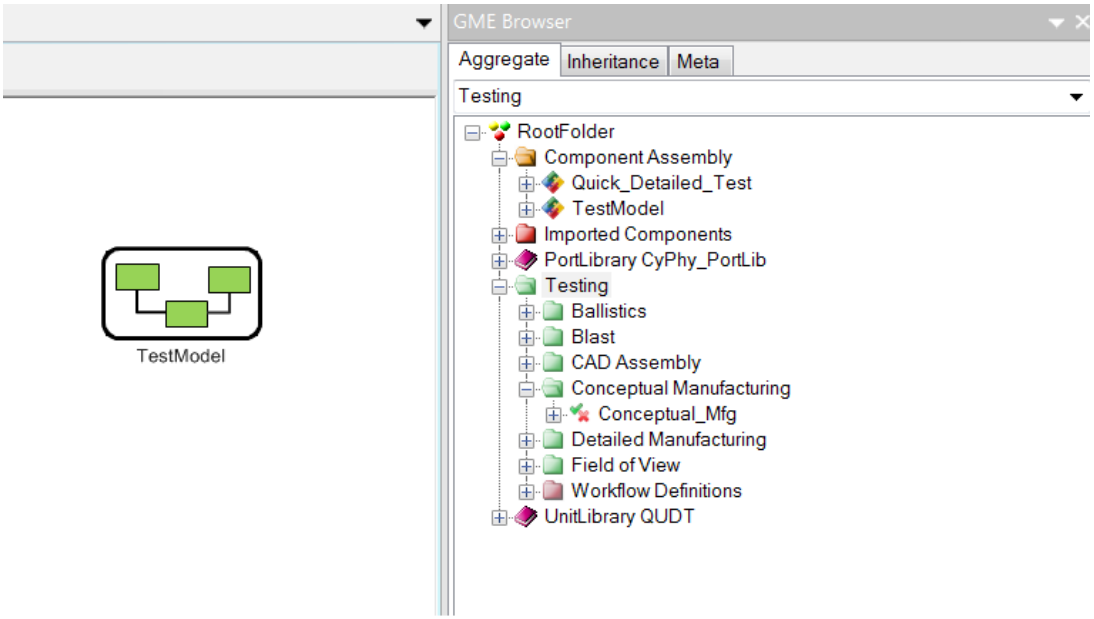

Figure 2: Copy/Paste…as Reference the Design Assembly.

Step 3

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

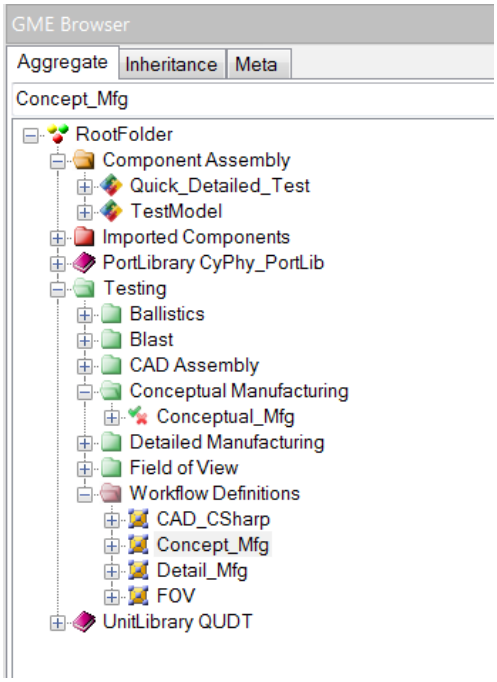

Figure 3: Workflow Definition (highlighted).

Step 4

Open the “Concept_Mfg” **Workflow Model**, drag a "Task" element into the workspace window, and select "CyPhyCADAnalysis" as the interpreter from the pop-up window. The Concept_Mfg Workflow Model is shown in Figure 4.

