Manufacturing Analysis Augmentation Tool (Creo Plugin)

User Tutorial for Manufacturing Analysis Augmentation Tool (Creo Plugin)

May 2, 2014

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1.0 Purpose

The purpose of the Manufacturing Analysis Augmentation Tool (MAAT) is to provide a mechanism for designers to provide additional information for custom manufactured components, i.e. components that are made in the iFAB Foundry distributed manufacturing environment. This data (e.g., part class selection, material specification, and general tolerance definition) is required in order for the detailed manufacturability testbench to return an associated cost and lead time for a submitted part or assembly. All custom designed components (e.g., brackets, weldments, etc.) need to be augmented using the MAAT for a submitted design to be considered manufacturable.

Designers are encouraged to augment custom designs as early as possible and submit these independently for detailed manufacturability assessment. This will enable designers to identify non-manufacturable designs before incorporating these components into their large design. Also, the evaluation of independent custom component designs (parts or assemblies) is more efficient than receiving this feedback by submitting an entire vehicle design. Designers can also use the detailed manufacturability testbench results to improve their designs in an effort to reduce cost or lead time.

More details about the information requested from the designer for custom components is detailed in the iFAB Foundry Detailed Manufacturability Assessment file.

2.0 Procedures

The instructions in this manual assume that the user has installed the latest version of GME, CyPhy and PTC Creo 2.0.

2.1 Installation

Ensure that you have sufficient privileges to install software on your computer. The minimum system requirements are:

- Windows 7, 32- or 64 bit
- 8 GB RAM (or more is recommended)
- Creo2 Parametric previously installed

Uninstall any previous versions of MAAT. The resulting MAAT installation folder may have files remaining after the uninstall process as shown in Figure 2. The user can optionally remove these or the files can be left there without affecting the newest installation.

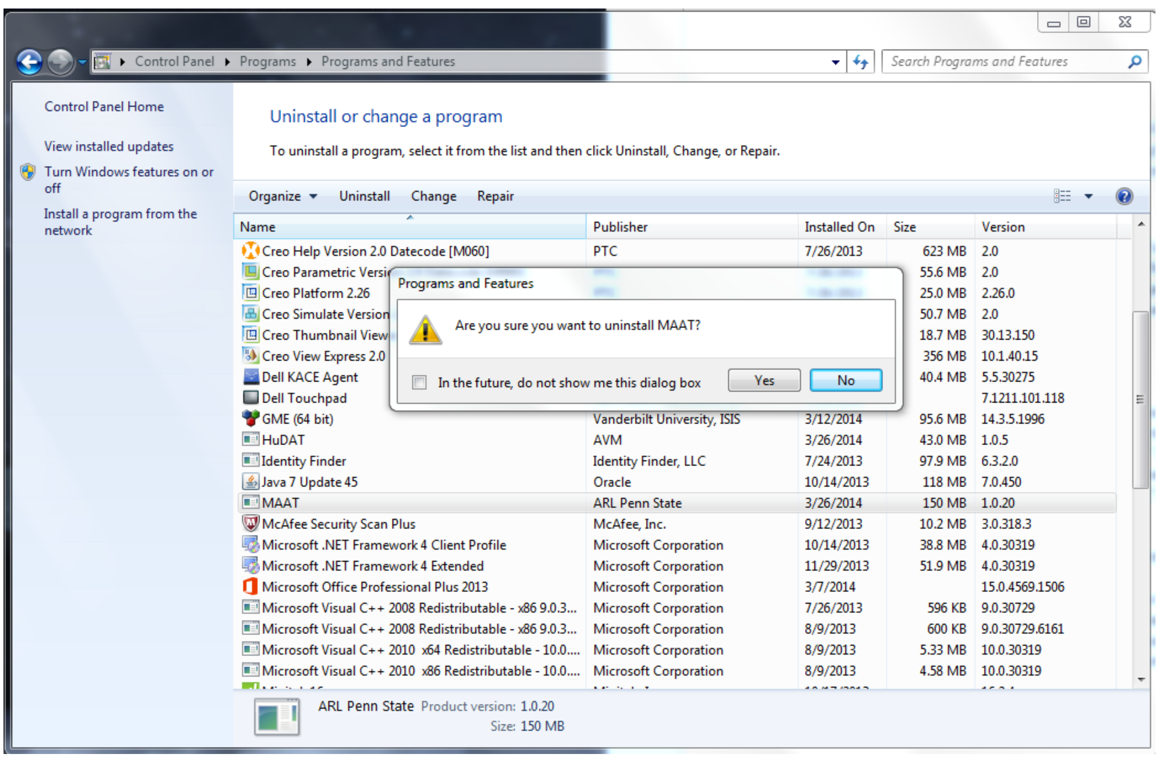

Figure 1: Uninstall any previous versions of the tools

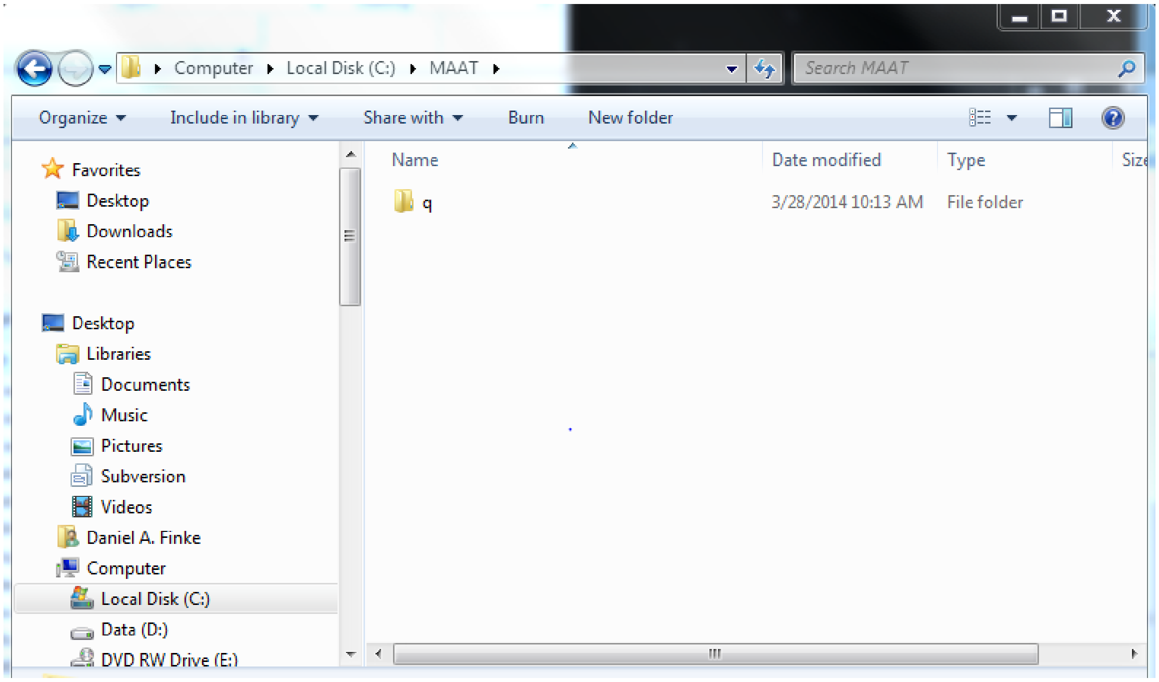

Figure 2: Previous installation directory with extraneous files

Install the MAAT software by executing the HuDAT-MAAT.msi (combined HuDAT MAAT Installer) or the ManufacturingCreoPluginInstaller.msi file, as shown in Figure 3.

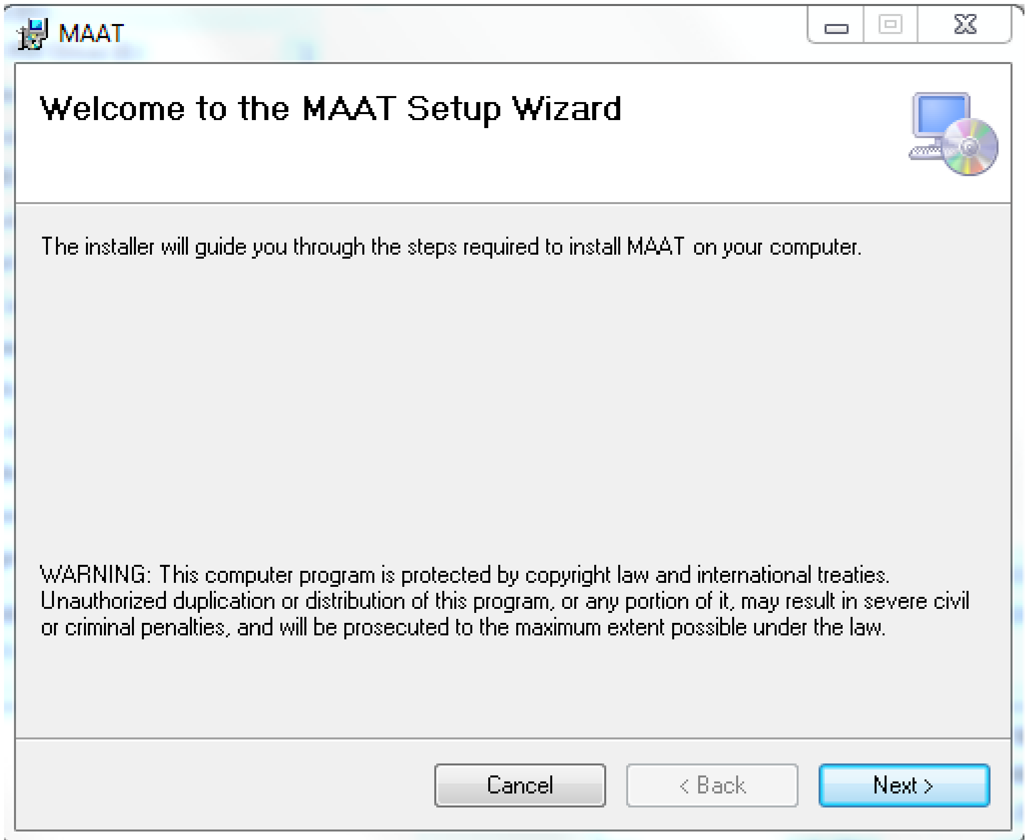

Figure 3: Run ManufacturingCreoPluginInstaller.msi

Specify the installation directory (recommended to be one where you have both read and write access), as shown in Figure 4.

