Hull Design Assist Tool

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1.0 Purpose

The purpose of the Hull Design Assist Tool (HuDAT) is to provide the designer with the capability to fully define the hull with the information needed to perform detailed analyses including, blast, ballistics, and manufacturability, in addition to the information needed to manufacture the designed hull. The functions needed to create this information include creating hull plates, internal hull structure, and weld joints.

HuDAT is a plug-in to the Creo CAD tool that provides an additional set of functions and user buttons to help the designer move from a concept level design to a fully detailed design. These added functions are linked to buttons added in two additional ribbons in the Creo environment.

In HuDAT, the hull design process begins with a concept level hull that has been analyzed using CyPhy to determine a suitable length, width, height, configuration, plate thickness, and material type. This concept level hull can be downloaded from Vehicle Forge or imported from the user's machine.

2.0 Procedures

The instructions in this manual assume that the user has a Vehicle Forge (beta.vehicleforge.org) account and has access to the components (hull and others), either on Vehicle Forge or that have been downloaded from Vehicle Forge to the user's local machine.

For BETA testing, the user will install the plug-in, open a hull seed model, check the concept hull model, create detailed plates and ballistic welds. The user will be able to export the hull model with detailed plates and welds in ACM compliant format.

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

Step 1

Uninstall any previous versions of HuDAT (current release version is 0.4.0). The resulting HuDAT installation folder may have files remaining after the uninstall. The user can optionally remove these.

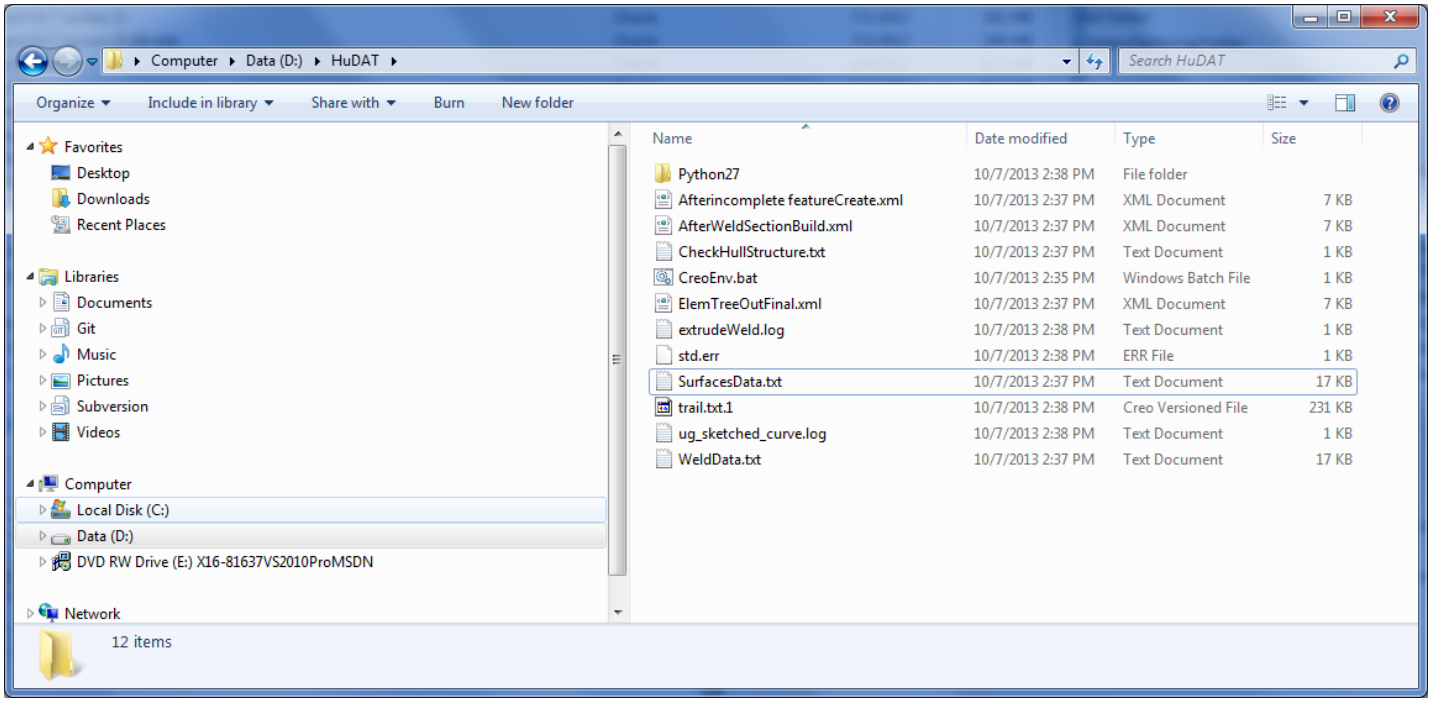
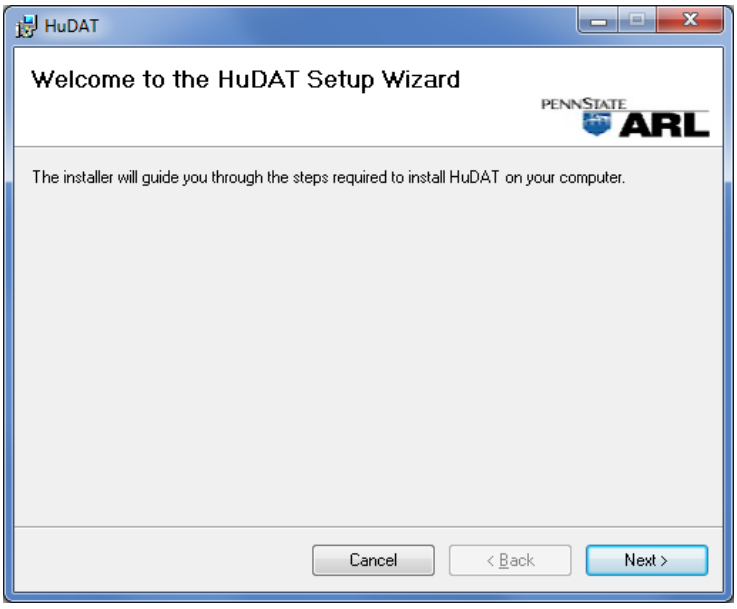


Figure 1: Files that may be left after uninstalling a previous version of HuDAT. The user can optionally delete these files.

Step 2

Start the HuDAT installation executable by double clicking on the DATInstaller.msi file. The installer includes a license agreement and installation path page. It will notify you once the installation is successful. The environment variable $hudat_installdir is set to the chosen installation path.



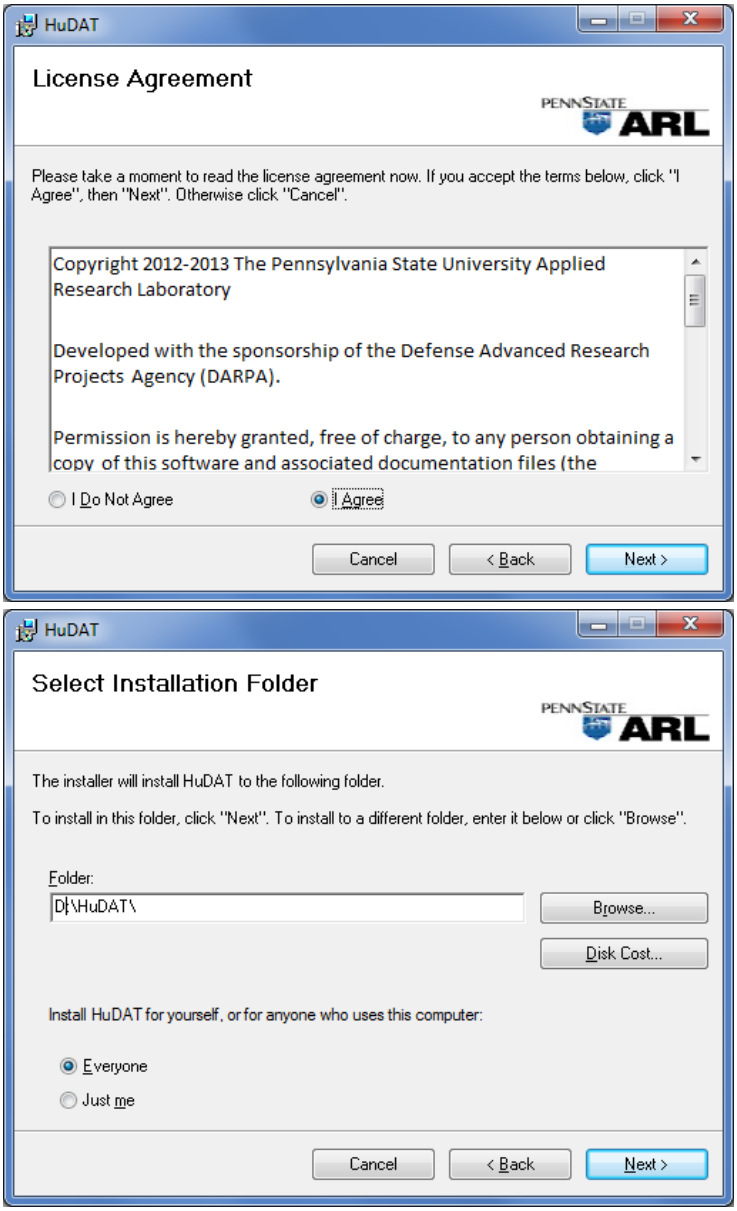


Figure 2: Windows included in the HuDAT installation wizard.

Section 2.2 describes how to launch CREO and start HuDAT. The HuDAT ribbon should look like the image in Figure 3.