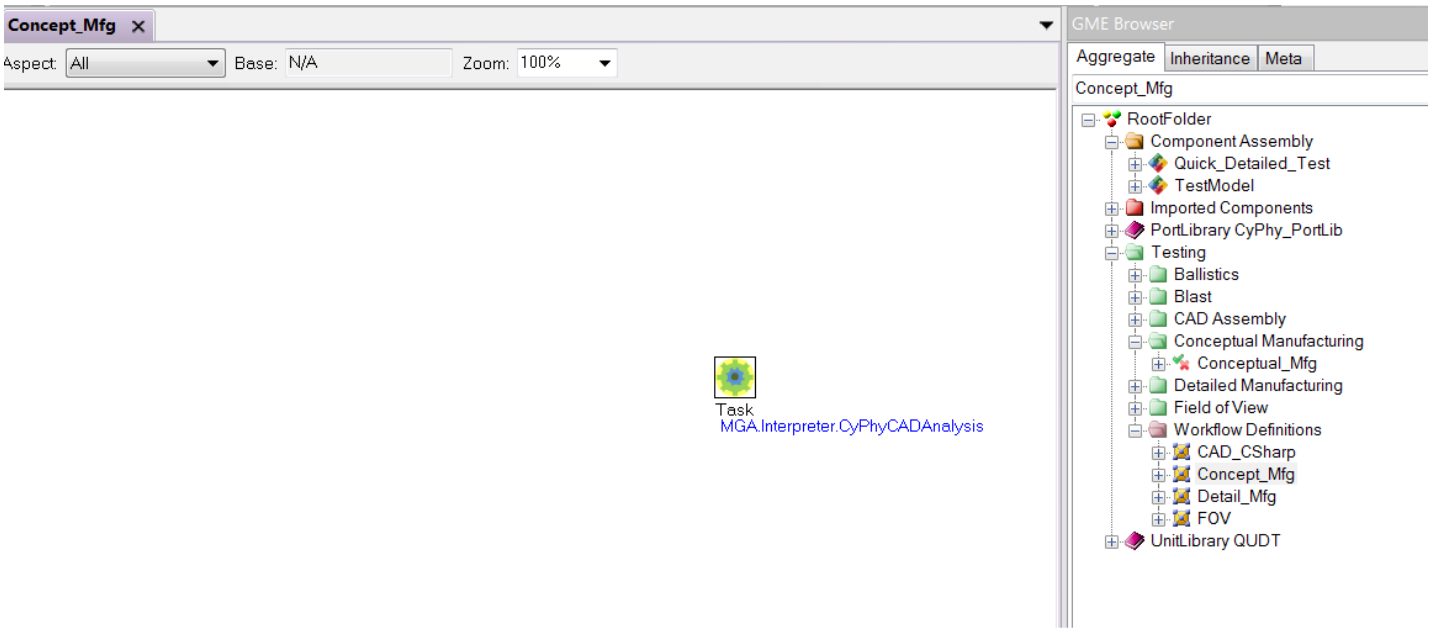

Figure 4: Concept_Mfg Workflow Model with Task.

Step 5

Setup the workflow parameters by Double-clicking on the newly created task and select "Conceptual_mfg" as analysis tool. After exiting object inspector, parameter should mimic Figure 5.