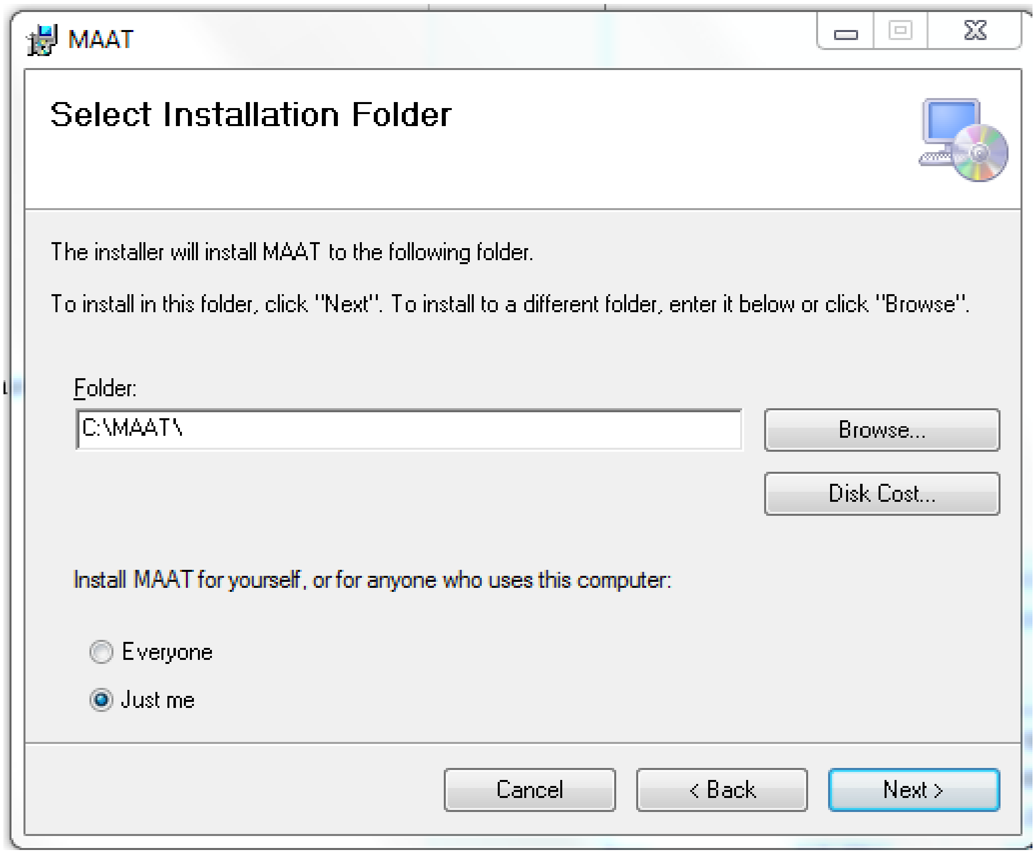

Figure 4: Specify installation directory

The resulting installation directory should look like the one shown in Figure 5.

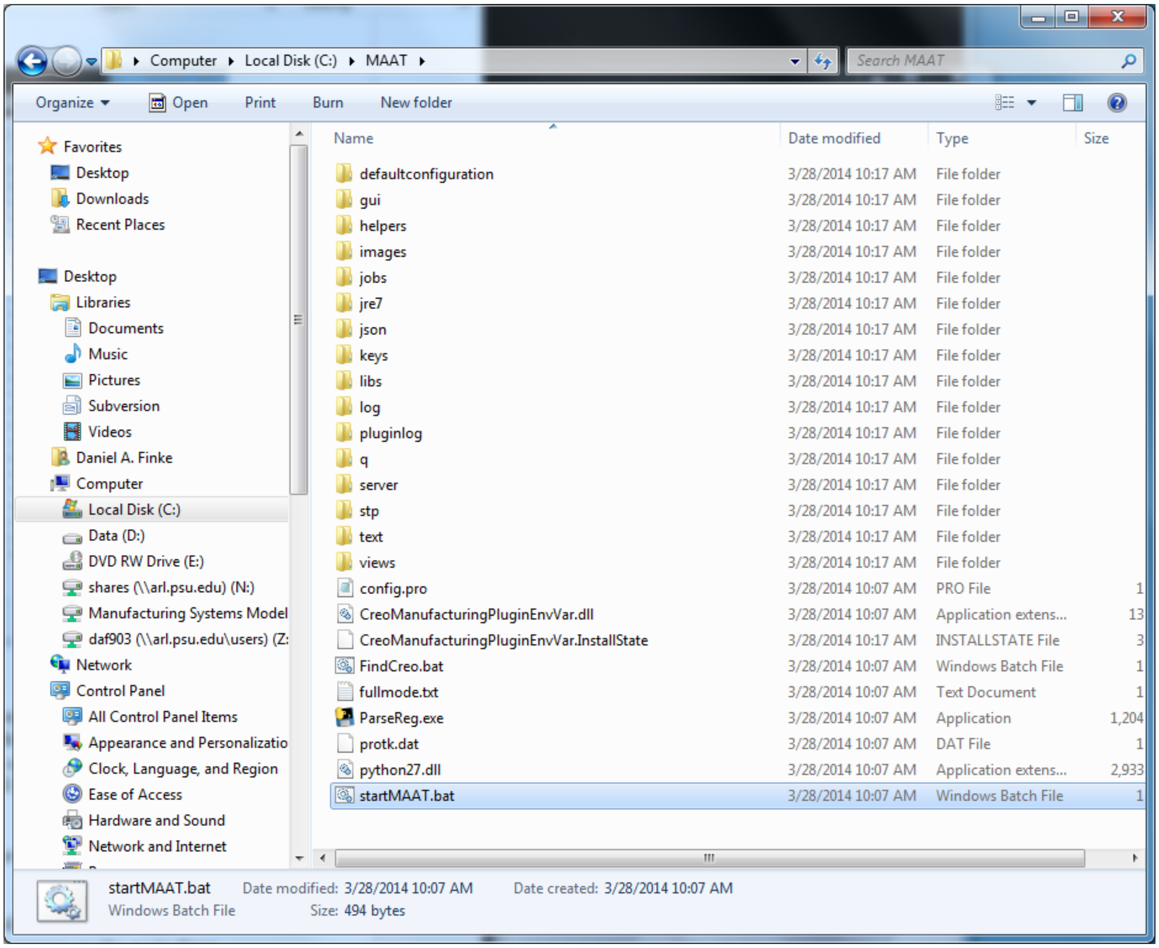

Figure 5: Run startCreoManufacturingPlugin.bat

2.2 Tool Operation

After MAAT has been installed, there are three different ways that it can be loaded into the Creo environment. The first way that the MAAT ribbon will be loaded is by opening a session of Creo through METALINK. METALINK automatically checks if a version of the MAAT software is installed and, if it is, it will load the ribbon.

The second method to launch the MAAT is to run the *startMAAT.bat* file (highlighted in Figure 5). This will do two things:

1. The Creo Parametric 2.0 will be located and Creo will launch as normal.
2. The MAAT plugin will be started and a new tab will appear on the main Creo ribbon upon opening a part or assembly.

The third method to start MAAT is to open Creo Parametric and then enter the Utilities>Auxiliary Application functions.

In the *Auxiliary Applications* you can select Register and select the Protk.dat file that was installed in the MAAT Installation directory ($maat_installdir\protk.dat). When prompted, select “maat” and then select Start to add the plug-ins into the Creo environment.

To begin the manufacturing augmentation data process using the MAAT, open any Creo part or assembly as you normally would, as shown in Figure 6.

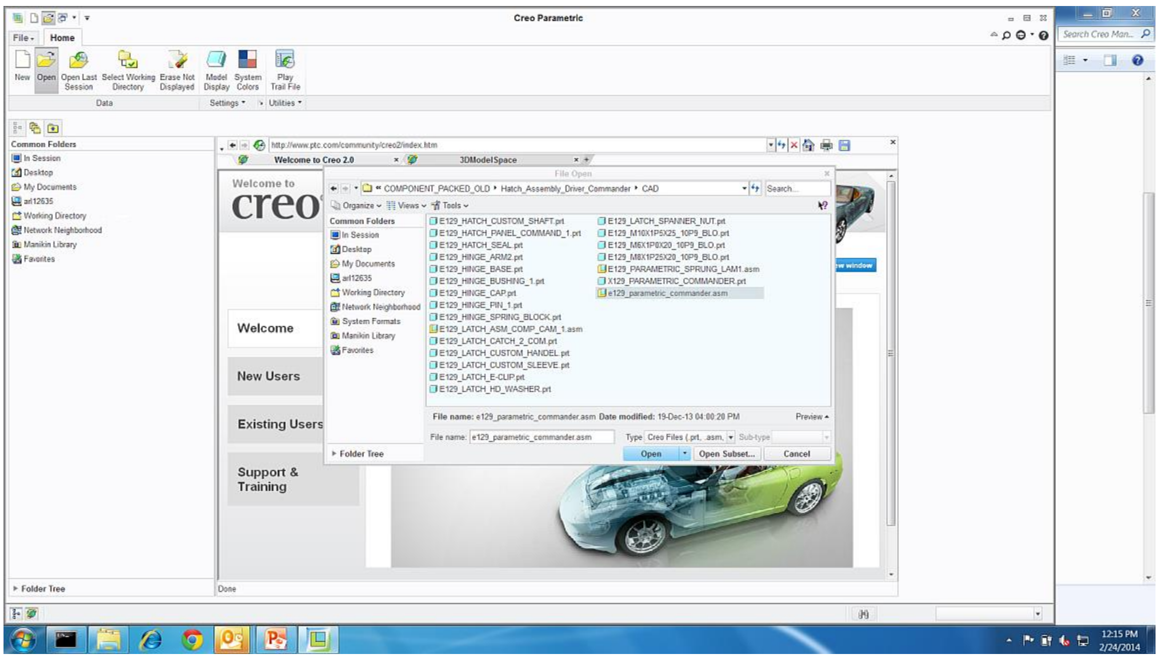

Figure 6: Open a Creo assembly

Once the part or assembly is opened, you will notice the addition of the Manufacturing tab in the main Creo ribbon, as shown in Figure 7. To begin manufacturing data augmentation process, select a part or assembly from the Model Tree and click the Manufacturing Analysis button in the Manufacturing tab (you can alternately right click a part or assembly and select Manufacturing Analysis).

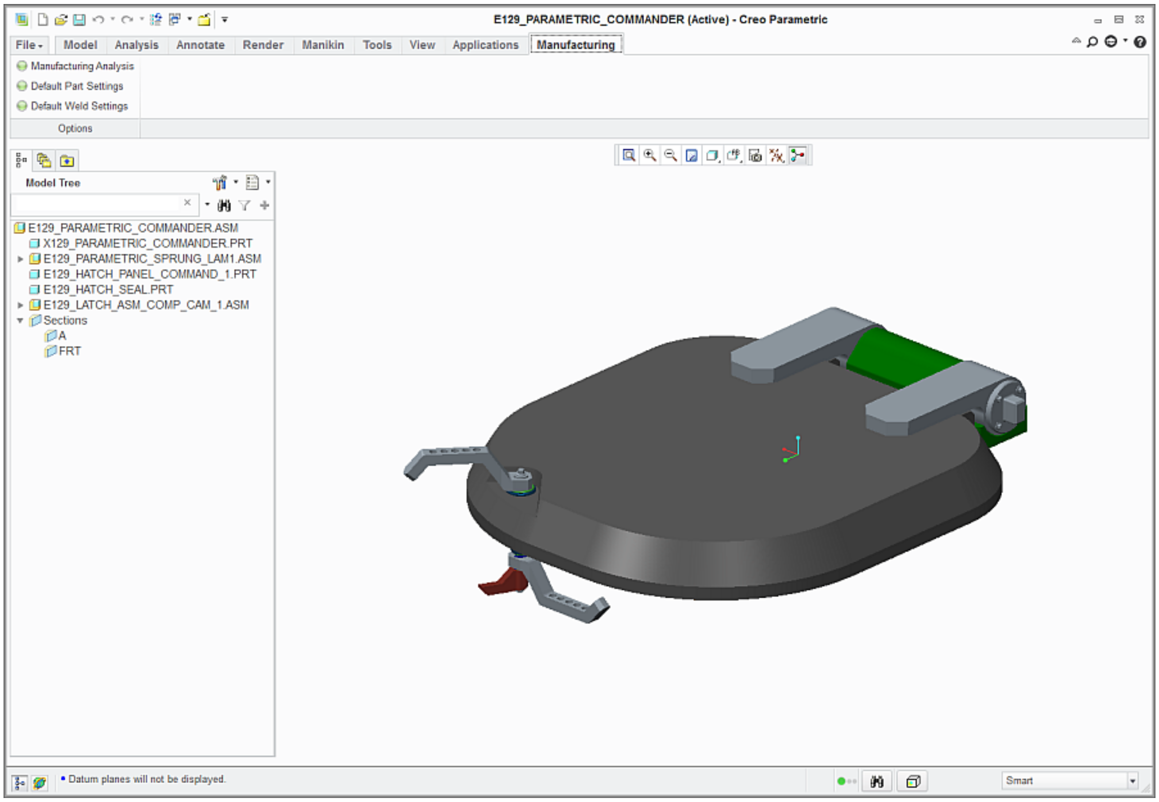

Figure 7: Manufacturing tab appears in main Creo ribbon

You will be initially prompted to provide login credentials. This is to allow for direct submission to the iFAB information architecture for manufacturability assessment feedback. Enter your Gamma VehicleForge credentials and click the Login button, as shown in Figure 8.