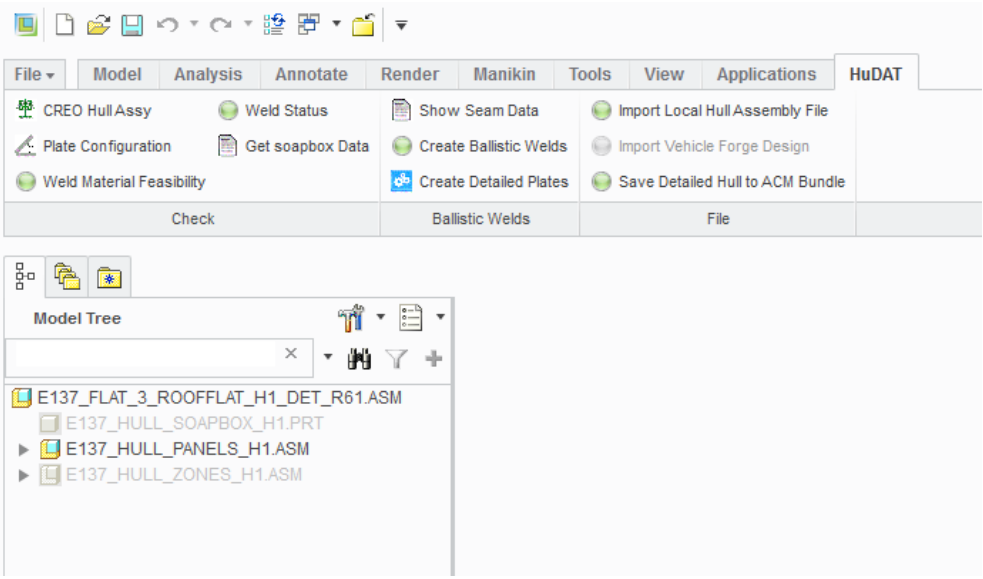


Figure 3: HuDAT toolbar displayed in Creo

2.2 Use

The main window in Creo looks like the picture in Figure 3. In Figure 4 a concept hull component has been loaded and is visible in the Geometry Window.

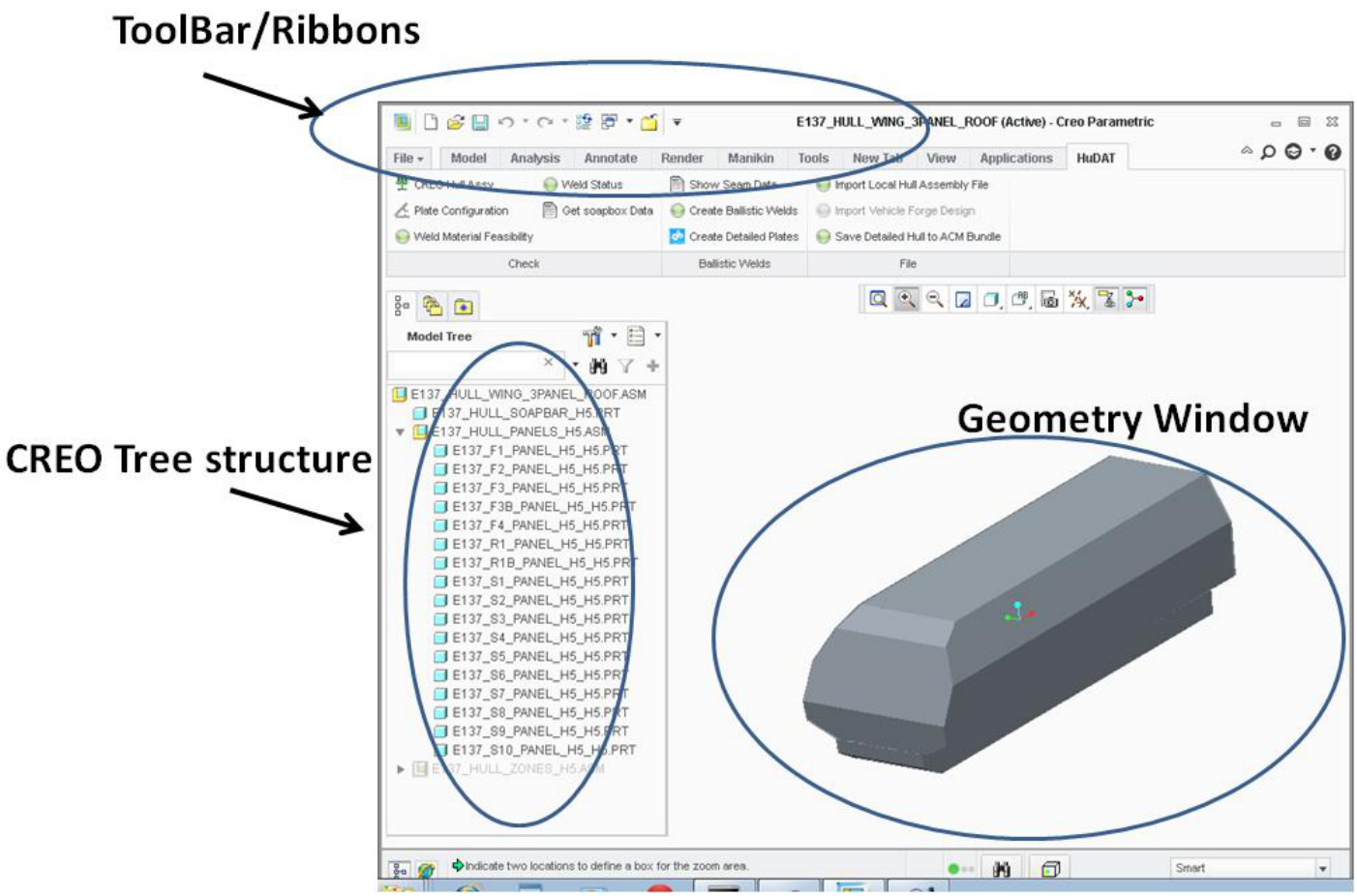


Figure 4: Creo Main Window

The Creo interface is divided into 3 main areas: 1) the Toolbars/Ribbons, 2) Tree Structure, and 3) the Geometry Window. HuDAT is comprised of custom toolbars that contain buttons used to invoke functions that modify the Creo model tree in a structured way and show the results in the geometry window.

2.2.1 Launching Creo/Running HuDAT

After HuDAT has been installed there are three different ways that HuDAT can be loaded. The installer will create a batch (HuDAT.bat) file in its installation directory (as seen in figure 5) that can be used when designing in Creo with HuDAT (double click to run the launcher). This file will start Creo, install the plug-ins, and add the HuDAT toolbars to the Creo interface.

Another method to start HuDAT 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 Hudat Installation directory. ($hudat_installdir\protk.dat). When prompted, select all three applications titled “Common, Hull and Utilities” to start.

The third way that the HuDAT ribbon will be loaded is by opening a session of CREO through META-Link. META-Link looks to see if HuDAT is installed, and if it is, it will load the ribbon.

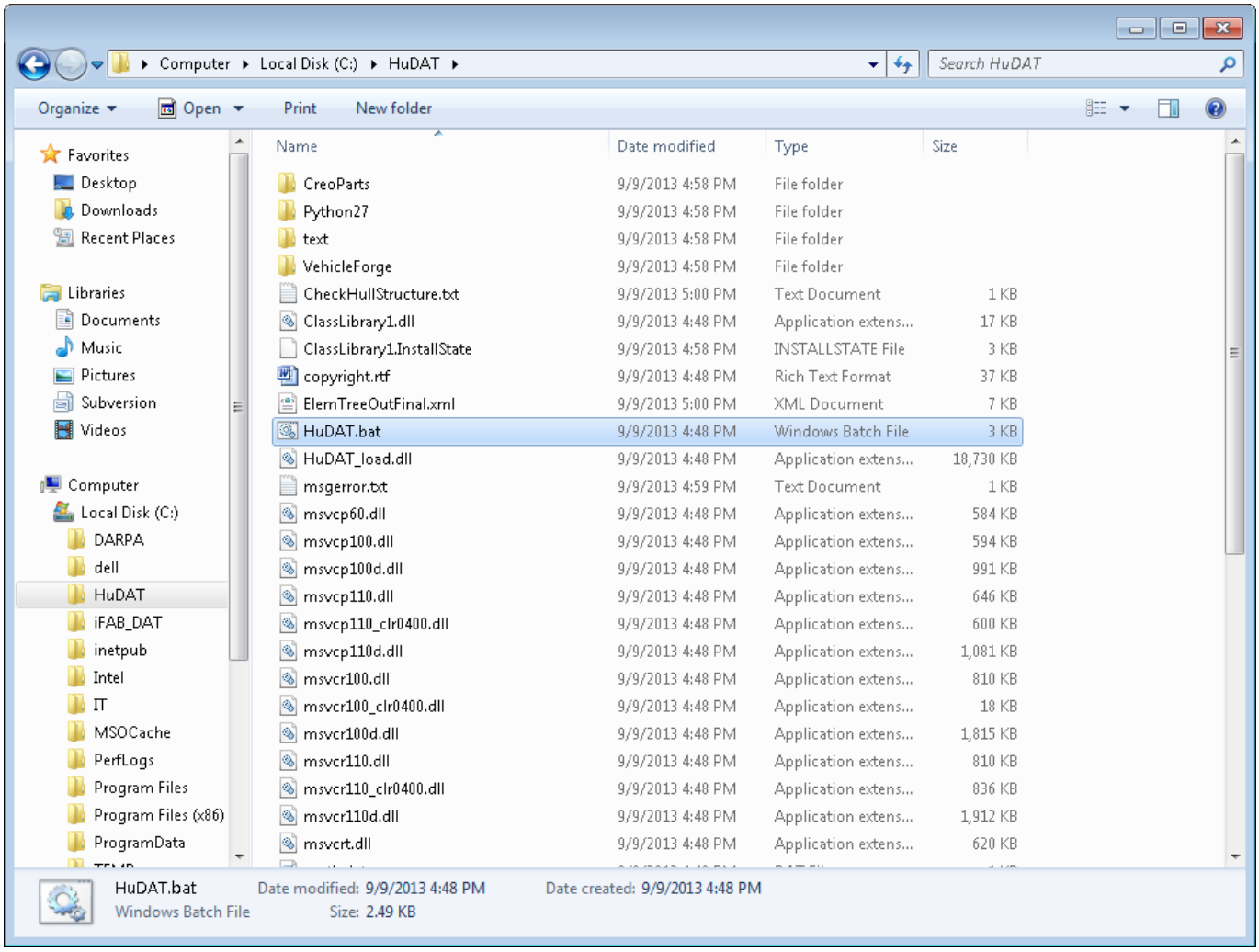


Figure 5: Launching Creo

A ribbon titled “HuDAT” is loaded whenever CREO is in Assembly mode. Clicking on this ribbon will display the functions that the plug-in can perform on the concept hull.