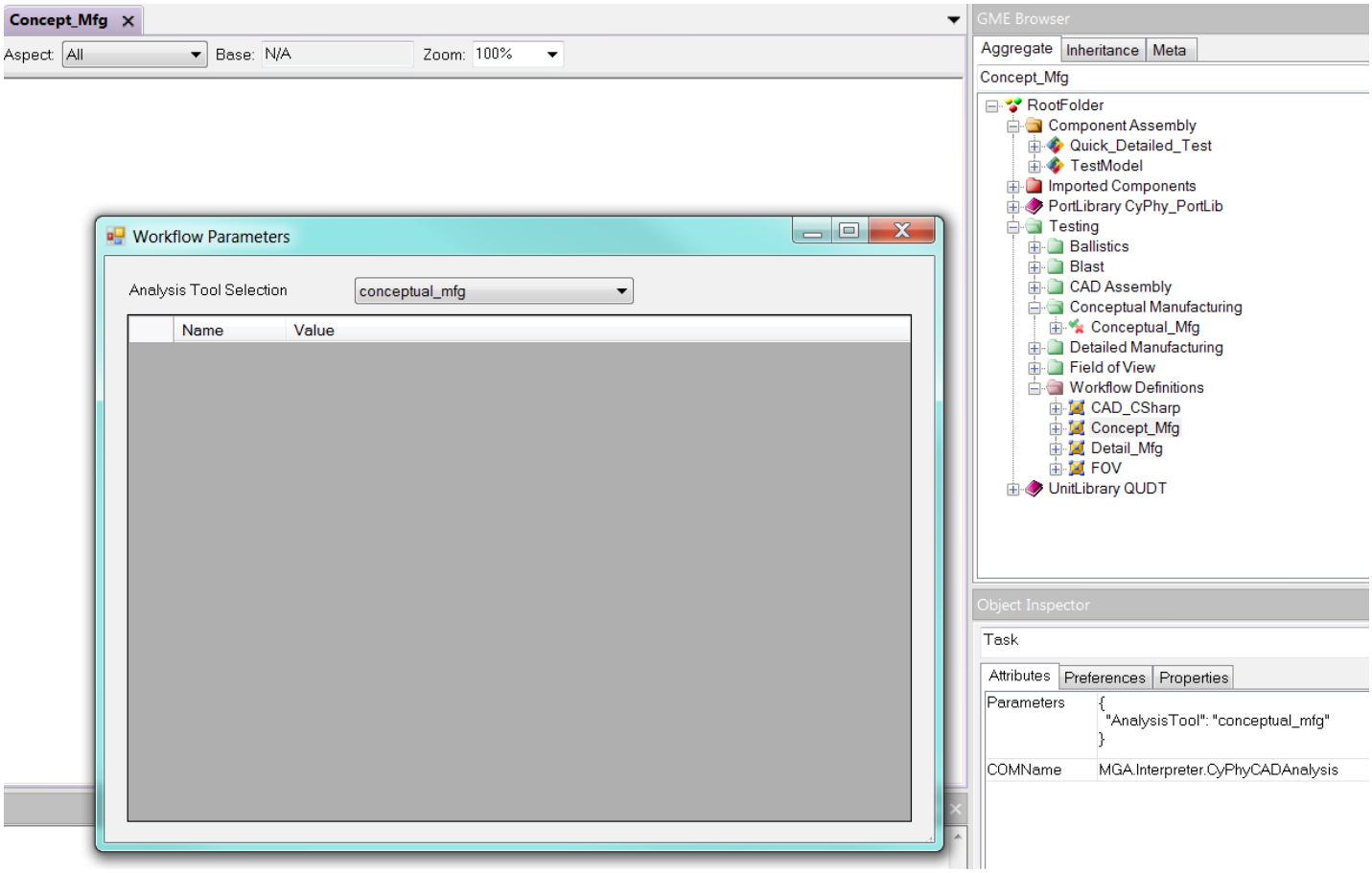

Figure 5: Setting up the Metrics.

Step 6

Now open the “Conceptual_Mfg” test bench and drag/drop the “Concept_Mfg” workflow definition and 2 metrics (from Part Browser) into test bench. Metrics must be named “Estimated Cost (Conceptual)” and “Estimated Lead Time (Conceptual)” as shown in Figure 6. This is what is searched for in the summary.testresults.json file.