> **NOTE:**
> **You must click on the login button to proceed.**

When you do this, the MAAT will analyze the assembly structure, identify the individual piece parts, and determine assembly seams (i.e., physical contacts between parts in the model tree). The main MAAT interface will then appear, as shown in Figure 9.

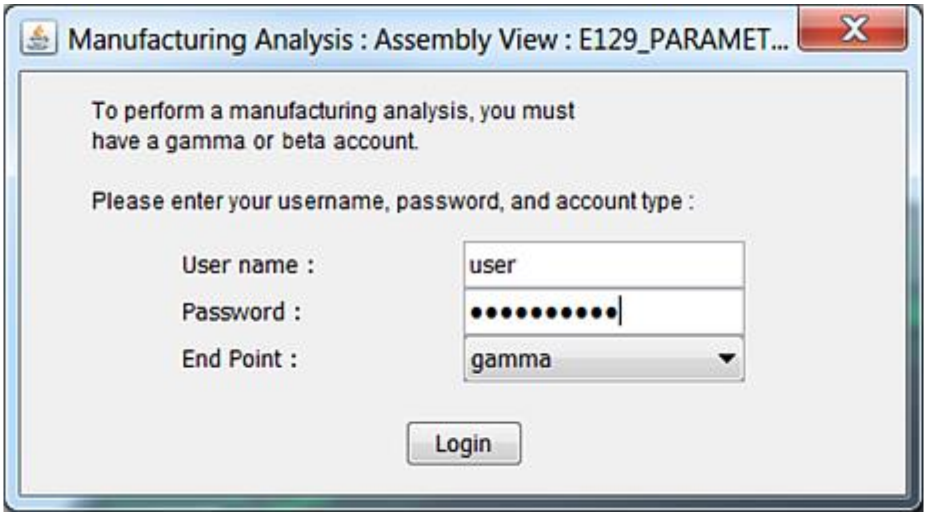

Figure 8: Login for manufacturability assessment submission using VehicleForge credentials

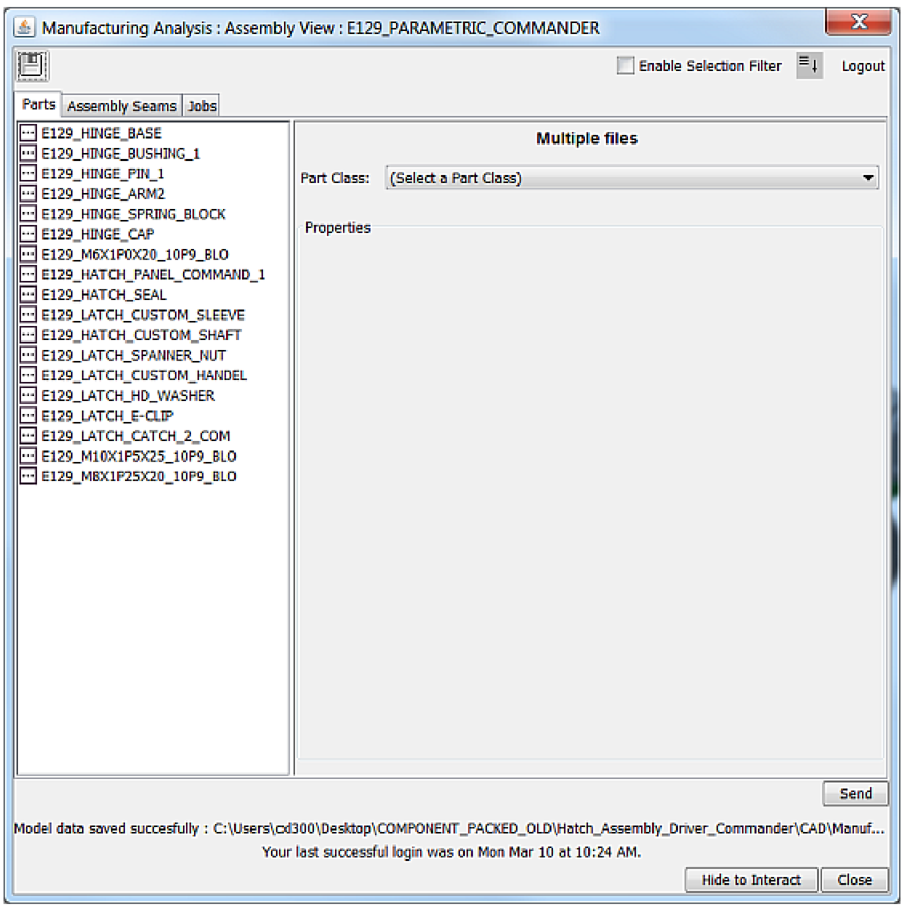

Figure 9: MAAT user interface (example shown for assembly in Creo model tree)

Begin the manufacturing augmentation process for piece parts by selecting a proposed manufacturing part class, as shown in Figure 10.

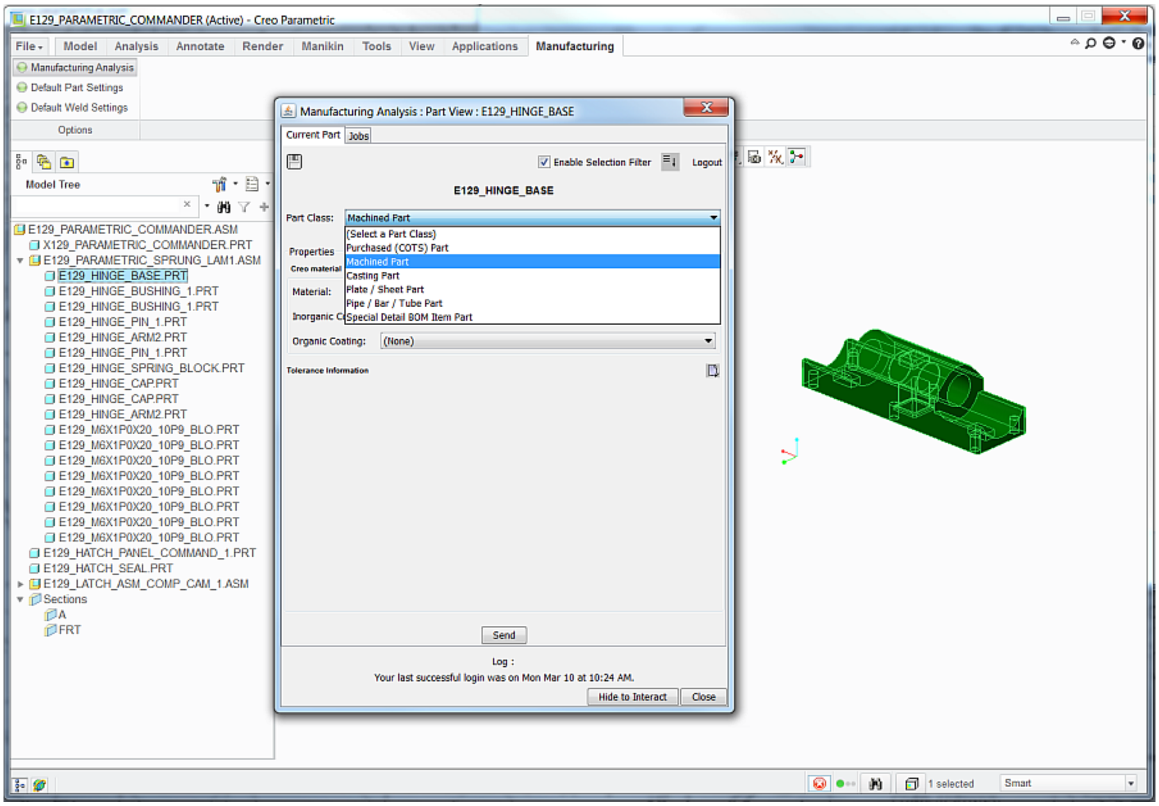

Figure 10: Select Manufacturing Part Class

The next piece of required information is the part material. If a material is present in the Creo part parameters, an attempt will be made to automatically select the MAAT material to match that parameter. Otherwise, the user will be required to select the material based on the procurable materials in the iFAB information system. Material selection is displayed in Figure 11, where the Creo material parameter "steel_stainless_316_l" is mapped to the Stainless Steel 316 material selection in the MAAT.

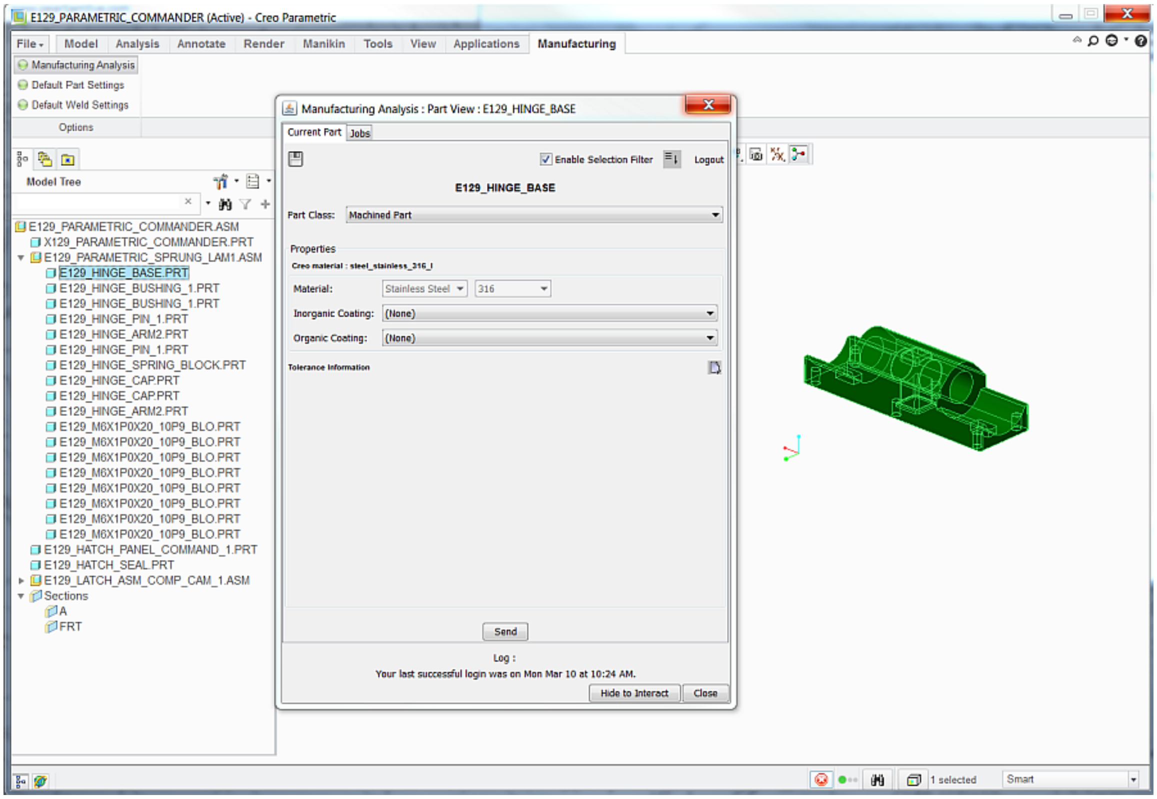

Figure 11: Material selection in MAAT for piece part data augmentation

Expand the tolerance/surface finish details to modify default-selected values, as shown in Figure 12.