Details about the functions are discussed in sections 2.2.3 and 2.2.4.

2.2.2 Open Hull Component

In CREO, open a seed hull component that has been downloaded from the Vehicle Forge component exchange. (Please see the release notes in section 2.3 on which hull seed models are supported in this release.)

The Vehicle Forge component download will have compressed files which are extracted into a directory structure. The CAD folder contains the STEP and Creo specific files for the component downloaded. The ManufacturingModel folder contains the *.xml schema for the component. The doc folder contains information about the distribution statement and other important information. The images folder contains screenshots of the component. Loading a component is performed through the CAD folder. This folder will contain the geometry for the component. Figure 6 shows the file folders that exist in the directory structure from a Vehicle Forge component.

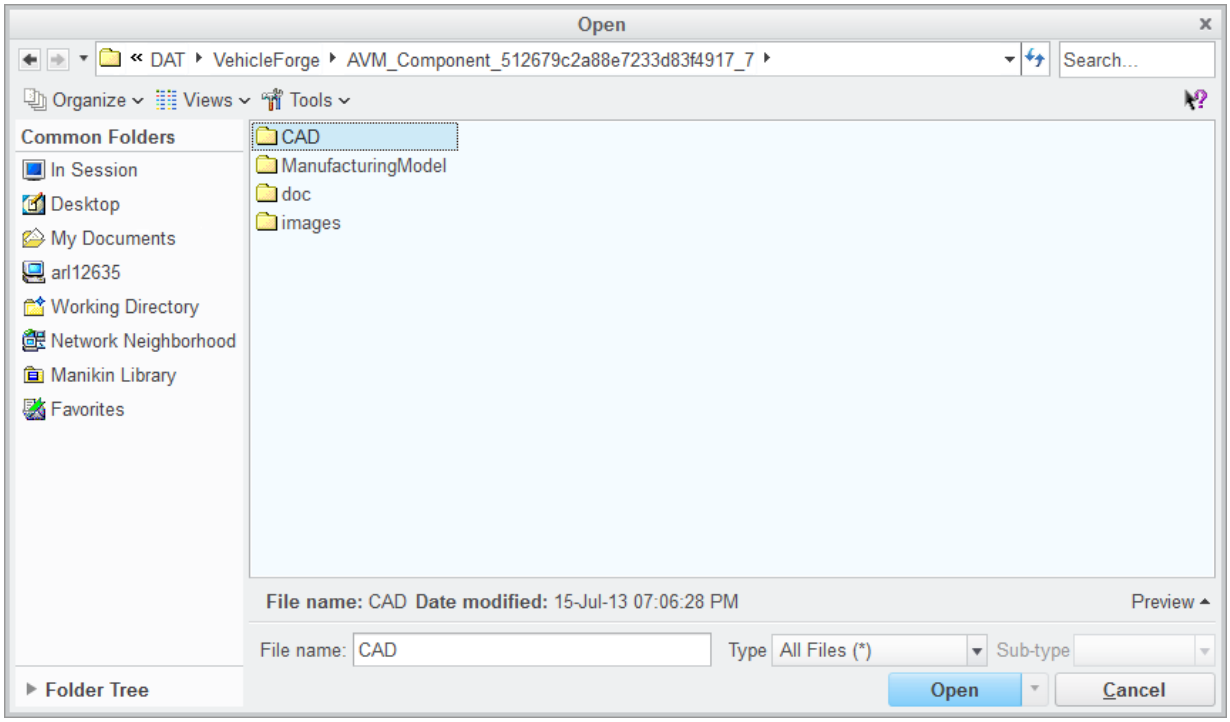


Figure 6: Select CAD Folder File Chooser

Concept hull assemblies can also be loaded into the Creo interface by double clicking or selecting a component and choosing open from the Open file dialog box as shown in Figure 7.

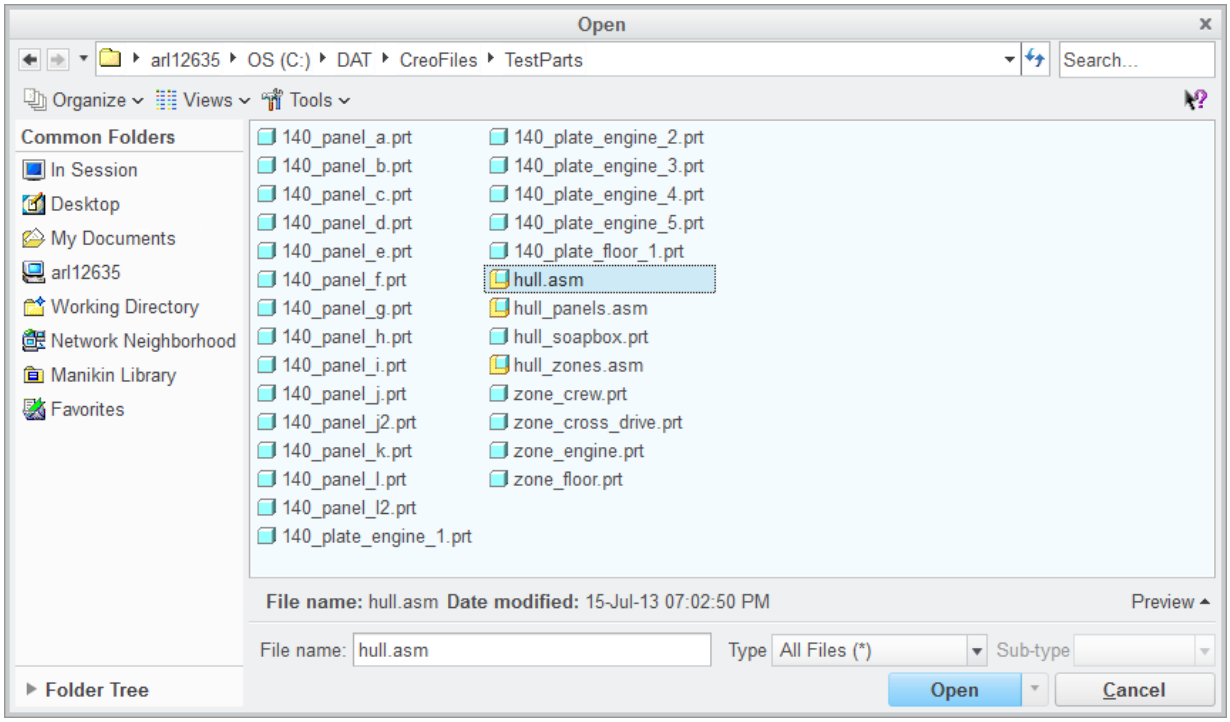


Figure 7: Select hull.asm File

2.2.3 Check CREO Hull assembly

When an assembly is loaded in CREO the HuDAT ribbon bar will be displayed. Figure 8 shows the HuDAT ribbon bar buttons.