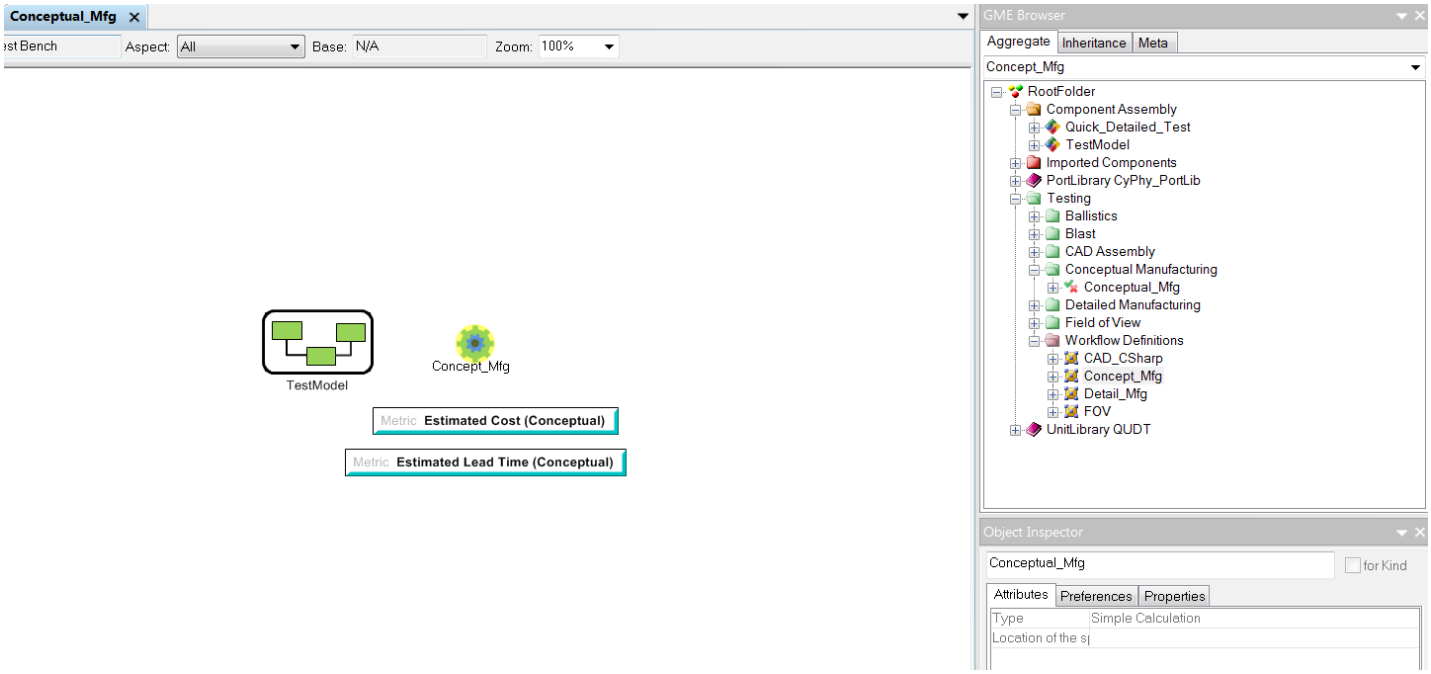

Figure 6: “Conceptual_Mfg” Test Bench.

Step 7

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.

This test bench can be run either locally or remotely using the Job Manager.