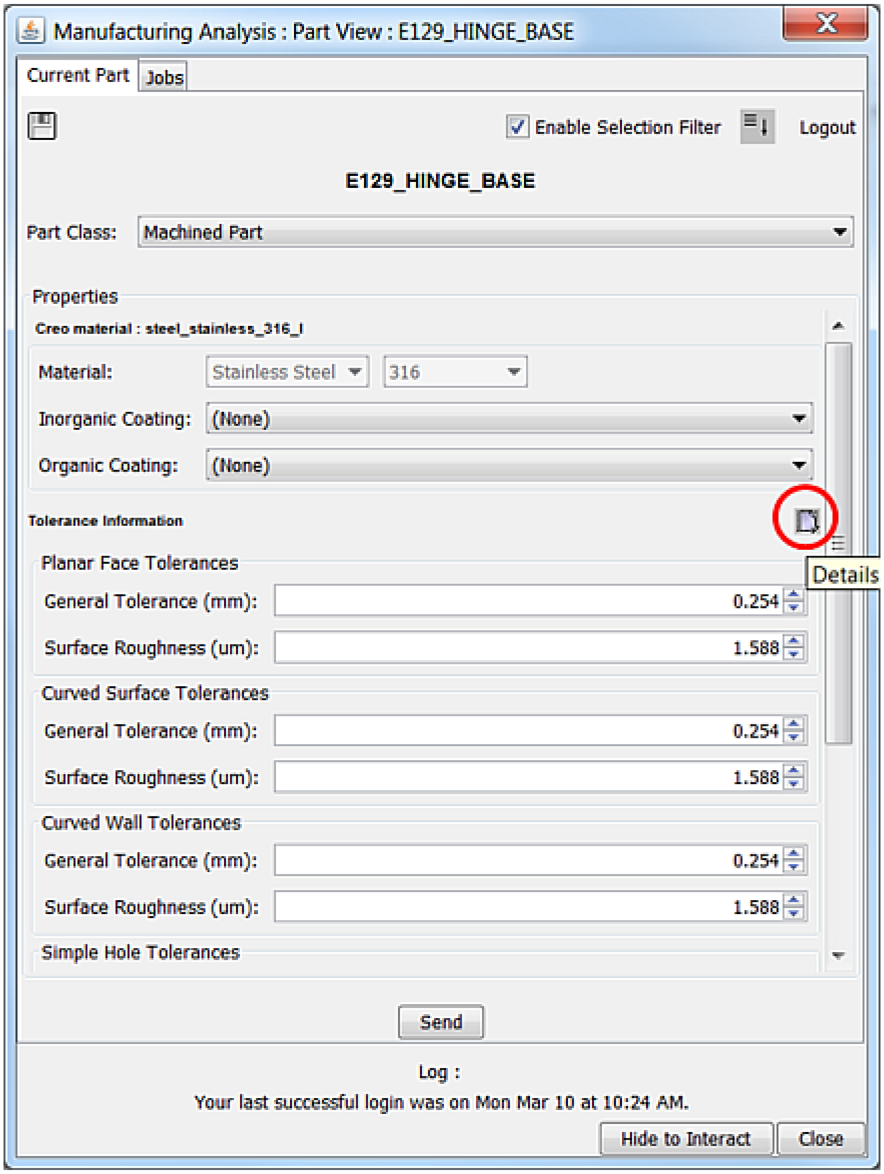

Figure 12: Tolerance, surface finish, and threading details

The remaining parts in the assembly can be viewed or hidden by selecting the "Enable Selection Filter" option at the top of the MAAT interface.

When the data augmentation process is completed, the user can save the information by clicking the save button at the top of the MAAT interface, as shown in Figure 13. This will generate a "Manufacturing" Windows directory at the same level as the CAD part and save an XML file that embeds the manufacturing data.

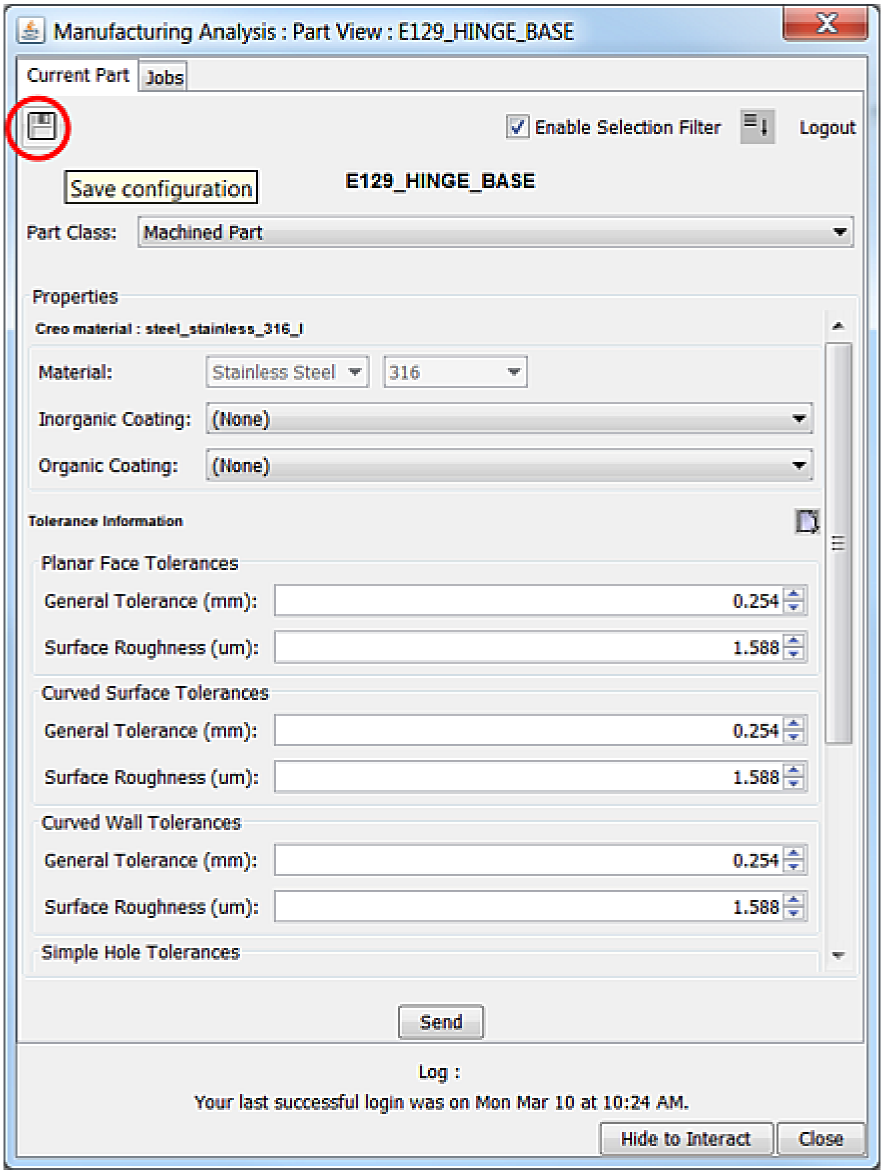

Figure 13: Saving manufacturing data (xml)

Manufacturing data augmentation for assemblies involves the definition of assembly seams. Assembly seams will appear in a separate tab in the MAAT interface when selecting Manufacturing Analysis for an assembly in the Creo model tree, as shown in Figure 14.

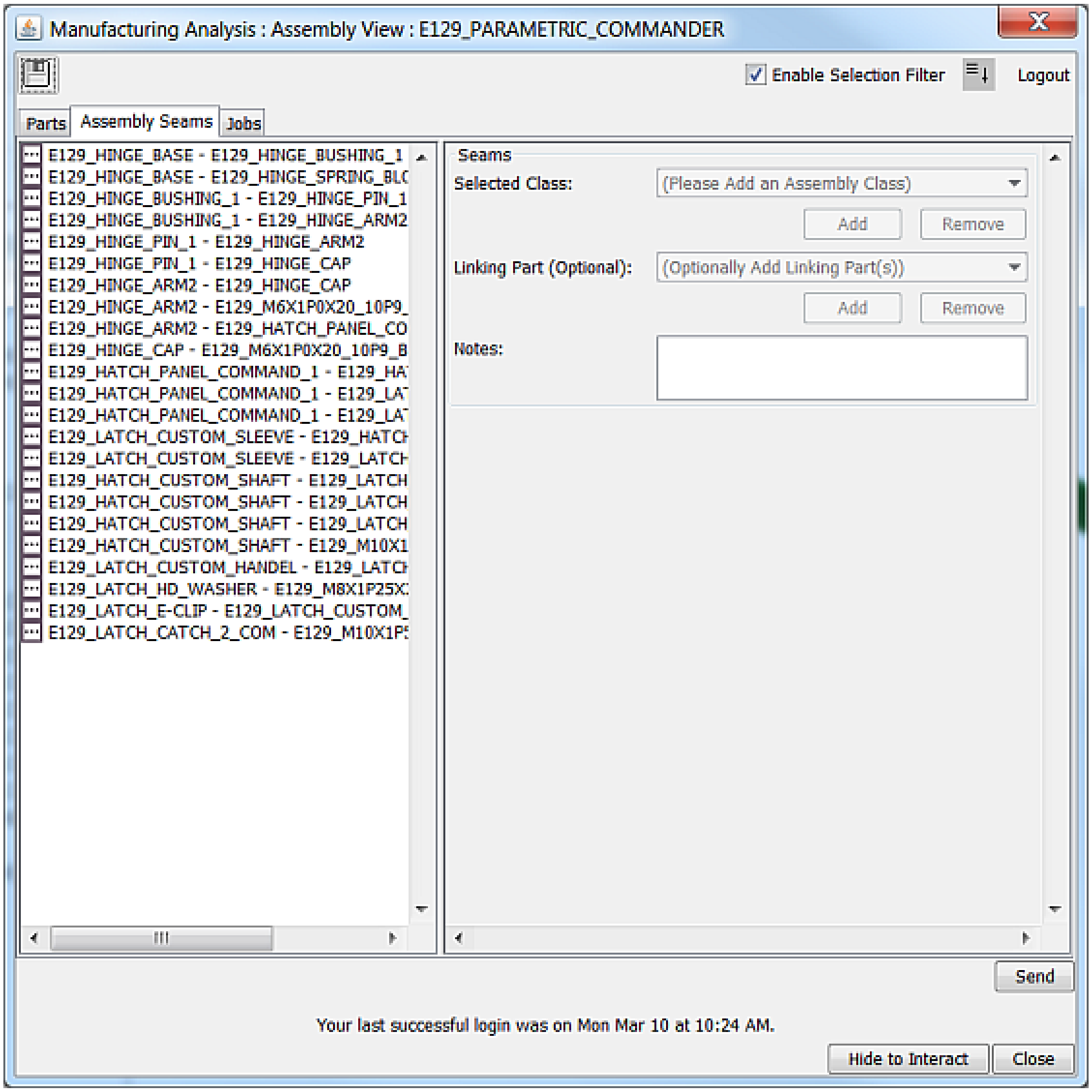

Figure 14: Assembly seams listed in the MAAT interface

Begin the assembly seam definition by clicking the Add button under (Please Add an Assembly Class), and selecting from one of the available assembly classes, as shown in Figure 15. A completed Mechanically Fastened seam definition is shown in Figure 16, where the Fastening Method ("Bolted (Blind)"), Fastener Quantity (4), and Torque Requirement (36 Nm) are specified. Also shown in Figure 16 is the selection of the linking parts for that seam. Linking parts are those BOM items that are needed to complete the assembly process (e.g., fasteners, clamps, etc.). In the example shown in Figure 16, a hex cap screw is selected as the linking part for the seam.