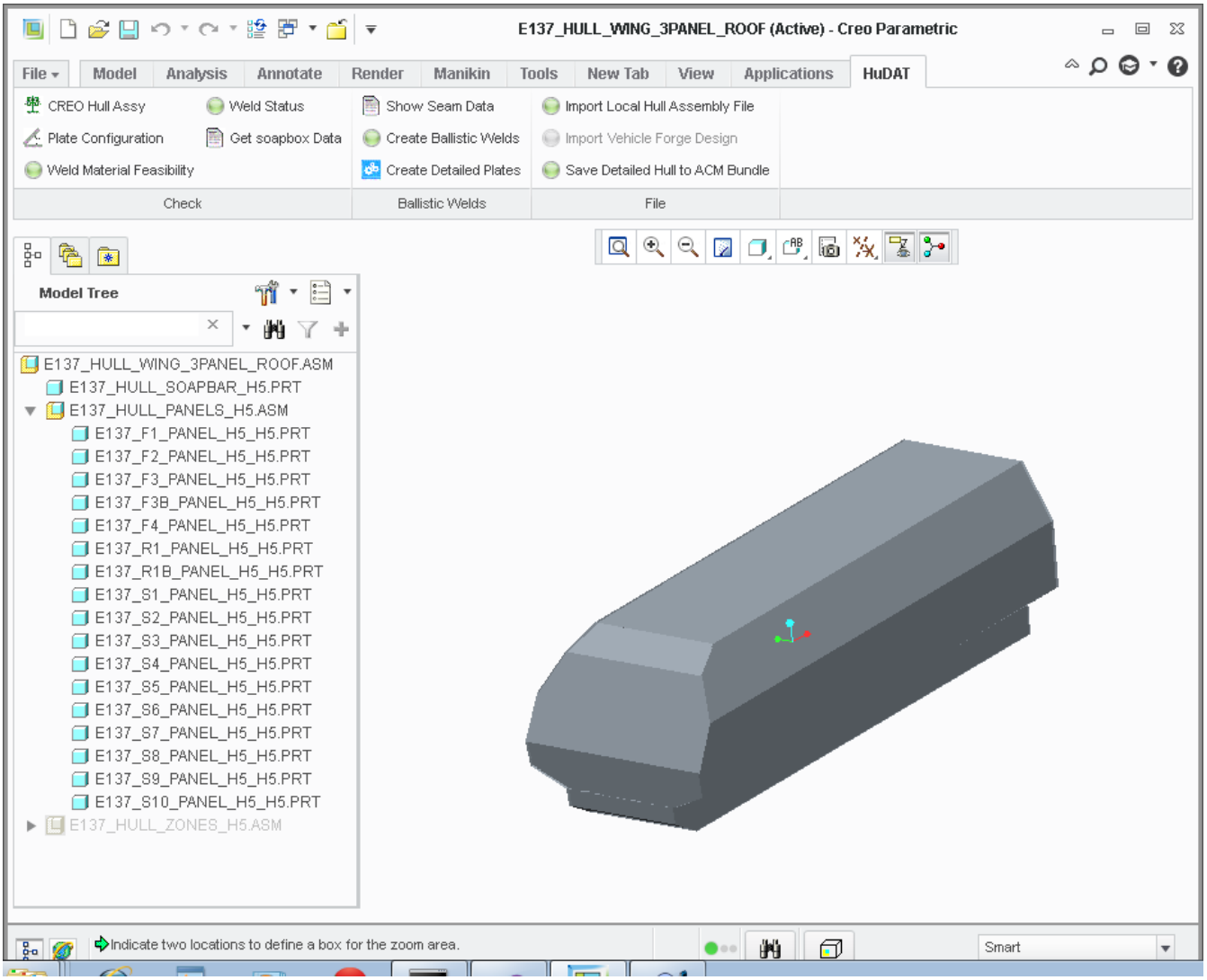


Figure 8: HUDAT Ribbon Bar

In order for HuDAT to operate, a legitimate concept hull model must exist in the current Creo workspace. The concept hull model must also contain a hull soapbox part that contains the hull exterior plates and a hull panel assembly which specifies plate thickness and material. To check that the active model meets the hull assembly composition requirement select the “CREO Hull Assy’ button under the HuDAT ribbon, in the “Check” menu group. The command will check that the current model is an assembly, that the current model is or contains a hull assembly and that the hull.asm assembly contains a part called hull_soapbox and a subassembly called hull_panels. A message box will appear with a successful or unsuccessful flag message. The “CREO Hull assy” button is circled in red in 9. The picture also shows the report that will be display if the hull concept model contains the correct parts and subassemblies.

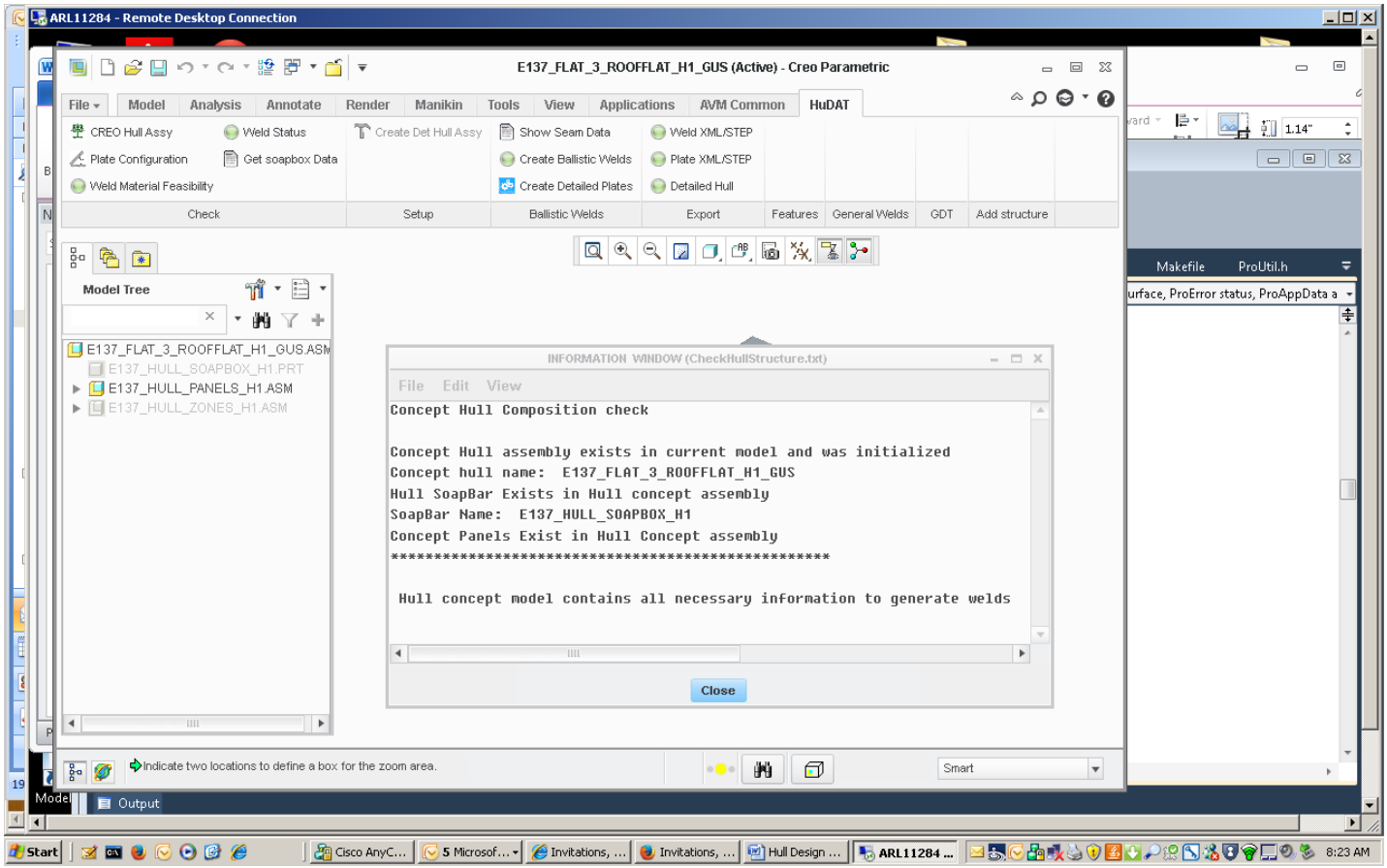


Figure 9: Check Creo Hull Assembly

2.2.4 Checking hull concept information

Before a detailed hull assembly can be created using HuDAT, the concept hull must be analyzed to determine where welds will be placed and how plates will be modified for manufacturing. Two buttons exist in the HUDAT toolbar that will display information that is extracted from the soapbox. The button titled “Get SoapBox Data” in the check group and the button titled “Show Seam Data” in the ballistic weld group. When these buttons are pressed the toolkit interrogates the hull concept to gather all the information needed to create a detailed plate. If the analysis is successful reports will be displayed that show the weld and plate information that has been retrieved. Figure 10 shows an example of the reports that are presented when the “Show Seam Data” button is selected.