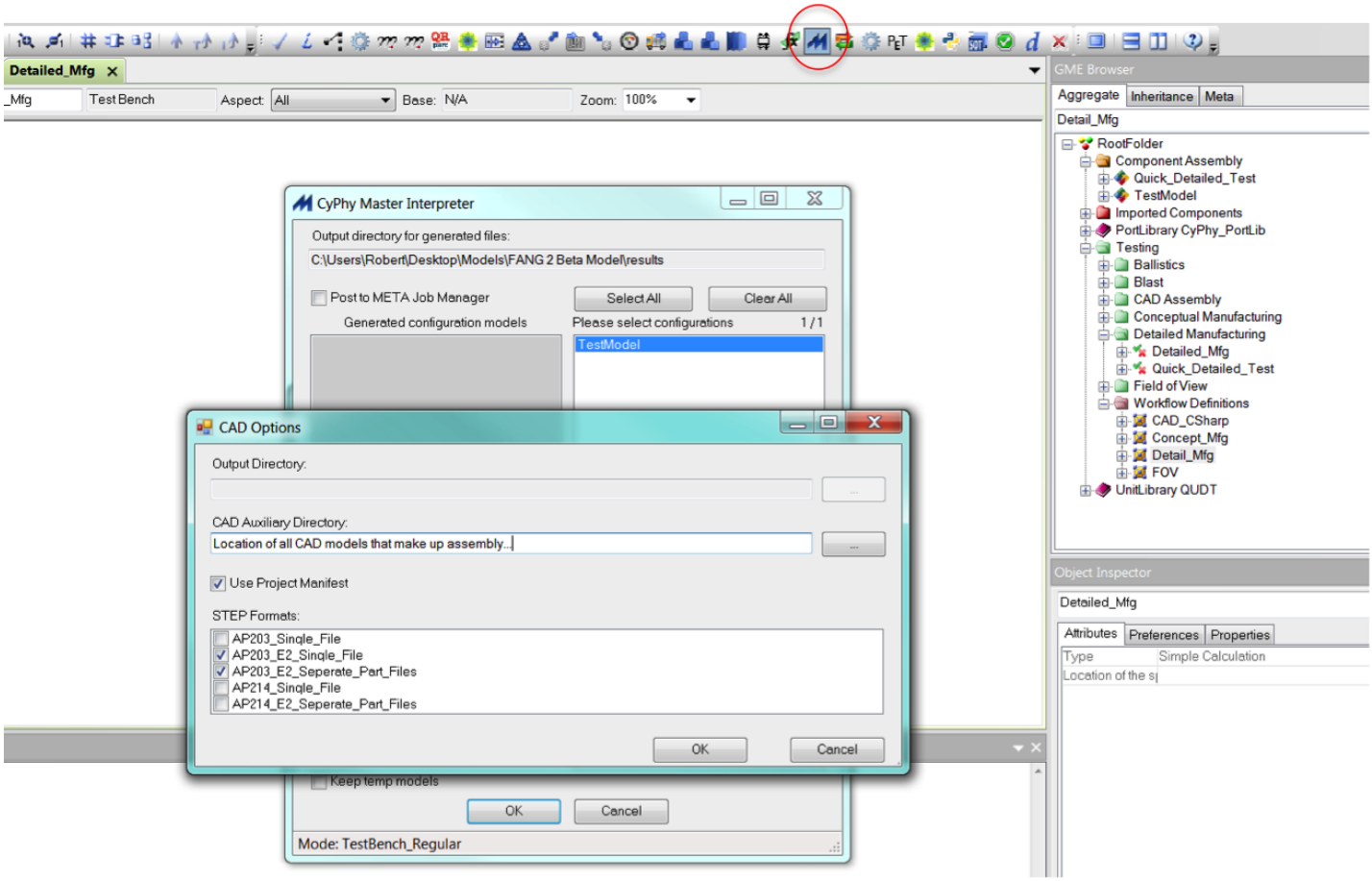

Figure 7: Running the Test Bench.

Step 8

The test bench will create a results folder with the manufacturing information about the design. The Job Manager will show the specific results folder which will contain two files of interest: summary.testresults.json and conceptual_cost.json. The summary.testresults.json file contains cost and leadtime information that can be used to evaluate the design. The conceptual_cost.json file shows detailed information about the hull and the components in the design. It is intended that the designer would use the detailed results to modify the design to improve either cost or lead time.

We are working with Vehicle Forge to provide a data visualizer for the detailed information to provide a more informative interface to the designer. An example of this interface is shown in Figure 8. This capability is not included in the Spiral 4 release, but will be available soon.