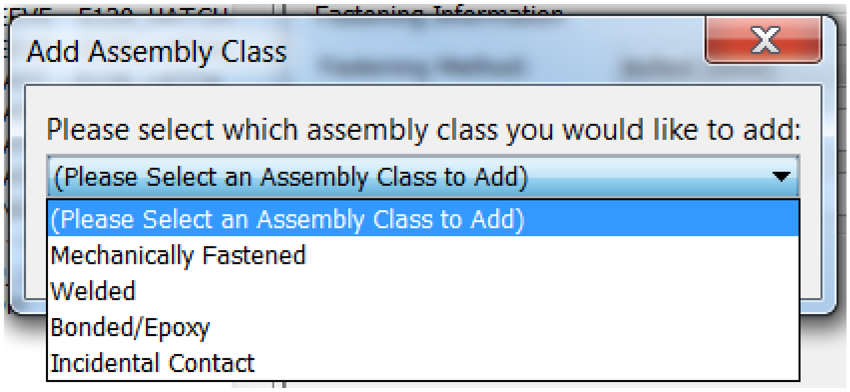

Figure 15: Assembly seam class selection

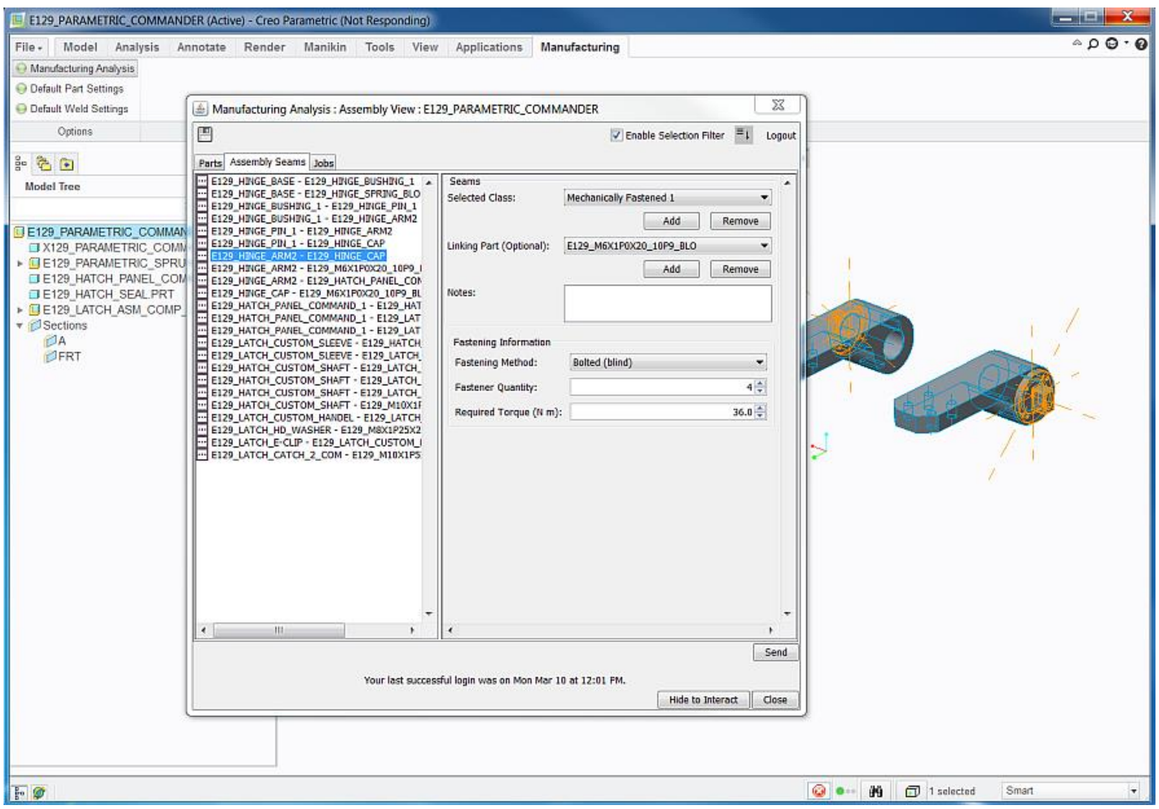

Figure 16: Adding assembly class specification (example shows Mechanically Fastened)

The majority of assembly seams requiring definition will be in the Mechanically Fastened and Welded classes. Figure 17 displays the data requirements for a welded seam in the MAAT.

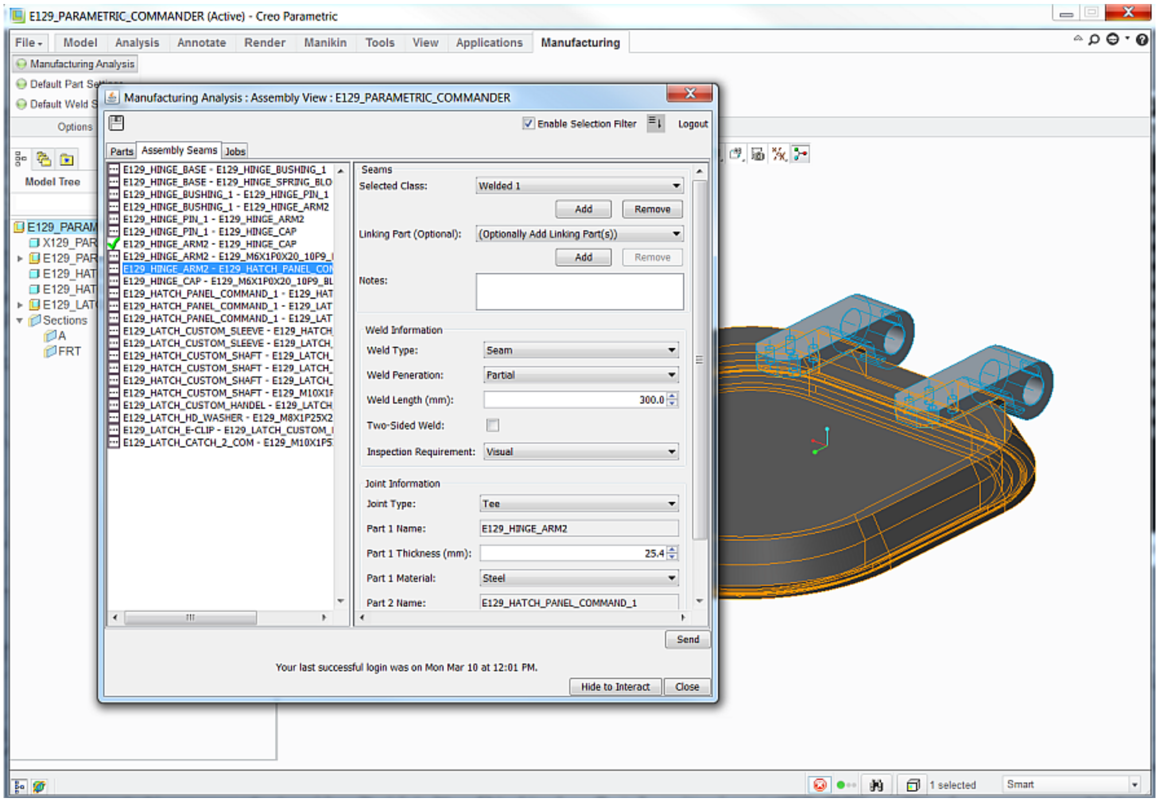

Figure 17: Specifying welded assembly information

There are cases when an assembly seam is detected, but there is really no joint mechanism that needs to be defined. For instance, a part may be in in contact with another part but the parts are not fastened, welded, or bonded to each other. We refer to these as Incidental seams, which can be selected when adding the assembly class (as shown in Figure 18).

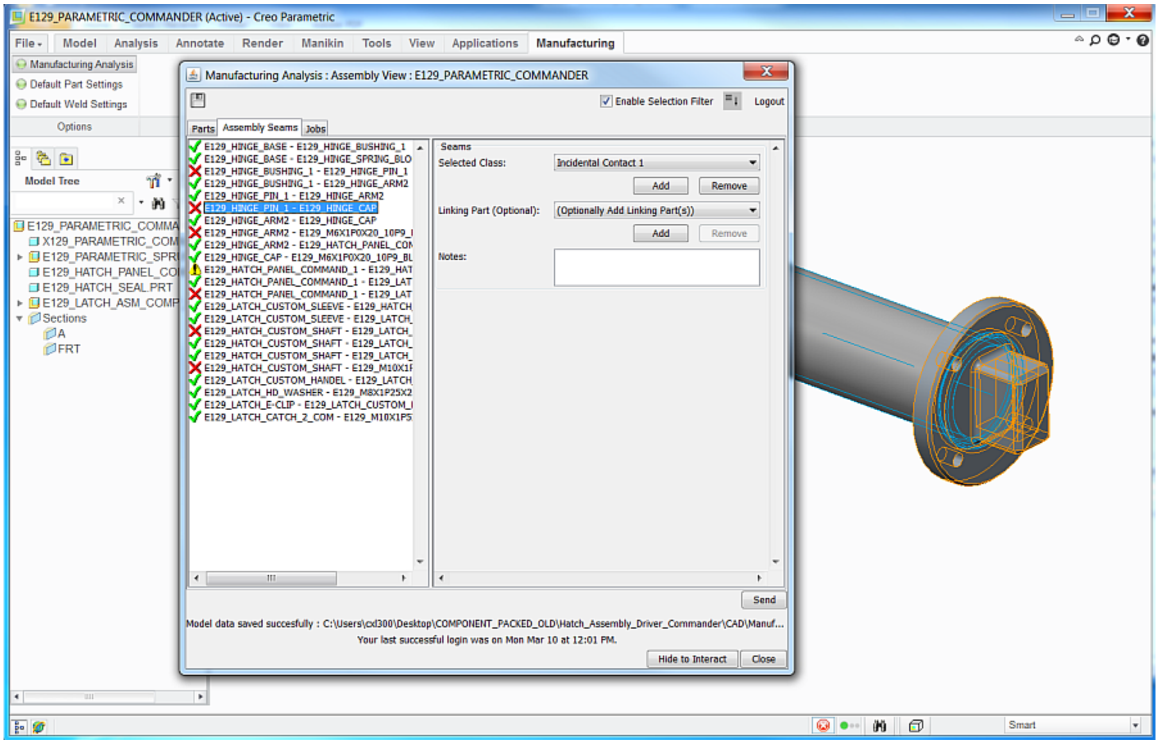

Figure 18: Incidental assembly seam definition

When parts or assembly seams are fully specified in the MAAT, a green check mark will appear in the list window. Parts or seams that are partially defined and require additional information will be specified by a yellow caution icon. Finally, incidental seams will be highlighted by red X's in the list window. This is shown for a list of assembly seams in Figure 18.