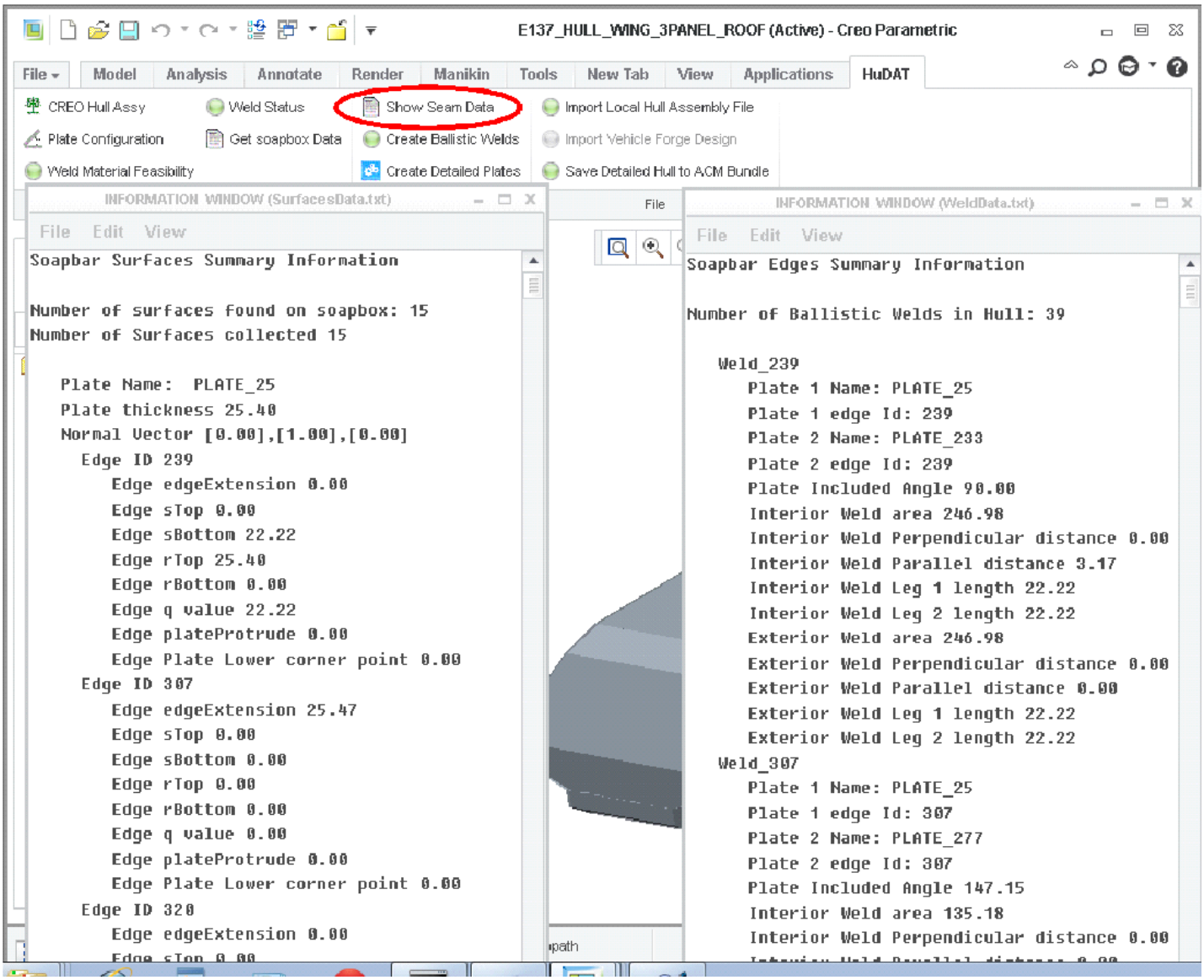


Figure 10: Show Seam Data & Get Soapbox Data

The button titled “Plate configuration” in the check button group reviews the angles between all ballistic plates and assures that they meet iFAB constraints. Currently, the included angle between plates cannot be less than 40 degrees. If any included angle between plates is less than 40 degrees, an error is produced. Figure 11 below shows the message that is displayed if all included angles are within acceptable ranges.

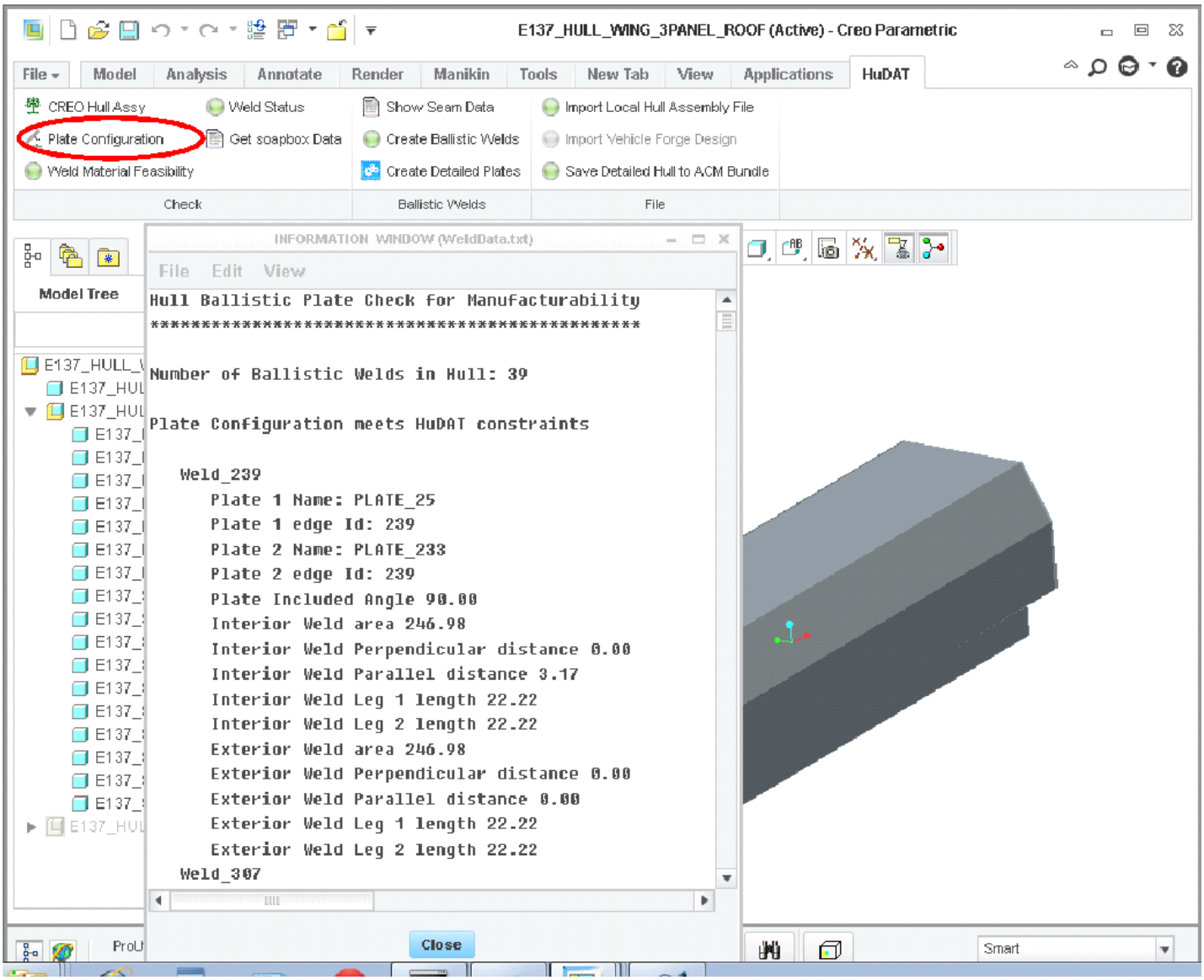


Figure 11: Check Plate Configuration

2.2.5 Creating Detailed Plates

The function “Create Detailed plates” creates extruded plates from the soapbox surfaces. These plates will be extended or trimmed correctly for manufacturing and welding and will contain chamfers as necessary. To created the detailed plates for manufacturing select the button “Create Detailed Plates” in the Ballistic Welds ribbon group. Creo will again perform a test to ensure that the model conforms to the standard tree structure. Once the model has been verified, the geometry of the new detailed plates will be created and added to the existing model tree structure. The HuDAT application creates a Hull Detailed Assembly and places the detailed plates into this assembly. Several Creo regeneration progress windows will be displayed during this operation. Figure 12 shows the message that will be displayed if the HuDAT application successfully creates the detailed plates. In order to see the detailed plates being created in sequence the user may want to hide the concept plates and the soapbox in the Creo assembly before generating detailed plates.

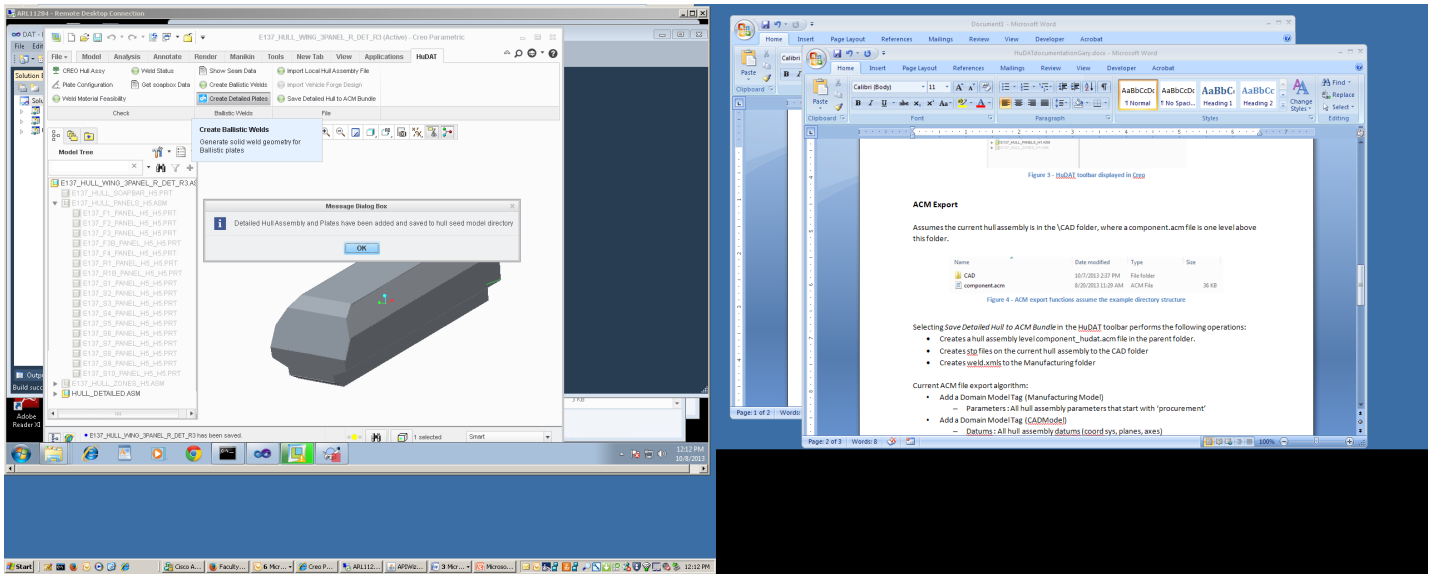


Figure 12: Create Detailed Plates

Figure 13 shows the Hull Detailed assembly structure that will be created by HuDAT after the plates are created. Notice that two sub-assemblies are created under the "HULL_DETAILED" assembly. One sub-assembly contains the detailed plate assembly called "PANELS_DETAILED" which contains the panel geometric models in their final form including cuts, extensions and chamfers. The other subassembly titled "PANELS_AS_CUT" contains a manufacturing staging model that represents the plate geometry as cut from stock and before chamfers are applied.