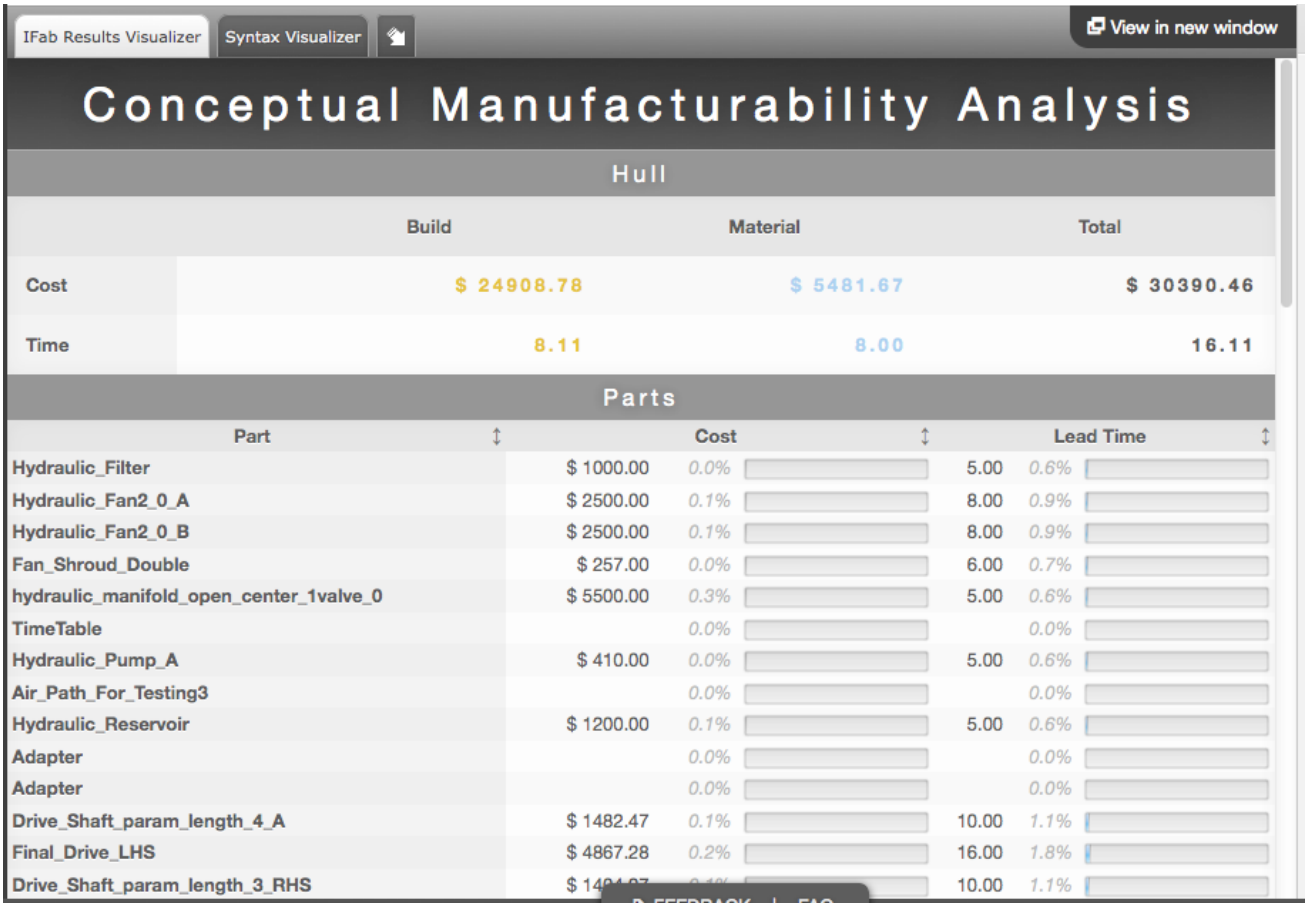

Figure 8: Concept-Level Manufacturability Analysis Results in Vehicle Forge Visualizer.

Description

Concept-Level Manufacturability analysis calculates the cost and lead-time of the design under test. This tool analyzes the information provided in the design, specifically the components (engine, transmission, etc.) and the hull. The test bench is designed to analyze designs from initial conceptual hull through detailed design. This test bench is used as a tool to get a cost and lead time estimate of the design quickly but lacks the detail analysis capability found in the Detailed Manufacturability Test Bench.

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 analyzed by the Concept-Level Manufacturability Analysis Tool as a post-processing step.

Results are returned in two files, “summary.testresults.json” and “conceptual_cost.json,” containing summary results and more detailed results, respectively. The summary results can be viewed in the dashboard, and the detailed results will be viewed in the VF manufacturability visualization tool.

Metrics

- **Manufacturing Lead Time (days):** Time required to manufacture the first vehicle, from design release to build completion.
- **Vehicle Unit Cost ($):** Vehicle unit cost.

Required Connections to System Under Test

NONE

Outputs

The output of this test bench is two results files, “summary.testresults.json” and “conceptual.manufacturabilityResults.json”. The summary results summarize the cost, and leadtime and can be viewed/interpreted in the dashboard. A portion of the summary results is shown in Figure 9.

summary.testresults.json


```
{
    "Parameters": [],
    "Artifacts": [
        {
            "Path": "AP203_E2_SEPERATE_PART_FILES/DoubleV_Hull_asm.stp",
            "Name": "STEP Assembly"
        },
        {
            "Path": "Just_DoubleV_Hull_metrics.xml",
            "Name": "Metrics"
        },
        {
            "Path": "Just_DoubleV_Hull.metadesign.json",
            "Name": "Design Model"
        },
        {
            "Path": "Just_DoubleV_Hull.bom.json",
            "Name": "BOM"
        },
        {
            "Path": "manufacturing.manifest.json",
            "Name": "Component Manufacturing Models"
        }
    ],
    "AnalysisStatus": "OK",
    "TestBench": "Just_DoubleV_Hull",
    "DesignName": "Just_DoubleV_Hull",
    "Metrics": [
        {
            "Unit": "Dollars",
            "Name": "Estimated Cost (Conceptual)",
            "Value": "1556299.056"
        },
        {
            "Unit": "Days",
            "Name": "Estimated Lead Time (Conceptual)",
            "Value": "336.263979917"
        }
    ],
    "DesignID": "{01ba7a97-5a2f-416c-8d9d-d847a1a18ac6}",
    "Design": "Just_DoubleV_Hull.metadesign.json",
    "Details": "",
    "Time": "2013-10-07T20:37:30.8529419Z"
}
```


Figure 9: Portion of Summary Results.

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 a detailed estimate of the cost of the hull.