Once a part or assembly is fully defined with the required manufacturing data, it can be saved to generate the resulting manufacturing models (as shown in Figure 13). The design can then be submitted to the iFAB manufacturability assessment testbench for feedback directly from the MAAT by pressing the Send button, as displayed in Figure 19. You will also be prompted to provide a input note for the submission.

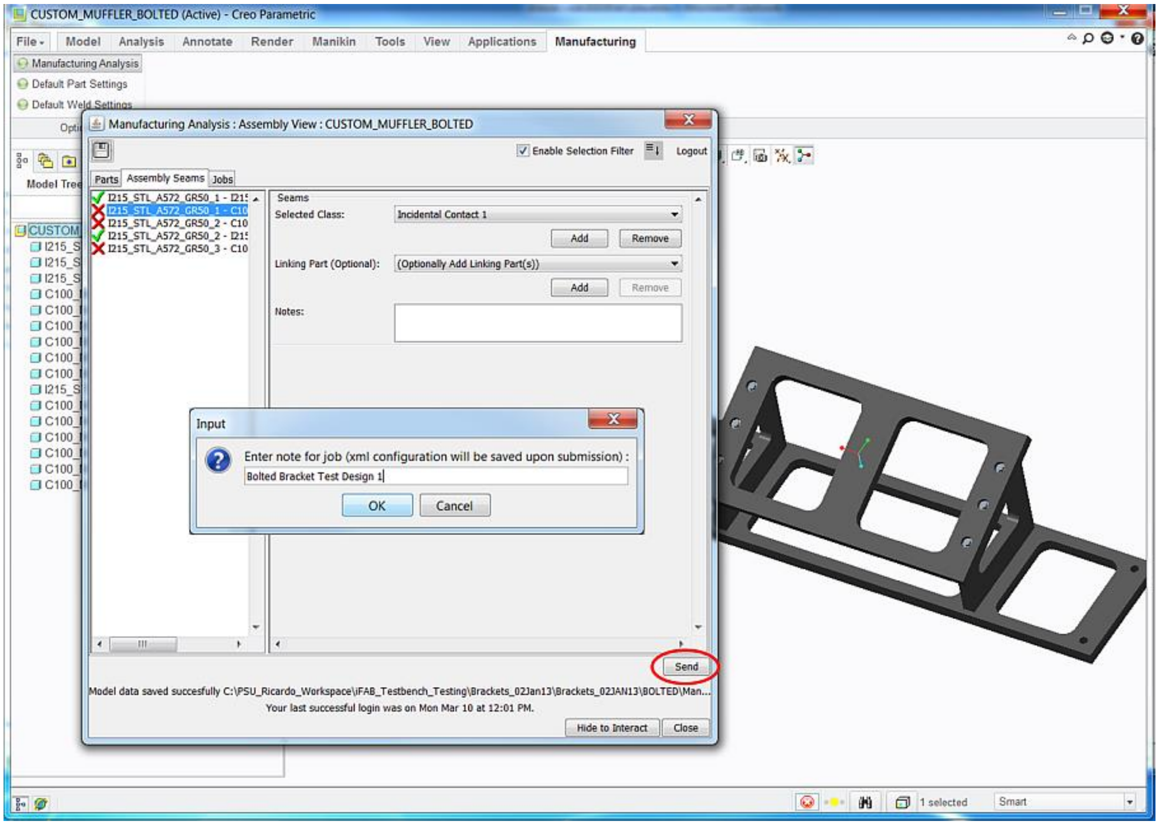

Figure 19: Manufacturability analysis submission directly from the MAAT

Once a job is submitted, you can select the Jobs tab in the MAAT to monitor the progress of that design submission. Once the manufacturability analysis for the job is completed, the resulting manufacturability details will be displayed for the submission, as shown in Figure 20.

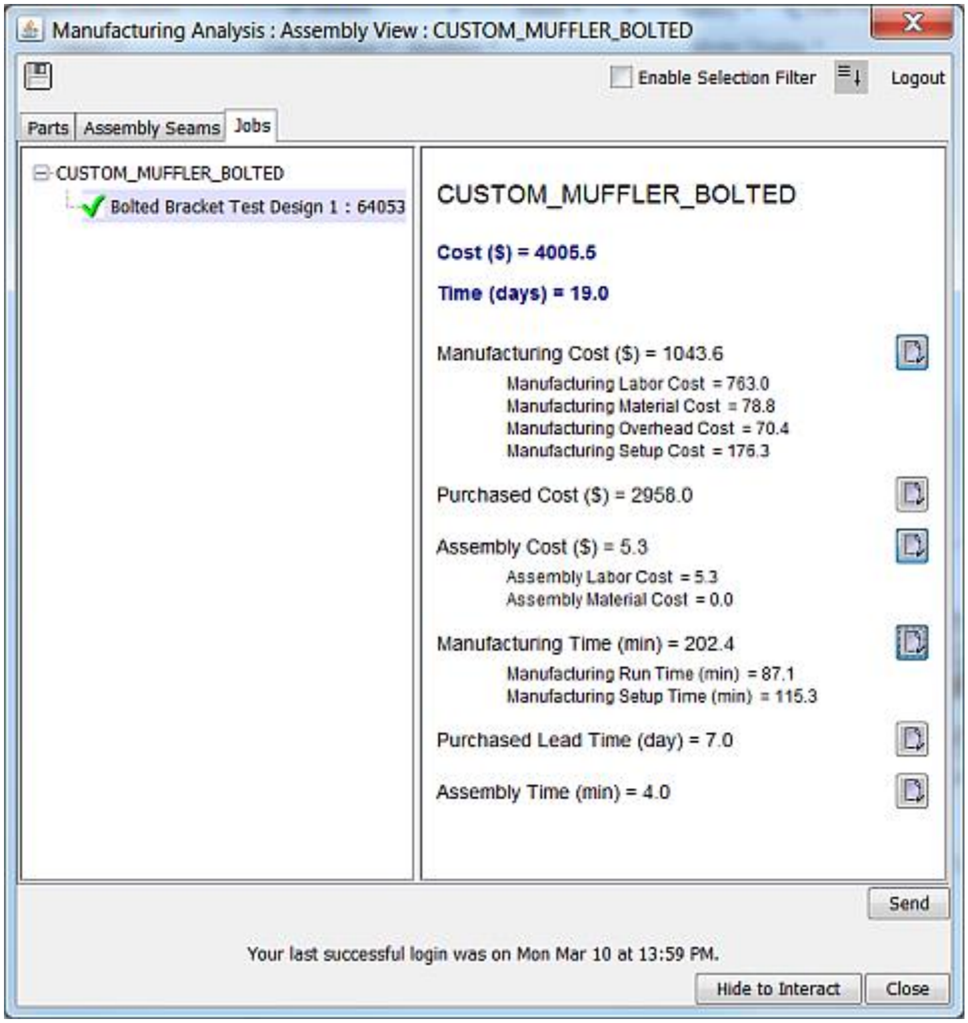

Figure 20: Manufacturability analysis feedback in the MAAT

2.3 Manufacturability Assessment

The Detailed Manufacturability Analysis Tool is used by the designer to analyze the design for cost, lead time, and manufacturing feasibility. The MAAT will display the information resulting from the detailed analysis.

2.4 AVM Toolchain Integration

The Manufacturing Analysis Augmentation Tool (MAAT) is used to create content for a custom manufactured component which can be integrated into an AVM component using the MetaLink and the Component Authoring Tool. This section describes the process of using the MAAT generated data to create a CyPhy component for use in your system design.

Step 1: Design Setup

Begin the design of the bracket or custom component in Creo. It is suggested that you start with a file structure as shown in Figure 21.

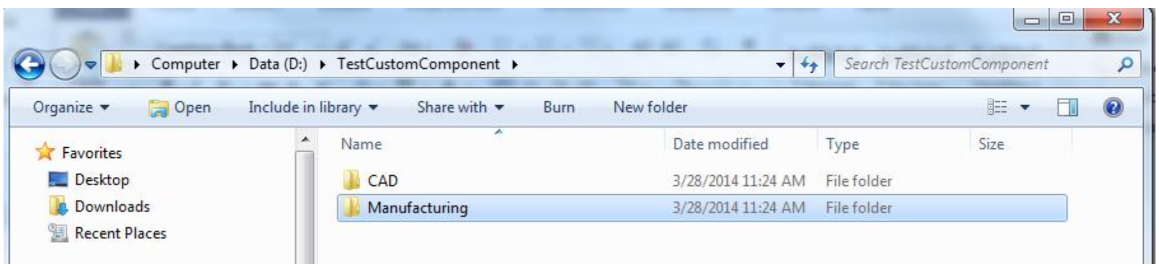

Figure 21: Starting File Structure for Custom Component

Use the CAD folder as the working directory for your Creo models. MAAT will create and place .xml files in the Manufacturing folder.

Step 2: Instantiate a Component Via MetaLink

In GME, use the MetaLink function to open a blank component in Creo. This process is the same as described in the Custom Hull Creation process. Once in Creo, open the Creo design located in the working directory.

Step 3: Use MAAT to Create Manufacturing Information

Use the MAAT functionality to iterate on your design for cost and lead time. Once you are satisfied with the design, click the Create New Component in CyPhy button as shown in Figure 22.

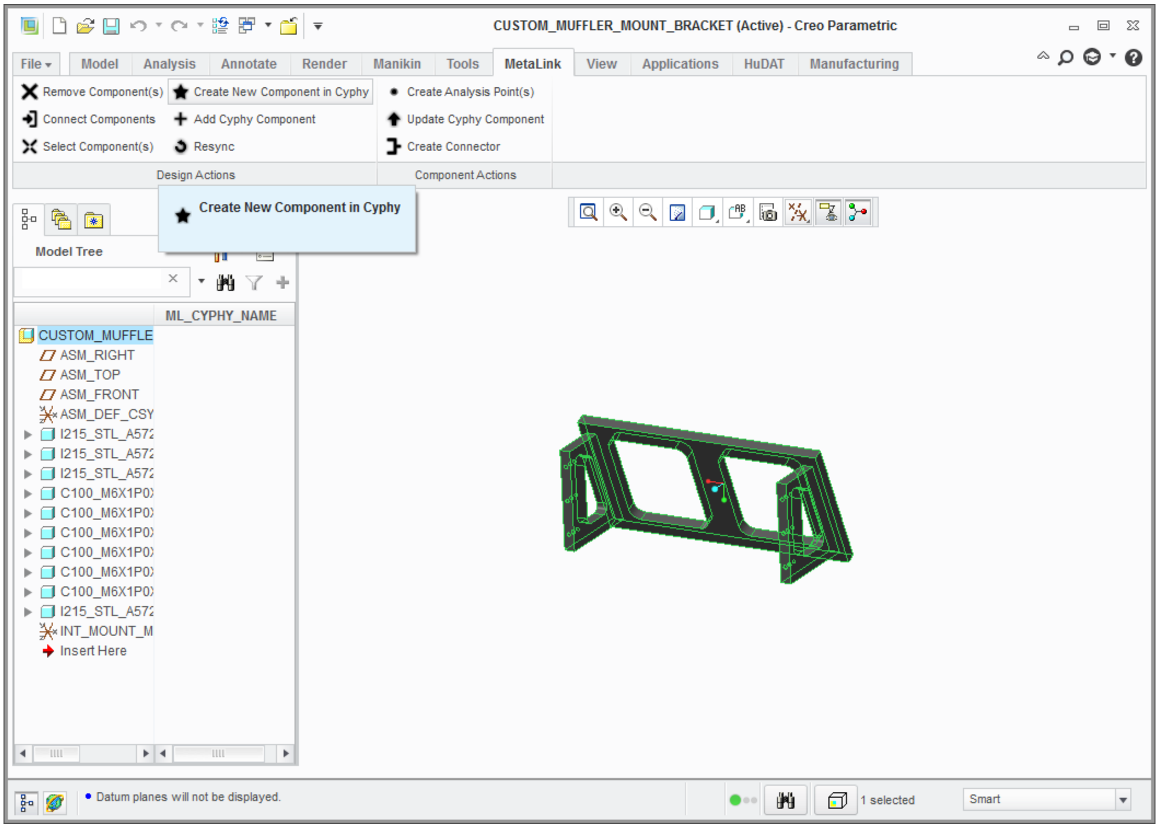

Figure 22: Porting Custom Design to CyPhy (GME)

You will be prompted to enter a name of the design as shown in Figure 23.