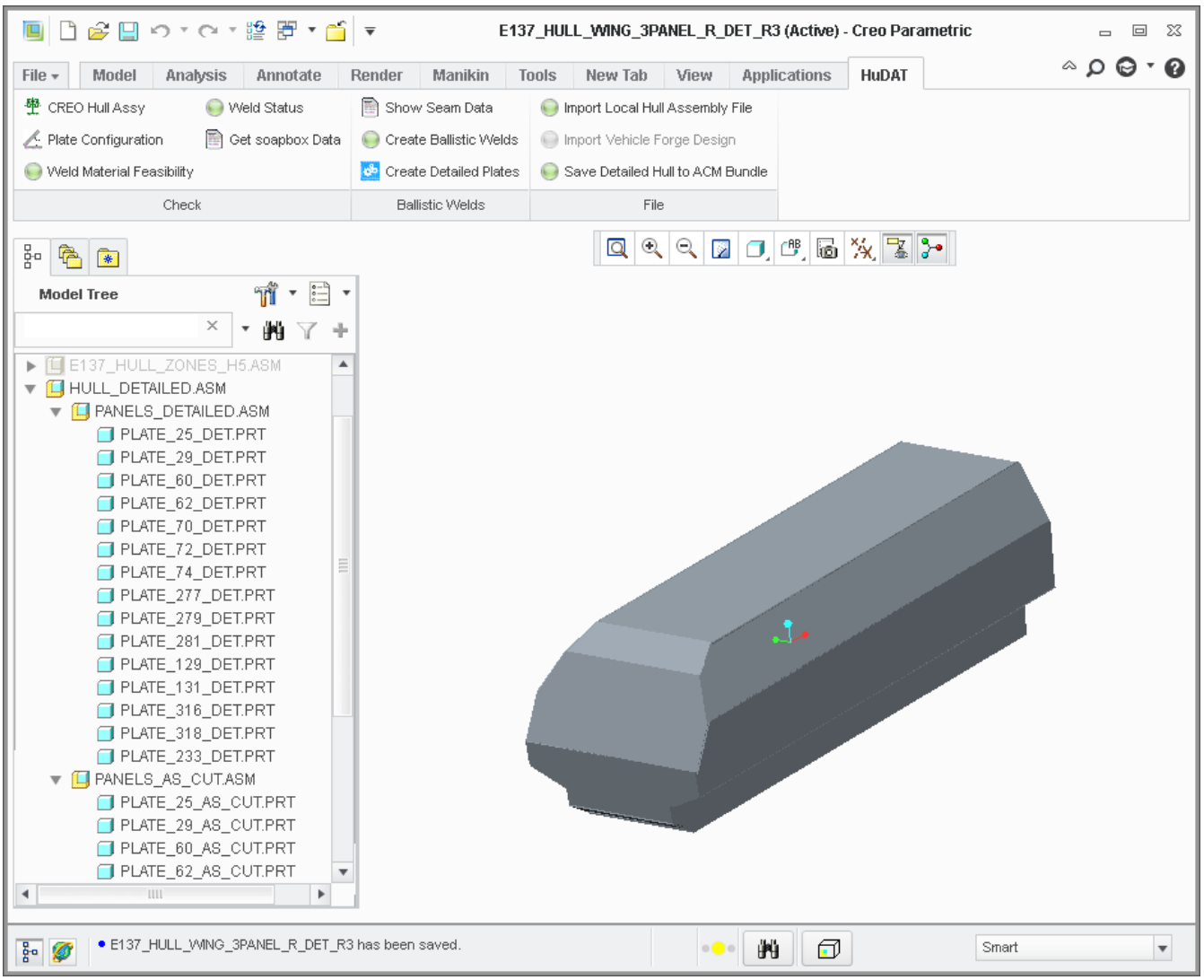


Figure 13: Hull Detailed structure

After the hull detailed assembly is created, the top level assembly is renamed and saved. The tool appends "_DET_RX" to the concept seed model name, where X is a random number. If the concept seed hull model name is too long, characters are removed to append the "_DET_RX.asm" name. If the user already has an assembly with the same name in their hull directory, the save model will fail and an error message will be produced. To view the new plate geometry the user can hide the soapbox and the concept hull plates to view the detailed plates.

The detailed plates are configured to create a valid ballistic weld, which is always a full penetration weld. Figure 14 shows the arrangement between two plates to assure a full penetration weld can be accomplished.

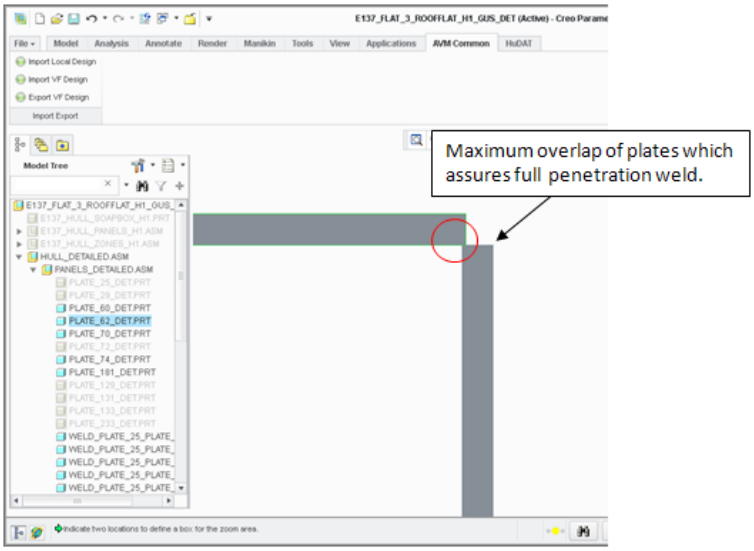


Figure 14: Ballistic Plate Configuration

2.2.6 Creating Ballistic Welds

The button "Create Ballistic Welds" under the "Ballistic Welds" ribbon group creates solid weld geometry between all external hull plates. The welds are created by extruding a solid along the weld seam line with the correct weld section geometry. Each ballistic weld part will contain two solid welds, one interior and one exterior to the hull. To create the solid welds select the "Create Ballistic welds" button. Creo will again perform a test to ensure that the model conforms to the standard tree structure, and it will confirm that detailed plates have already been produced. Once the model has been verified, the weld geometry will be created and added to the existing HULL_DETAILED assembly. Several Creo regeneration progress windows will be displayed during this operation. Figure 15 shows the message that will be displayed if the HuDAT application successfully creates the detailed plates.