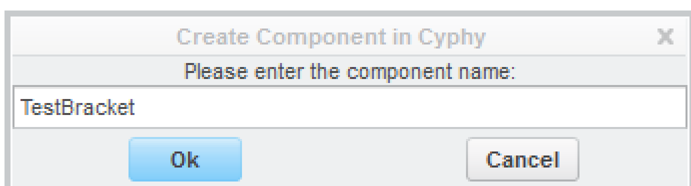

Figure 23: Name the New Component

The new component will appear in the Imported_Components folder in your GME session. Your view should look similar to Figure 24.

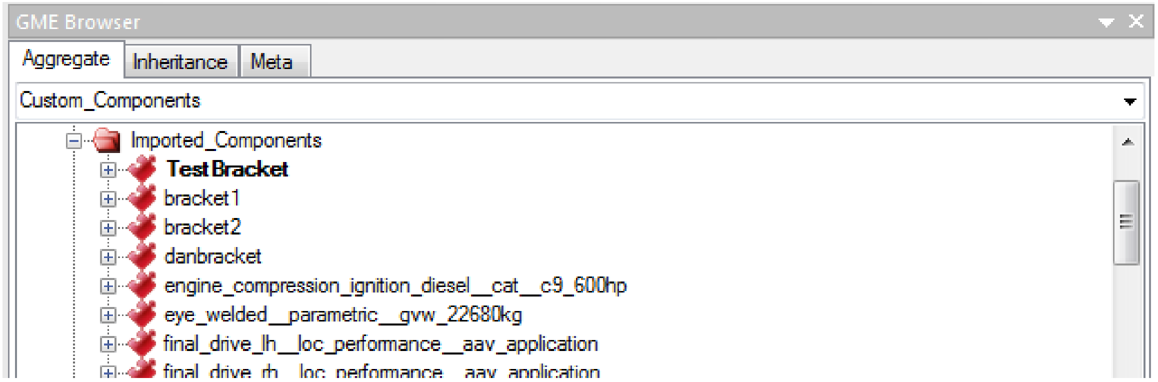

Figure 24: New Component Appears in Imported Components Folder

Step 4: Associate the Manufacturing Model with the CAD Model

At this point, the manufacturing model needs to be associated with the CAD model to form a complete AVM component. Start by double clicking on the new component. The view of the example component appears as shown in Figure 25.

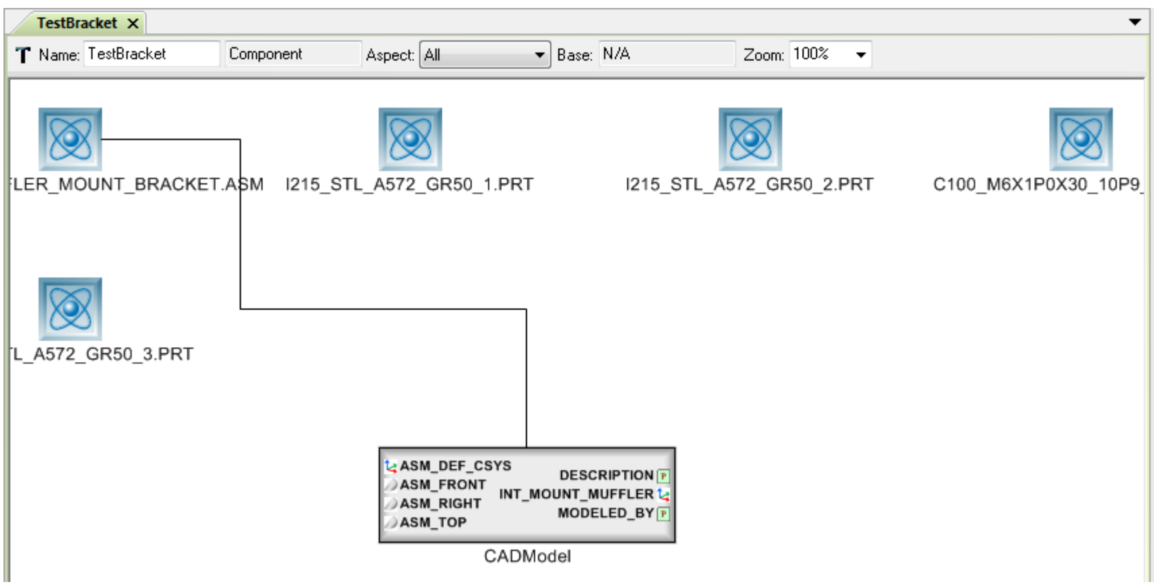

Figure 25: Detailed View of Component

There are two methods to associating the manufacturing model to the component:

1. Using the Component Authoring Tool
2. Manually assigning the model.

Using the Component Authoring Tool method, select the puzzle piece button, highlighted in Figure 26.

Figure 26: Component Authoring Tool Button

This will bring up the tool and mimic the image in Figure 27.

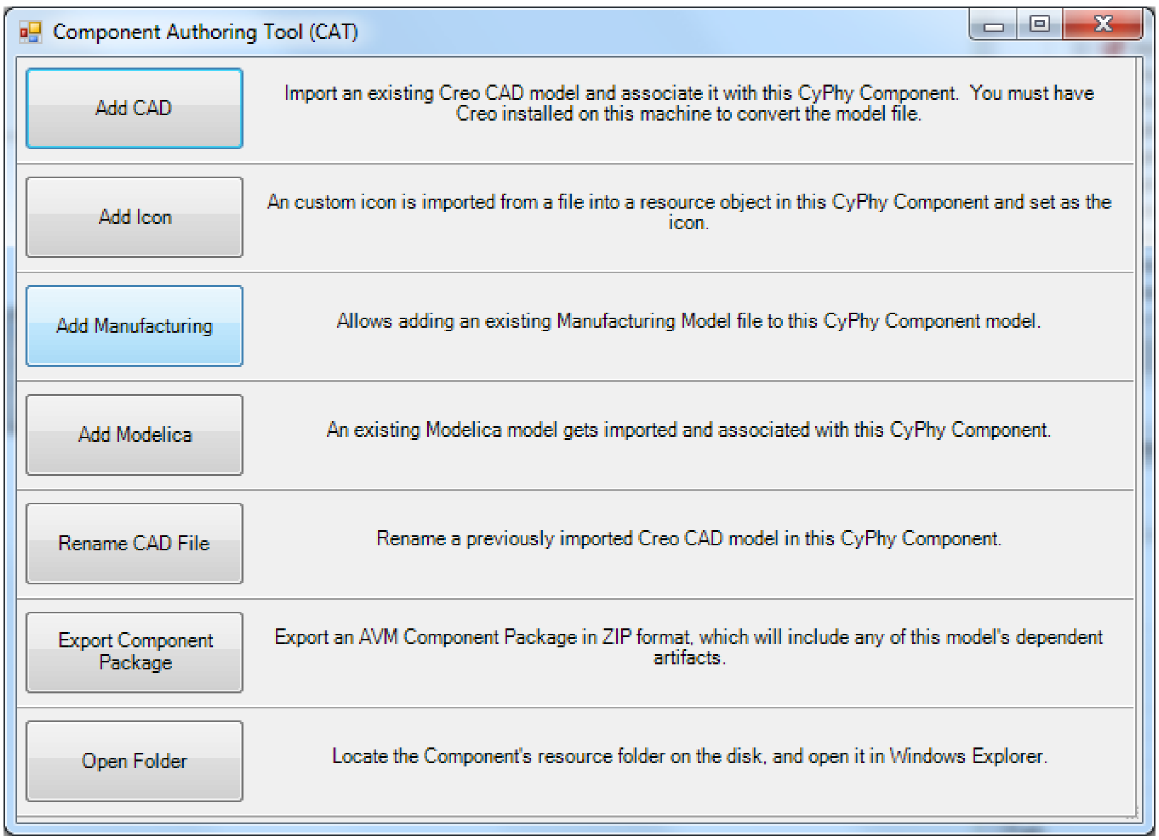

Figure 27: Component Authoring Tool

Select the 'Add Manufacturing' button. A file selector will appear and request that you select the manufacturing model. Figure 28 shows the options to select the manufacturing model. If you are creating an assembly, the eBOM.xml file is used for the manufacturing model. If you are creating a single part component the manufacturing model will be 'part_name.xml'.

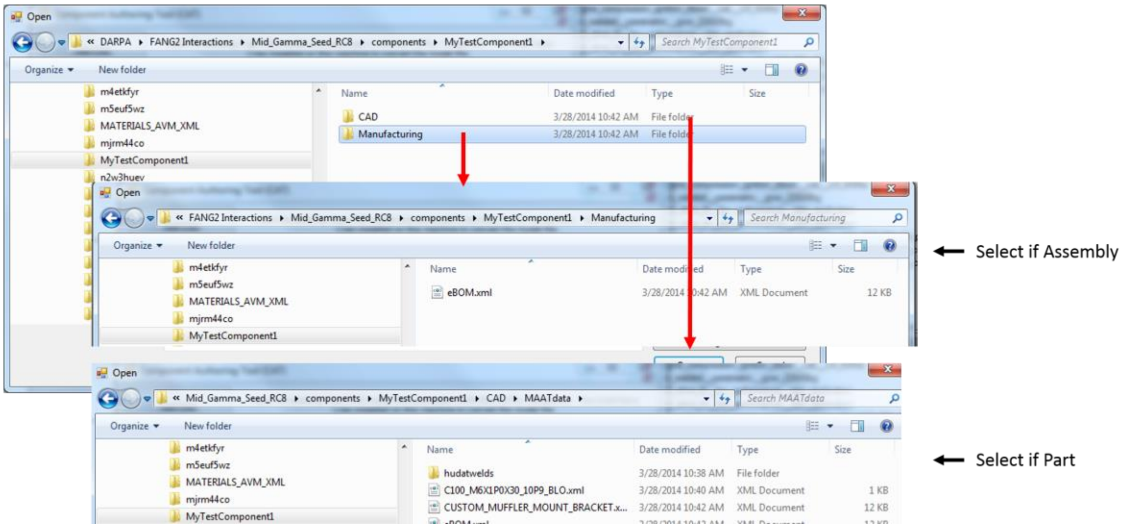

Figure 28: Selection of Manufacturing Model

Once the manufacturing model is selected the component will be updated to include the link and look similar to the image in Figure 29.