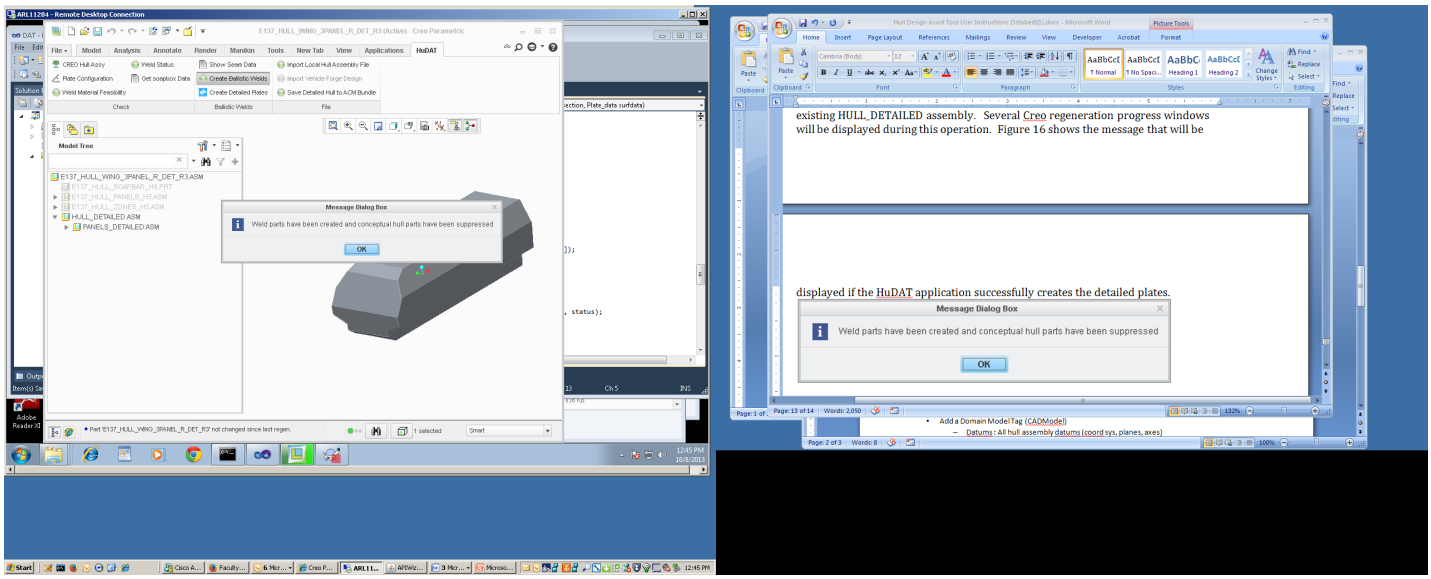
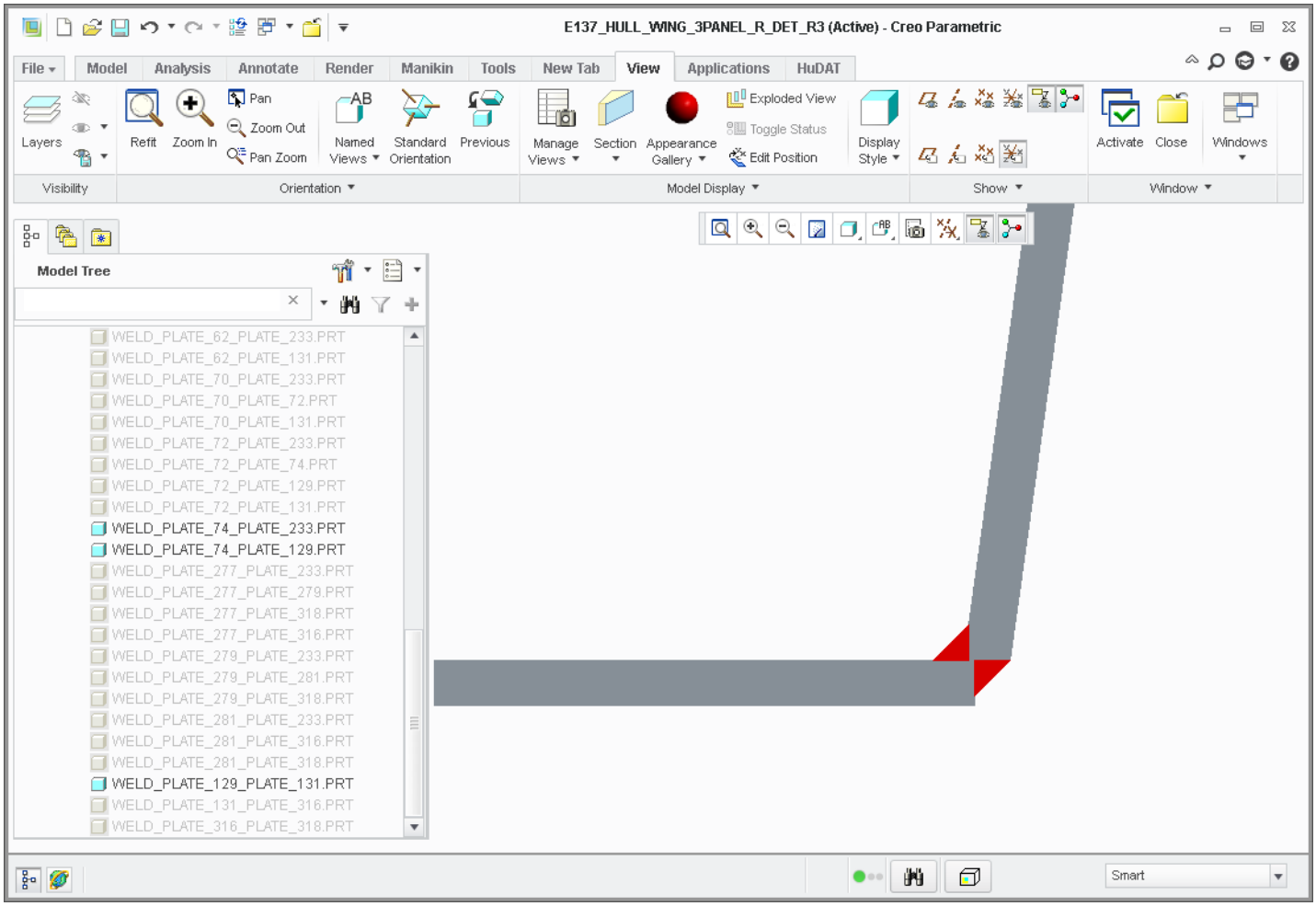


Figure 15: Ballistic Plate Configuration

In order to clearly see the welds it helps to hide concept hull soapbox and concept hull panels and to change the color on the welds. Figure 16 below shows a close view of two of the welds between two plates.


E137_HULL_WING_3PANEL_R_DET_R3 (Active) - Creo Parametric
File
Model
Analysis
Annotate
Render
Manikin
Tools
New Tab
View
Applications
HuDAT
Layers
Refit
Zoom In
Pan
Zoom Out
Pan Zoom
Named Views
Standard Orientation
Previous
Manage Views
Section
Appearance Gallery
Exploded View
Toggle Status
Edit Position
Display Style
Activate
Close
Windows
Visibility
Orientation
Model Display
Show
Window
Model Tree
WELD_PLATE_62_PLATE_233.PRT
WELD_PLATE_62_PLATE_131.PRT
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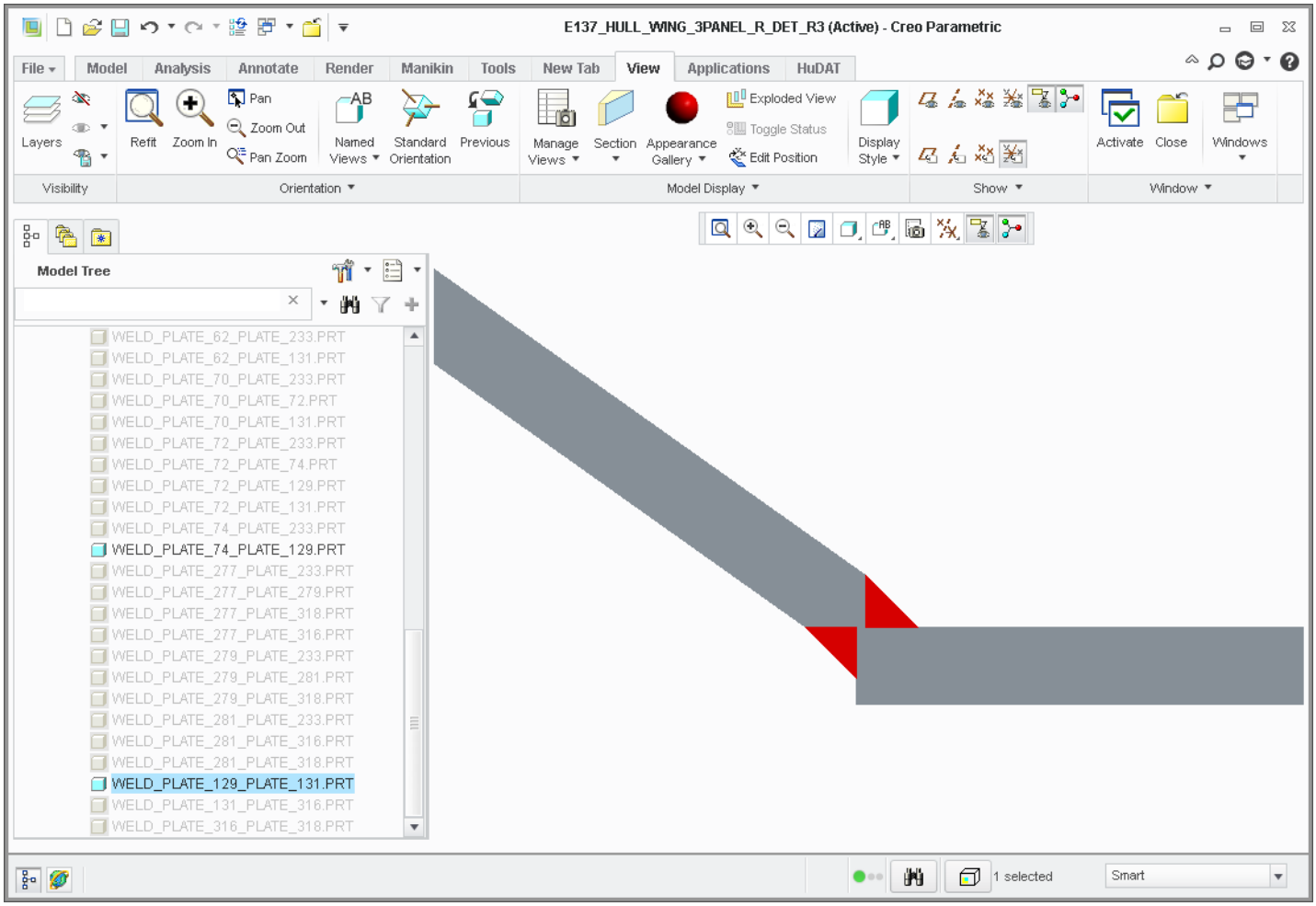

Figure 16: Example of 2 Ballistic Welds

After ballistic welds are created, the top level assembly model is saved and the PLATES_AS_CUT assembly is suppressed, as it is only needed for manufacturing purposes. The tree structure for the HULL_DETAILED.asm should look like figure 17.