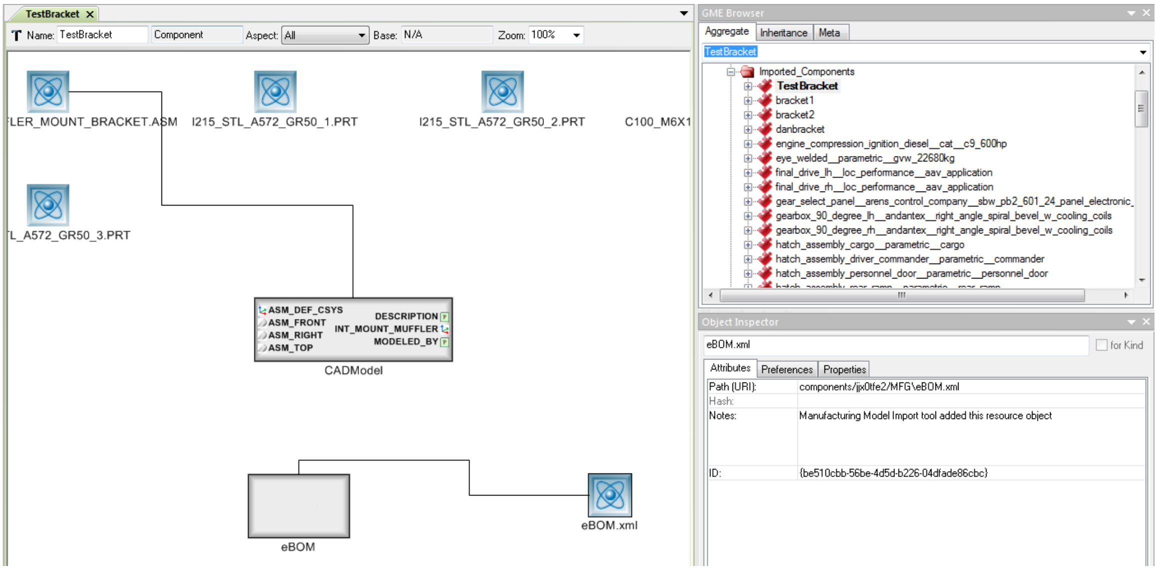

Figure 29: Updated Component with Manufacturing Data

There is currently a bug in the system that adds extra information to the file path in the GME browser. For this release, please modify the Path(URI) information that will initially look like that in Figure 30 to the file path shown in Figure 31.

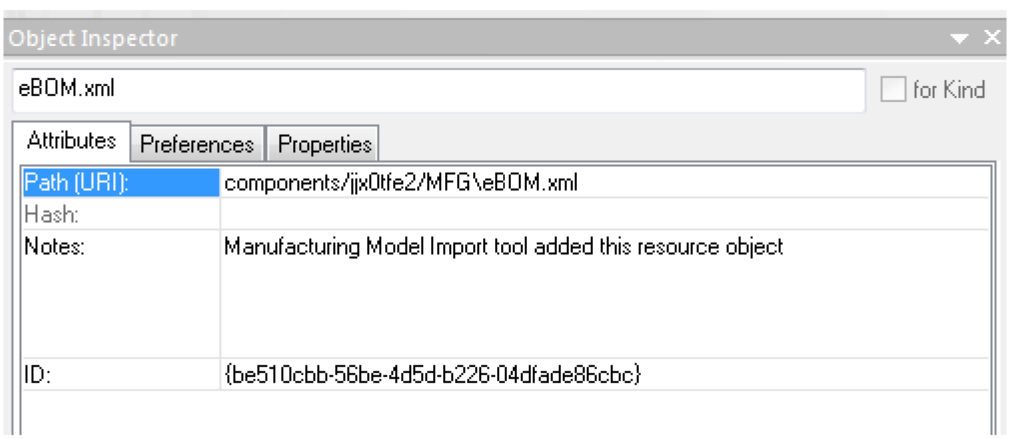

Figure 30: Filepath to Manufacturing Model Location - Bug.

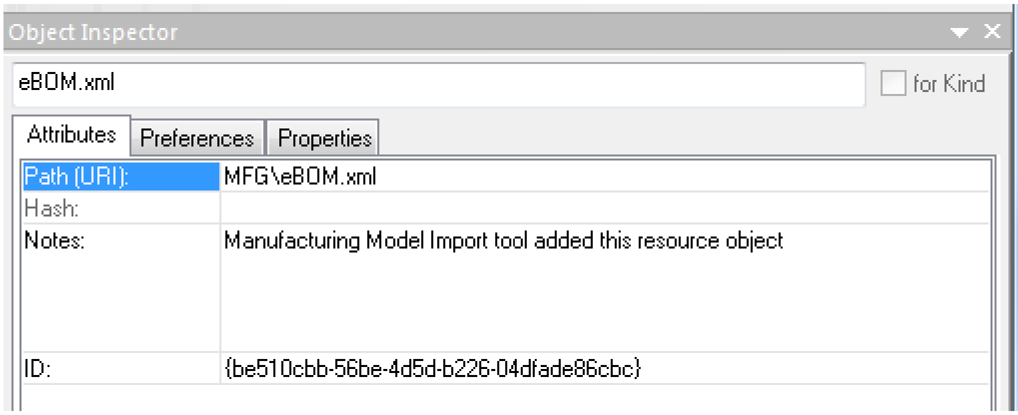

Figure 31: Modification to Filepath

Alternatively, you can define the manufacturing model without using the Component Authoring Tool by following these steps.

1. Place the manufacturing xml file associated with the part in this component's “Manufacturing” folder. Examples of the manufacturing models are shown in Appendix A.
2. Create a ManufacturingModel block. Leave all attributes for this part blank.
3. Create a Resource block and connect it 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). For example: If the manufacturing xml is located at "\components\Engine\Manufacturing\<xml>", the Path (URI) would be "Manufacturing\<xml>".
4. At this point the component is complete and can be used in your design. It should be noted that this is a single component in CyPhy, but will be treated as an assembly in the Detailed Manufacturability Test Bench.

Appendix A: Manufacturing Model Examples

Purchased Part Example


```xml
<?xml version="1.0" encoding="UTF-8"?>

<part uuid="130eb4b9-3d37-41e8-bccd-8207ba773afc">
  <name>DAMPER</name>
  <length unit="mm">10.82392220292394</length>
  <width unit="mm">34.0000002</width>
  <height unit="mm">10.82392220292394</height>
  <volume unit="mm3">1415.7810285672138</volume>
  <weight unit="kg">0.011113881074252627</weight>
  <file type="STEP">DAMPER.stp</file>
  <manufacturingDetails>
    <purchased>
      <notes>none</notes>
      <NSN></NSN>
      <supplier>
        <CAGEIdentifier>
          <CAGECode>
            <code>N/A</code>
          </CAGECode>
        </CAGEIdentifier>
        <catalogNumber>3692K15</catalogNumber>
        <componentInfo>N/A</componentInfo>
        <FOB>Origin</FOB>
        <leadTime>2.0</leadTime>
        <leadTimeBasis></leadTimeBasis>
        <leadTimeUncertainty>0.0</leadTimeUncertainty>
        <packaging>Box</packaging>
        <partDescription>Damper Part</partDescription>
        <paymentTerms>30</paymentTerms>
        <price>34.71</price>
        <quantity>1</quantity>
        <shipmentDimensions>{0.05,0.05,0.05}</shipmentDimensions>
        <shippingMass>1.0</shippingMass>
        <shippingPointAddress>600 N. County Line Road, Elmhurst, IL 60126-2081</shippingPointAddress>
        <transportationNeeds/>
        <unitOfIssue>1</unitOfIssue>
      </supplier>
    </purchased>
  </manufacturingDetails>
</part>
```

Plate-Sheet Example


```xml
<?xml version="1.0" encoding="UTF-8"?>

<part uuid="69748e49-7174-47a5-a4c1-059258dffab5">
  <name>I215_STL_A572_GR50_1</name>
  <length unit="mm">700.0000002</length>
  <width unit="mm">163.5000002</width>
  <height unit="mm">15.875000200002098</height>
  <volume unit="mm3">744200.7477175256</volume>
  <weight unit="kg">5.841975869582575</weight>
  <file type="STEP">I215_STL_A572_GR50_1.stp</file>
  <manufacturingDetails>
    <plate>
      <notes></notes>
      <material>
        <carbonSteel>A-572</carbonSteel>
      </material>
      <planarFaces>
        <generalTolerance unit="mm">0.254</generalTolerance>
        <surfaceRoughness unit="mm">0.0015880000000000002</surfaceRoughness>
      </planarFaces>
      <bends>
        <bendAngleTolerance unit="degrees">0.1</bendAngleTolerance>
      </bends>
      <simpleHoles>
        <diametricalTolerance unit="mm">0.127</diametricalTolerance>
        <positionalTolerance unit="mm">0.127</positionalTolerance>
        <surfaceRoughness unit="mm">0.0015880000000000002</surfaceRoughness>
        <threaded>false</threaded>
      </simpleHoles>
      <complexHoles>
        <generalTolerance unit="mm">0.254</generalTolerance>
        <surfaceRoughness unit="mm">0.0015880000000000002</surfaceRoughness>
      </complexHoles>
      <inorganicCoatings/>
      <organicCoatings>
        <organicCoating>non-CARC</organicCoating>
      </organicCoatings>
    </plate>
  </manufacturingDetails>
</part>
```

Machined Part Example


```xml
<?xml version="1.0" encoding="UTF-8"?>

<part uuid="448de5cc-d9d4-42a5-8481-0005da612c3a">
  <name>STEEL_MASS</name>
  <length unit="mm">50.0000002</length>
  <width unit="mm">12.000000199999999</width>
  <height unit="mm">50.0000002</height>
  <volume unit="mm3">25000.0</volume>
  <weight unit="kg">0.19624999999999998</weight>
  <file type="STEP">STEEL_MASS.stp</file>
  <manufacturingDetails>
    <machined>
      <notes></notes>
      <material>
        <alloySteel>
          <hotRolled>4130</hotRolled>
        </alloySteel>
      </material>
      <planarFaces>
        <generalTolerance unit="mm">0.254</generalTolerance>
        <surfaceRoughness unit="mm">0.0015880000000000002</surfaceRoughness>
      </planarFaces>
      <curvedSurfaces>
        <generalTolerance unit="mm">0.254</generalTolerance>
        <surfaceRoughness unit="mm">0.0015880000000000002</surfaceRoughness>
      </curvedSurfaces>
      <curvedWalls>
        <generalTolerance unit="mm">0.254</generalTolerance>
        <surfaceRoughness unit="mm">0.0015880000000000002</surfaceRoughness>
      </curvedWalls>
      <simpleHoles>
        <diametricalTolerance unit="mm">0.127</diametricalTolerance>
        <positionalTolerance unit="mm">0.127</positionalTolerance>
        <surfaceRoughness unit="mm">0.0015880000000000002</surfaceRoughness>
        <threaded>false</threaded>
      </simpleHoles>
      <inorganicCoatings/>
      <organicCoatings/>
    </machined>
  </manufacturingDetails>
</part>
```

Component Assembly Manufacturing Model Example


```xml
<assembly>
  <name>custom_muffler_bolted_asm</name>
  <unusedParts/>
  <assemblyDetails>
    <assemblyDetail>
      <name>I215_STL_A572_GR50_1 - I215_STL_A572_GR50_2</name>
      <part1 id="e066d588-9d63-4687-ab7b-4892c8738c81">I215_STL_A572_GR50_1</part1>
      <part2 id="92d205a3-df38-4a0a-928c-83dc45f5ab2c">I215_STL_A572_GR50_2</part2>
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