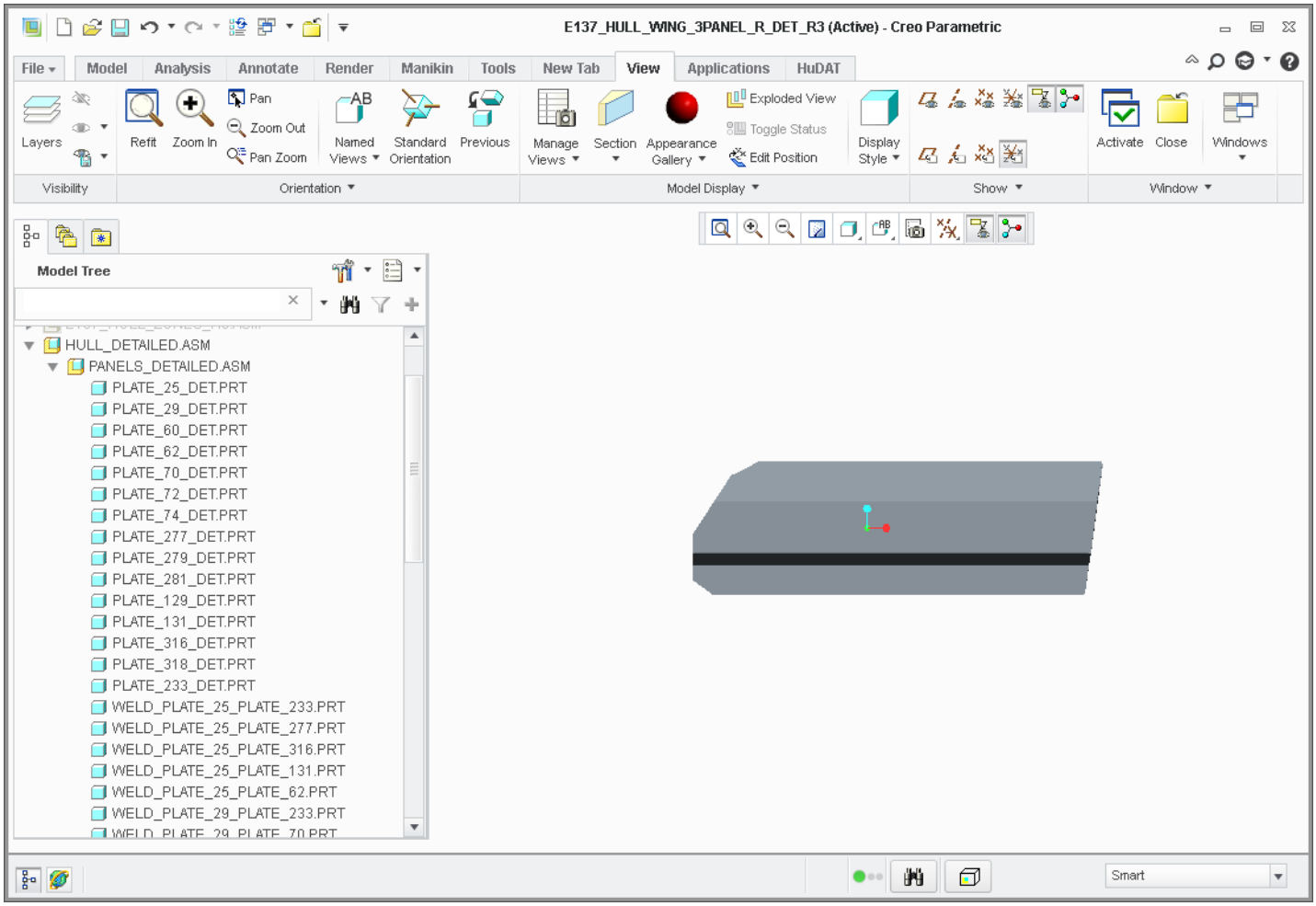

Figure 17: Hull_Detailed Tree structure after welds

2.2.7 Exporting to Vehicle Forge

The button “Save Detailed Hull to ACM Bundle” button in the File group ribbon tab exports the current assembly in ACM format. The save command assumes the current hull assembly is in the \CAD folder, where a component.acm file is one level above this folder. Figure 18 shows the directory structure.

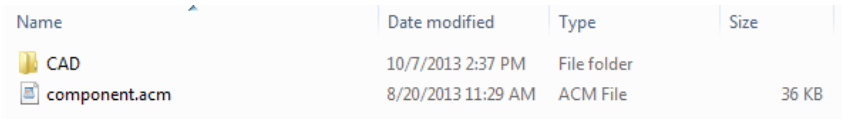

Figure 18 - ACM export functions assume the example directory structure

Selecting “Save Detailed Hull to ACM Bundle” in the HuDAT toolbar performs the following operations:

- Creates a hull assembly level component_hudat.acm file in the parent folder.
- Creates step files on the current hull assembly and saves them to the CAD folder.
- Creates the weld.xmls file and saves it to the Manufacturing folder.

The following message box (Figure 19) will appear if the save operation performed successfully.

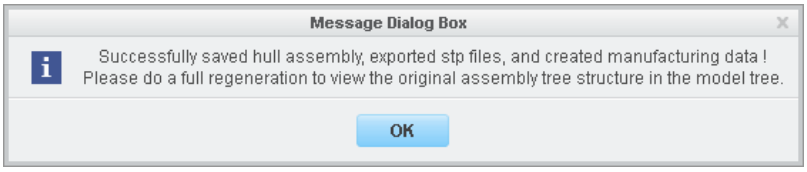

Figure 19 - ACM export functions assume the example directory structure

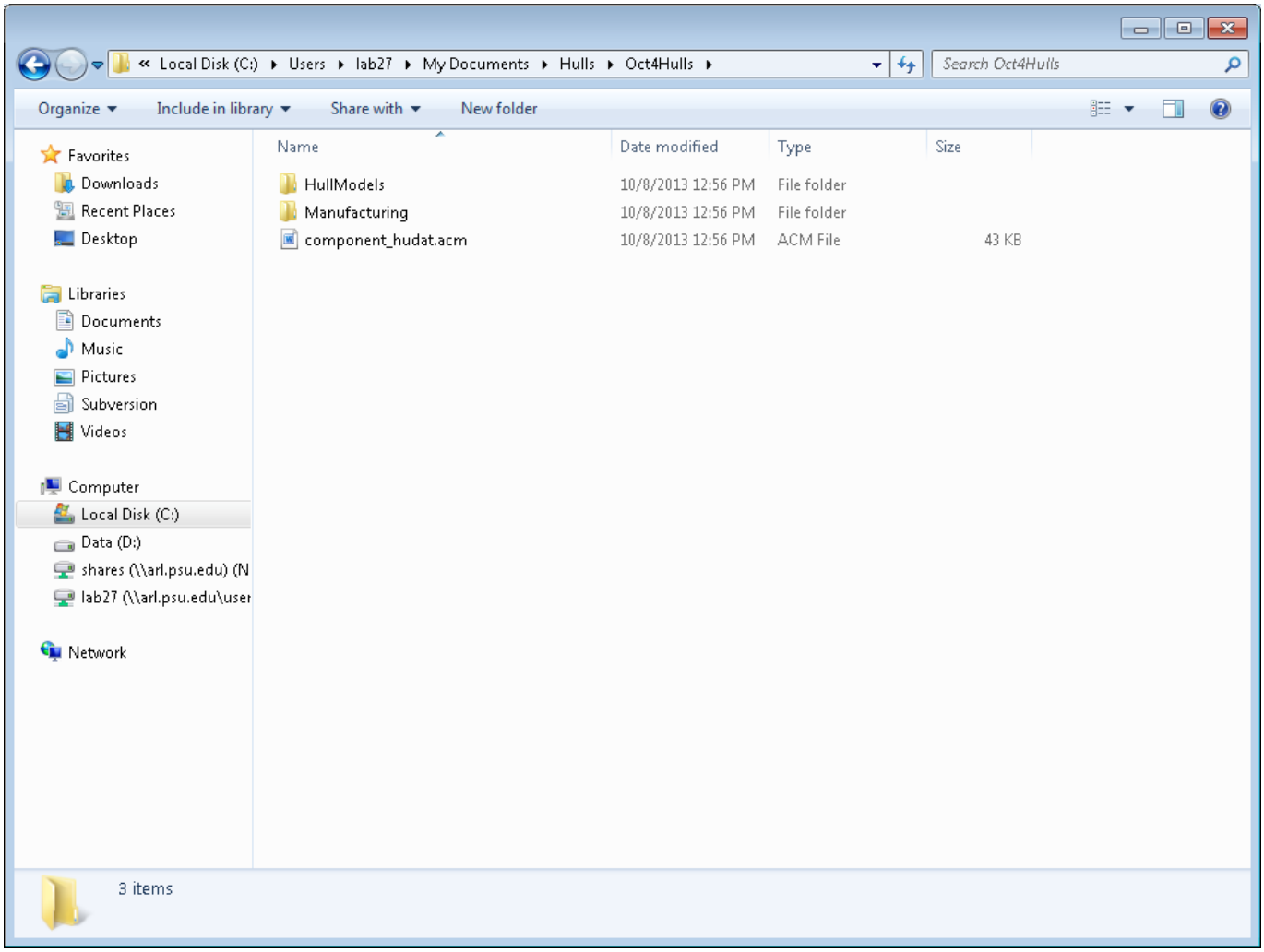

Figure 20 - HuDAT will create a component_hudat.acm file in the parent directory

The weld.xml file contains the xml data for each weld that was created in the detailed hull assembly. The weld name element is derived from the part name without the .PRT suffix and the UUID element is generated programmatically. The rest of the elements in each weld come from named parameters of the weld part in CREO.

2.3 Release Notes

This release of HuDAT has some known limitations. It currently works on 2 of the hull models that exist in the Vehicle Forge component library.

The names of the hull assemblies that should be used for testing are:

- E137_HULL_WING_3PANEL_ROOF.asm
- E137_HULL_FLAT_BOT_3PANEL_ROOF.asm
- E137_FLAT_3_ROOFLAT_h1_Gus.asm
- E137_FLAT_3_ROOFLAT_h1.asm
- E137_HULL_V_BOTTOM_3PANELROOF.asm
- E137_HULL_DOUBLE_V_3_PANEL_roof

In this release several of the solid weld models will not have the correct geometry for a ballistic weld. This will be fixed in the next HuDAT release.

2.4 Future Tool Capabilities

Future Tool capabilities and enhancements include the following:

- Adding new hull plates, sheets, or structure from approved database.
- Incorporating aluminum ballistic joint designs.
- Incorporating alternate ballistic joint designs for both steel and aluminum.
- Developing a user interface so that the joint design choices can be made by the user.
- Adding features to detailed panels.
- Adding GD&T.
- Exporting more information.